Supply Chain Optimization in the Oil Industry:
A Case Study of MOL Hungarian Oil and Gas PLC
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Master’s Thesis in International Logistics and Supply Chain Management

Title: Supply Chain Optimization in the Oil Industry: A Case Study of MOL Hungarian Oil and Gas PLC

Authors: Daniel Szucs & Kedir Hassen

Tutor: Beverley Waugh

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Abstract

Problem discussion: The significance of the oil industry’s impact on the global economy is obvious. Oil supply chain management has to solve a lot of challenges caused by the nature of the supply chain in the oil industry such as complexity, inflexible characteristics, long lead time, limited transportation forms at the different stages in the supply chain, rigid take or pay procurement and limited primary distribution capacity. Other challenges are caused by unforeseen events such as political or economic changes which have an impact on the price of the oil. This thesis seeks to add value by signifying and indicating optimization as a way to address uncertainties and points out a way to utilize resources efficiently in order to gain further development and cost savings in the long term. Finding options for optimization of the oil supply chain is vital because any cost saving means vast amounts of money for the oil companies therefore optimization is at the centre of attention in the oil supply chain management.

Purpose: The purpose of this thesis is to investigate supply chain management in the oil industry and find options for optimizing the supply chain in the oil industry by reviewing and analyzing previously written literature on the chosen topic for the research.

Method: A single case study was applied in this thesis. The company chosen for the case study is called MOL Hungarian oil and gas PLC and is located in Hungary. To carry out the research, a qualitative research approach was implemented. Primary data was collected through semi structured interviews via telephone and the internet with the company’s staff. In addition to this, secondary data from different sources such as articles and books were used to construct or build the theoretical frame of reference for the thesis.

Delimitation: The scope of the thesis is limited to the supply chain management in the oil industry and its optimization. Further narrowing the scope, this thesis gives more attention to the downstream section of the supply chain in the oil industry.
Conclusion: Optimization is recognised as main tool for the oil companies to achieve competitive advantage. Analysing MOL Group gives a factual example how optimization works in an oil company and contributes to manage its supply chain efficiently and handle the many uncertainties surrounding the oil industry. It is demonstrated what factors play key role in optimization and how they interact with each other. MOL Group’s solution for optimization builds around a serious planning process, IT solution, marketing and refinery operation triggering and working in synergy with many other factors which cannot be excluded from the optimization process. Due to the excellence of supply chain optimization, MOL Group has a very strong presence and leading position in the East Central European region generating increasing profit margin year by year in last two decades.
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1 Introduction

The introduction contains a brief discussion about the background of the topic, the problem statement, purpose of the thesis, research questions and delimitation of the research. Finally it outlines briefly the content of the thesis.

1.1 Background Information

There is no doubt of the significant effect of the oil industry in today's world economy and in our daily lives (Mast, 2005). Due to globalization, the role of world trade and transportation has increased. The oil is the number one energy source for many industries, especially for those which are based on motor driven machines for instance transportation companies, modern production and agriculture since oil meets their basic requirements such as portability, energy density, safety and ease of handling whereas other sources do not (Mast, 2005). Accordingly, along with the increase of globalization, the world trend for oil consumption shows a constant increasing tendency (Tierney, 2004; Nation Master, 2009 - Appendix 1; CIA, 2010 - Appendix 2; Hilmola, 2011).

The US is reckoned to be the biggest oil consumer and China has become the second one (Hussain, Assavapokee & Khumawala, 2006; Nation Master, 2009 - Appendix 1; CIA, 2010 - Appendix 2). Moreover, Hölschler, Bachan and Stimpson (2008) state that China’s robust economy and other fast developing countries’ growth will continue the increasing trend in oil consumption in the near future. For the engine of these growth rates a stable energy supply is indispensable. But there are other facts too that strengthen the petroleum corporations’ further significance. For instance Hilmola (2011) asserts that China is not just the second largest consumer of oil in the world but its oil reserves are decreasing thus China is forced to import more oil to keep moving its economic growth. The European Union (EU) is in a similar situation, it is highly dependent on imported oil too, in addition, EU depends on Russian import oil which sometimes can cause supply availability problems since the oil pipelines cross many countries until it arrives at the receiving country (Hölschler, Bachan & Stimpson, 2008; Nation Master, 2009 - Appendix 1; CIA, 2010 - Appendix 2; Hilmola, 2011).

The biggest producers and exporters in the industry are from the Middle East territory, especially Saudi Arabia and Russia (CIA, 2010 - Appendix 3). Due to the economic importance of the oil, oil companies are among the most profitable companies. Other alternative energy sources such as renewable wind, water and solar energy are still not equal competitors of oil. Although oil reserves are limited, they will be available and exploitable for several decades, therefore, their importance can remain and will provide the base for the global economy in the near future (Hussain et al., 2006). The organization of the Petroleum Exporting Countries (OPEC), which was formed by the Middle East countries, emphasises the importance of this mutual interest between oil importer and exporter countries. OPEC's mission statement says that the organisation dedicates itself to ensure the stabilization of the oil market in order to secure an efficient, economic and regular
supply of petroleum to the customers, a steady income to producers and a fair
return on capital for those investing in the petroleum industry (OPEC, 2012).

The high level of demand growth, the eased trade barriers and the technological
growth in the oil industry has developed a strong competition among the oil
corporations (Jenkins & Wright, 1998; Anderson, 2003; Himola, 2011). Therefore,
ol companies, just like companies in every industry, endeavour to achieve
competitive advantage over their competitors in order to be successful in the long
term. This competitive advantage derives from the capabilities of the businesses
which make them able to provide a superior product or service among the
competitors in a certain market (Johnson, Scholes & Whittington, 2009). In the last
few decades good supply chain management has been recognised as a vital
capability of the businesses to achieve competitive advantages. Christopher (2011)
argues that the company with better logistics and supply chain management can
improve and sustain their competitive advantage over the rival companies.
Competitive advantages of the companies are very closely related either to their
cost or their value advantages, or in the most optimal case both exist at the same
time. Therefore, supply chain management has the ultimate goal to satisfy the
customers preferably on the most cost effective level through the supplier-buyer
integration and cooperation (Christopher, 2011).

1.2 Problem Statement
The oil industry faces many problems setting several constraints and challenges
for the industry. Resulting from the above mentioned, demand growth, eased trade
barriers and technological growth built a strong competition among the petroleum
corporations (Jenkins & Wright, 1998; Anderson, 2003; Himola, 2011). Although
the whole business world, especially the private sector is characterized by a high
level of competition, it has a greater significance in the oil industry because of the
enormous amount of money involved in (Anderson, 2003; Gainsborough, 2006).
For illustration, out of around US$ 1.5 trillion oil business globally, Exxon Mobile
alone made US$ 41 billion annual profit in 2011 (Gainsborough, 2006; Taxpayer,
2011). The competition is complicated by very volatile circumstances surrounding
the whole oil industry. Unforeseen events, for instance political changes such as
the recent Libyan situation or governmental decisions have an impact on the price
of the oil. Fluctuated oil prices affect the accurate demand forecasting which could
lead to distortion in the supply (Anderson, 2003).

The oil supply chain is also known to be a very complex chain compared to other
industries’ (Jenkins & Wright, 1998; Hussain, Assavapokee & Khumawala, 2006). It
is due to several reasons. The whole oil supply chain is divided into up- and
downstream segments based on activities before and after the refining stage.
However, the distance from the oil exploitation point to the final consumers could
often be thousands and thousands of kilometers (km) which is the main reason for
the oil supply chain having longer lead time than in other industries. In addition,
crude oil has to go through a complex, capital intensive refinery process as well
(Gainsborough, 2006; Ribas, Leiras & Hamacher, 2011). 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 (Hussain et al., 2006; Ribas, Leiras & Hamacher, 2011).

Flexibility is a major source of the competitive advantage in this volatile and complex industry (Hussain et al., 2006). However, the oil supply chain bears several inflexible characteristics such as long lead time or rigid take or pay procurement which has to be set around 9 months before use and the limited primary distribution capacity. Although regarding the whole supply chain, many modes of transportation are involved, at the different stages in the supply chain, transportation is limited due to for instance geographical location or company's resource capacity which increase the inflexibility too. Due to the competition, complexity and inflexibility, oil companies strive for vertical integration which gives a potential advantage by having a greater control over the chain (Gainsborough, 2006). The vertically integrated oil supply chain is coupled with a push system since the cost of shutting down production is very high therefore production drives sales efforts (Hall, 2002). Following Fisher's (1997) supply chain strategy logic, a push supply chain focuses on low cost production. Hall (2002) and Gainsborough (2006) also emphasise that cost efficiency stands as a primary goal in order to maximize profit.

It can be seen that oil supply chain management has an important role to play not only to gain competitive advantage but it helps to solve many constraints and challenges caused by the many variables in this business. This thesis seeks to add value by demonstrating optimization as a way to tackle uncertainties and to use the resources efficiently in order to achieve further improvement and cost savings in the long run (Gene & McDougall, 1998; Anderson, 2003; Hussain et al., 2006). Finding options for optimization of the oil supply chain is important because any cost saving means vast amounts of money for the oil companies, therefore optimization is at the centre of attention in the oil supply chain management (Gainsborough, 2006; MOL, 2012).

Hussain et al. (2006) emphasize that despite the economic importance and the complexity of supply chain management in the oil industry, oil supply chain optimization is still in its infancy (Hussain et al., 2006). Executing this task is also challenging because many sources deal with optimization only from software development side. Although there are sources about analysing supply chain management generally in the oil industry, less literature and research articles can be found about the topic of optimization theory and techniques. Therefore, analysing this area of supply chain management could contribute to further research. Moreover, providing a logical framework for optimization also could be useful for any oil company, for their current and potential future employees too. Although the thesis deals with supply chain optimization regarding the oil industry, in a wider sense, many factors of optimization could be adapted by other business areas as well.
1.3 Purpose

In view of the problem statement, the main purpose of the thesis is to lay down the options of supply chain optimization generally in the oil industry by analysing previous research papers and literatures in order to find and outline common characteristics and current solutions of optimization. Afterwards, the Hungarian Oil and Gas PLC (MOL) is at the centre of the analysis.

The reason for the choice of MOL is that it is the number one company in Hungary in the sense of profitability and number of employees (Kitekinto, 2011). It is the second biggest in the Central European Region and also ranked in the top 500 companies in the world (Kitekinto, 2011; CNN Money, 2011). Regarding the topic of the thesis MOL is reckoned to be one of the most efficient oil companies in Europe in terms of net cash refinery margin and net production income per barrel (MOL, 2012 – Appendix 4 and 5). This result is mainly due to the development of MOL’s supply chain management philosophy implemented and continuously improved after the privatisation era in the 1990s (MOL, 2012). Supply chain management pays great attention to the optimization due to the unique position of MOL’s refineries. Their closeness to each other also gives a high potential for optimization (Sz. Szabó, personal communication, 2012-04-02).

MOL has been constantly focusing on increasing the significance of its presence in Central Europe. It firmed and increased its market position in the last two decades. To achieve its goal, MOL has paid more and more attention to the improvement of its supply chain, thus has invested a lot in optimization (MOL, 2012). The constant strengthening and expanding of MOL’s market position in Central Europe, the yearly increasing profit, as well as its vertically integrated and widely expanded supply network demonstrate what complex tasks MOL manages successfully. Comparing the theoretical framework and the analysis of the MOL case study will provide the elements and method of supply chain optimization and will show how the theory is implemented in a real life example.

1.4 Research Question

Two main research questions are addressed by the thesis:

1. What options does the oil industry have for optimizing the supply chain under high levels of uncertainty?

2. What are MOL’s solutions of optimizing its supply chain and how does MOL benefit from it?

1.5 Delimitation

The petroleum industry consist of oil, gas and petrochemistry divisions. Due to the time limit as well as the greater significance of the oil, the thesis focuses on the supply chain in the oil industry and identifies the main options for optimizing and improving it towards a more cost efficient and customer focused supply chain. It
presents a case study about the MOL Hungarian Oil and Gas PLC in order to identify those optimizing techniques which MOL implemented in its supply chain management.

The thesis pays greater attention to the downstream segment of the chain because it has a more flexible nature than the upstream segment, therefore it bears more potential for optimization. However, it does not mean that the upstream is entirely excluded from the thesis as its link to the downstream is tight. The given time limit delimits the work to analyzing only one company. The choice of MOL is due to the success of MOL in the Central Europe region and also an opportunity to gain valuable information from MOL. Further research on studying other successful companies in the oil industry and analyzing their similar and different supply chain optimization techniques would improve this research topic in future. The regular reevaluation of the results is also suggested due to the dynamic nature of supply chain management and the oil industry.

1.6 Outline

The theoretical framework provides all the background information which will be necessary for the empirical study. It starts with a broad view of supply chain management that presents its relationship to gaining competitive advantage and illustrates why it is important for the current business world. After the analysis is narrowed down particularly to the oil industry, it examines the main characteristics of the oil supply chain as well as highlights the differences from other industries' supply chain management. Clarifying the differences is very important in this matter because it shows the uniqueness of the oil industry. Furthermore, this uniqueness serves as a base for the optimization of supply chain management in the field of the oil industry which is the main part of the theoretical framework. The concept of optimization also needs to be defined in order to give a direction for identifying core optimization areas within supply chain management. At the end of the theoretical framework the options of optimization will be identified for application in supply chain management in the oil industry. The determination of the optimization techniques will introduce the key areas that will guide the researchers to conduct the empirical study properly.

The methodology of carrying the empirical study out is based on qualitative research. The primary and secondary data collection include semi structured interviews regarding MOL and collecting information about supply chain optimization in the oil industry from literature and research articles. Theories and results found through secondary data are applied to the interviews, then in the analysis, they are examined and compared. Conclusion is made based on the analysis and provides answers for the research questions.
2 Literature Review

In this chapter the related theoretical concepts and research are reviewed. This determines key areas for optimization of the oil downstream supply chain which forms a basis for the further empirical study and for linking the theory to the practice.

2.1 Supply Chain Management Defined

Different academics have defined supply chain management in different ways and from different perspectives. Definitions given to supply chain management differ across authors and are categorized into three main classifications: management philosophy, implementation of a management philosophy, and a set of management processes (Mentzer, DeWitt, Keebler, Min, Nix, Smith & Zacharia, 2001). ‘The alternative definitions and the categories they represent suggest that the term supply chain management presents a source of confusion for those involved in researching the phenomena, as well as those attempting to establish a supply chain approach to management’ (Mentzer et al., 2001 p.5. ). Other individuals and groups define supply chain management in some other ways. Langley Coyle, Gibson, Novack and Bardi (2009) define supply chain management as an art and science that involves the integration and flows of the three components in the supply chain pipeline that is: products, information and finance starting from the suppliers’ supplier and ending with the ultimate consumer or the customers’ customer.

Assey (2012) mentions that supply chain management is focused on the management and examining of the network within the supply chain for gaining a better cost saving and providing a better customer service. Ganeshan and Harrison (1995) define supply chain management as a network or chain of facilities and distribution options that execute the process of the obtainment of products, the transformation of these products into intermediate and finished goods, and the distribution of these finished goods to customers.

2.2 Supply Chain Management for Competitive Advantage

There is no doubt that contemporary businesses endeavour to achieve competitive advantage over their competitors in order to be successful (Witt & Meyer, 2005). The competitive advantage derives from the capabilities of the businesses which make them able to provide a superior product or service among their competitors in a certain market. (Johnson, Scholes & Whittington, 2009). This idea arises from the resource-based view which asserts that the resources such as physical assets, financial resources, human capital and intangible resources result in distinction among businesses (Buller & McEvoy, 1999). It also stresses the importance of sustainability. This is supported by Johnson et al. (2009), they state that besides gaining competitive advantage, the businesses have to exploit such capabilities that contribute to sustain the competitive advantages. These capabilities can play a
key role in the strategy of the businesses in order to keep the business successful on a long-term basis (Johnson et al., 2009).

In the last few decades good logistics and supply chain management have been recognised as a vital capability of businesses to achieve competitive advantages. Better logistics and supply chain management can improve and sustain competitive advantage over rival businesses (Christopher, 2011). Christopher (2011) bases this idea on the model Three Cs. This model is about the linkage of the Company, its Customers and its Competitors. It serves as an alternative foundation for success in the business world. This approach to the competitive advantage corresponds with the suggestion of Johnson et al. (2009), namely that the source of competitive advantage depends on the ability of the business, and how it distinguishes itself in the eyes of the customer and from the competitors. Beyond that it emphasises cost efficiency in the interest of profitability. In short, competitive advantages of businesses are very closely related either to their cost or their value advantages, or in the most optimal case both exist at the same time (Christopher, 2011).

The traditional route to achieve cost advantage leads through the economies of scale based on greater sales volume. However, it does not couple with greater profitability all the time. Christopher (2011) argues that better logistics and supply chain management can result in further cost reduction contributing to the cost advantage because in many industries logistics cost represent a high proportion of the total cost. For instance good capacity utilisation, effective inventory management and closer integration with suppliers are critical factors within the strategic plan of logistics management to achieve cost leadership in the market place. In respect to the value advantage, product differentiation and service can play a key role as means of adding value. Superior customer service has been received greater attention than ever before. Reliability and ability for quick responsiveness can also have a great impact on achieving value advantage (Christopher, 2011). Johnson, Wood, Wardlow and Murphey (1998) state that logistics and supply chain management do have the potential to gain and sustain competitive advantages.

Supply chain management ultimately aims to satisfy the customers preferably on the most cost effective level through supplier-buyer integration and cooperation (Christopher, 1997, Christopher, 2011). Enarsson (2006) asserts also that 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. Christopher (2011) argues that since the customers are increasingly demanding and they have to be taken more and more into account.

2.3 The Oil Industry

Crude oil and natural gas are the raw materials of the petroleum industry. Hussain et al. (2006) describe the production process briefly. The production of crude oil can be found either deep underground or in offshore areas. These are used for the
production of petrochemicals and oil derivatives. After crude oil is accessed, it goes through a distillation process and different fractions of it are produced (Hussain et al., 2006). Fuel gas, liquefied petroleum gas, kerosene and naphtha are examples of the main fractions of the crude oil which are transferred to the refineries as a feedstock. That is followed by the cracking process and new products can be extracted for the petrochemical industry such as olefins and aromatics. Later, out of for instance ethylene, propylene, butadiene, benzene, toluene and xylenes, petrochemical plants can produce more specified products such as plastics, soaps, detergents and healthcare products, synthetic fibers, furniture, rubbers and paints (Hussain et al., 2006).

Hilmola (2011) mentions that the recent decades’ 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 and gas has become a necessity for the national economies and shows a growing demand tendency (Hilmola, 2011; Tierney, 2004; Appendix 1; Appendix 2). With globalisation the trade barriers have also been eased for smoother trade and technology development has clearly intensified (Jenkins & Wright, 1998). Hall (2002) notes that faster delivery, reliability and lower cost have also appeared as a need from the customers’ point of view. He also stresses that all these factors create a strong competition among the oil industry players and to be in the ‘game’ supply chain management plays an indispensable role. In a competitive market the companies aim to be more effective, more efficient and more profitable than their competitors. Hussain et al. (2006) supports the importance of supply chain management within the industry as the oil companies of today believe that the competition occurs on their supply chain level rather than within individual companies.

The oil market is also exceedingly volatile because of various unpredictable factors. One of the main factors, as Anderson (2003) explains, 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. Ribas et al. (2011) add that 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 (Ribas et al., 2011).

### 2.4 The Oil Supply Chain and Its Characteristics

There are 3 core characteristics have been identified based on the analyzed researches and literatures. Complexity and inflexibility are two elements which bear the most uncertainties, therefore many constrains and challenges can be derived by them. Due to the many variables and the inflexible nature of the oil supply chain are the main reason that oil companies are integrated vertically in order to have a greater control on all over the chain. This section examizes these attributes in more detail.
2.4.1 Complex Supply Chain

Hussain et al. (2006) describes how the whole supply chain in this industry as very complex compared to other industries. The crude oil has to make a long journey from the point of production to the refineries. Long distance results in a long lead time of several weeks and in numerous players in the supply chain. The production is concentrated in certain areas but the product itself is demanded all over the world. The refinery process is a complex and capital-intensive part of the chain. The refined products are distributed either by road, water, rail or pipeline (Hussain et al., 2006).

Gainsborough (2006) states that the oil supply chain is fundamentally based on a traditional model and the different stages in the chain also illustrate it. The oil companies have their classic way to serve the customers with products being 'manufactured', marketed, sold and distributed. The main goals are the same like in other industries, deliver the right product to the users in the right time and at the right price. The oil supply chain essentially can be divided into two closely linked major segments: upstream and downstream supply chain. The supply chain as a whole consists of 6 main stages where the middle refining stage separates the up- and downstream parts of the chain, although procurement as a vital function has to happen before refinery stage in order to provide the inputs for it (Stabell, 2001; Hussain et al., 2006; Jasuja, Sowmya, Chaudhary, Kanade & Panda, 2009). Figure 2.1 illustrates the before mentioned and gives a schematic view about the typical oil supply chain.

![Figure 2.1 Typical Oil Supply Chain (Ribas et al., 2011)](image-url)
**Upstream**

Upstream basically starts with the acquisition of crude oil and with the related operation such as exploration and production. Afterward logistics management has to be involved in order to deliver the crude oil from the exploitation point to the refinery.

1. *Exploration*: This stage involves seismic and geological operations.

2. *Production*: This concerns about exploitation of the crude oil from the reservoir by drilling. Production needs highly qualified engineering work and it also links to other activities such as procurement, transportation. The crude oil produced is transported by pipelines or oil tankers to the terminals for storage. From here it is either to transported directly to the refinery or exported to other companies’ refineries (Ribas et al., 2011).

**Downstream**

The first stage is the refining process which is based on demand forecasting and triggers the procurement and the logistics activities in order to supply crude oil to the refinery and deliver its derivatives to the customers.

3. *Procurement*: This is sourcing of and managing the supply of the raw material to the refinery in the right time and in the right quantity.

4. *Refining*: This is a complex, well planned process which involves the transformation of the crude oil into different types of derivatives based on demand forecasting. Therefore, this has a tight link to the next stage, to the marketing activities and also involves inventory management.

5. *Distribution*: Logistics management assures that the right products get delivered to the right customers in the right time preferably in a cost efficient way (Stabell, 2001; Hussain et al., 2006; Jasuja et al., 2009).

6. *Marketing*: This deals with marketing the different crude oil derivatives to the right customers. Marketing has to have an accurate knowledge about the current inventory level and refinery activities in order to manage its sale function.
2.4.2 Inflexible Supply Chain

One of the main characteristics of the oil supply chain is its inflexibility. Jenkins and Wright (1998) derive this inelasticity from three features of the oil industry. First of all the purchase of the product has to be determined 9 months prior to the actual sale. Secondly the primary distribution occurs with fixed pipeline capacity or with fixed coastal shipping capacity. Finally, since the depots’ capacity for the secondary distribution is limited, it has to be booked on a take-or-pay basis (Jenkins & Wright, 1998; Ribas et al., 2011 - Figure 2.1). Take-or-pay agreement in oil business means that one party agrees to purchase from other party a minimum amount of oil for certain period of time or to pay the same amount even if the oil is not needed (Yourdictionary, 2012).

The increasing level of competition and high quality requirements increase the complexity of the oil supply chain which also has a negative effect on the flexibility (Gainsborough, 2006). Hussain et al. (2006) also highlights reasons for the inflexibility such as the long lead time, manufacturing capacity and limited means of transportation. The long distances between supply chain partners and the slow means of transportation increase the lead time from shipping point to the end users. It becomes hard to meet a required service level but it also could hurt customers who have to keep costly safety stock (Hussain et al., 2006). However, Jenkins and Wright (1998) asserts that the logistics can be a flexible element of the supply chain which could increase the responsiveness to any change or could be a source of cost saving. Figure 2.2 below illustrates the inflexible and flexible parts of the downstream supply chain.

![Figure 2.2 Inflexibilities in the Petroleum Supply Chain (Jenkins & Wright, 1998)](image-url)

Figure 2.2 Inflexibilities in the Petroleum Supply Chain (Jenkins & Wright, 1998)
2.4.3 Vertically Integrated Supply Chain

Fundamentally the oil supply chain is a vertically integrated chain coupled with a push system approach (Stabell, 2001; Hall, 2002; Gainsborough, 2006). Based on the theory of Fisher (1997) about the basic supply chain strategies, the pushed chain couples with low cost. Hall (2002) underpins this by stating that low cost is the primary goal of this industry. Demand pull appears only at the scheduling activities for the delivery of the product to the customers. So positioning the decoupling point in the downstream segment and securing transportation can reduce the bullwhip effect. Using reliable transportation mode and placing inventory closer to the final users enhances the customer satisfaction because faster lead time and faster product availability can be achieved (Hall, 2002). On the other hand inventory is costly, however, exceeding production is not a preferable option of the oil companies because a possible production shut down is costly or it could result in massive discounting on price therefore they rather store it (Hall, 2002). Gainsborough (2006) also supports Hall’s thought that the vertically integrated nature bears a potential advantage within the oil industry by having great control all over the chain.

2.5 Supply Chain Optimization in the Oil Industry

As it was already mentioned, the analysis concentrates more on the downstream segment since this segment bears a greater potential for enhancing the flexibility and for cost saving (Jenkins & Wright, 1998; Gainsborough, 2006; Hussain et al., 2006). It should not also be forgotten that first of all the objective of optimizing oil supply chain has to be clarified. Normally it is aligned with the supply chain strategy and aims to achieve profit maximization by being cost efficient and satisfying customers (Jasuja et al., 2009). Jasuja et al. (2009) states that optimization is also a value creating opportunity for the oil companies as well as for gaining competitive advantage.

Supply chain optimization is the biggest opportunity for most companies to significantly reduce their cost and improve their performance (Ratliff, 2007). Optimization strives to achieve the most efficient, optimal way to manage the supply chain in order to satisfy customer needs on the lowest cost. The desired quantity, regular supply of the crude oil, reduced lead time, lower production and distribution cost are one of the main goals of the oil supply chain (Hussain et al., 2006). But which crude oil should be refined in which refinery? How much inventory should be kept in stock? When is it best to move the products? Which transport mode should be used? These are just a few of the questions which need to be answered. Supposedly supply chain optimization finds the answer which contributes to make the right decision in the long term planning. In this stage of the thesis, the options for optimizing the oil supply chain will be determined by analyzing and extracting the key information of the literatures. These options can serve as essential enablers for optimizing oil supply chain and for facilitating decision making activity.

Hasini (2008) states that supply chain optimization is basically a practice in which resources are proficiently utilized in satisfying the customer’s order, yet, subject to
the restrictions and limitations on the use and flow of these resources throughout network of companies. Geunes and Pardalos (2005) define supply chain optimization as the implementation and application of optimizing models in order to manage the supply chain and the components within the pipe line or supply chain channel members. The optimization of the supply chain helps firms make the right decisions in view of the fact that every company have its distinctive resources, opportunities and limitations. On top of these, it is mentioned that supply chain optimization focuses on growing and maximizing the firms’ returns on assets (Bryan & McDougall, 1998).

First the optimization process are reviewed and then, those approaches of supply chain management which inevitably need for optimizing the whole process in the oil industry, are discussed. The different divisions and their important functions in the downstream oil supply chain can be placed into five optimization activities which is explained in the next section below (Bryan & McDougall, 1998). Therefore, these divisions of oil downstream supply will be examined in view of linking them into the five optimization activities. At the end of literature review the authors of the thesis develop their own diagram which gives an overall view for the theoretical framework with the focus areas and activities of optimization in the downstream oil supply chain (Figure 2.3).

### 2.5.1 Activities and Process of Supply Chain Optimization

The framework used for this review is based on Bryan and McDougall’s (1998) five activities of supply chain optimization. Due to the lack of research on this topic, not many sources can be found which actually give a theoretical background for optimization of supply chains. Gene and McDougall’s (1998) five step activities can serve as a backbone for optimization in oil downstream supply chain.

Bryan and McDougall (1998) point out that supply chain management and advanced planning schedules are the key fundamentals of supply chain optimization. On the other hand they add that there are five types of activities that are involved in the supply chain optimization process as mentioned below:

1. Planning
2. Scheduling
3. Executing
4. Tracking
5. Adjusting

These five activities and their respective opportunities are applied to all the course of actions (strategic, tactical and operational) as well as to all four basic functions such as procurement, refinery, distribution and marketing (Bryan & McDougall, 1998).
1. Planning
According to Camillus (1986) planning can be defined as the act of thinking ahead or making decisions on what you should accomplish attain or achieve. 'Planning involves deciding in advance what has to be done, when, how and by whom it has to be done and how the results are to be evaluated' (Talloo, 2007, p. 304). Piotrowski (1992) mentions that planning is important because it offers managers a procedure to make decisions built on knowledge and information which in the long run saves time and money. In addition to this, Piotrowski (1992) adds that planning is helpful in a way that it helps firms to develop standard of performance.

2. Scheduling
Scheduling comes right after the planning has been approved by the management (Maccarthy & Lui, 1993). It basically breaks the plan down into daily or weekly basis. Scheduling, just like planning has to extend to all functions in the supply chain from the procurement to the distribution. The term scheduling refers to the allocation of resources in a specific period of time to execute or carry out certain tasks or operations. The significance of good quality scheduling strategies in production environments in today’s market where there is a high level competition cannot be overstressed. The need to react to market demands rapidly and to run plants efficiently gives rise to complex scheduling problems in all but the easiest production environments (Maccarthy & Lui, 1993).

3. Executing
Execution is when the plan and schedule are actually materialized. Sehgal (2009) defines it from supply chain perspective. Execution gives a support to the process that assist in running day to day operation and activities of a company. These processes commonly depend on the outcome of the supply chain planning processes. Such implementation from a planning process is highly required. Supply chain execution has two main benefits: it makes sure that operations within the supply chain are arranged in a line with the plans, and it also ensures a feasible plan of execution if the higher level planning was carried out with appropriately modelled constraints (Sehgal, 2009).

4. Tracking
Tracking is basically about the performance measurement. Gainsborough (2006) points out that the whole supply chain optimization process goes from forecasting, planning and scheduling to the execution. He emphasises that optimization is successful when experts analyse the result and actually the optimized plan achieves the expected Return on Investment (ROI). But to achieve this, Ratliff (2007) explains that objectives have to be determined and they have to be measurable at the beginning of any optimization. Because of the dynamic nature of the supply chain, the optimization needs place for improvement by monitoring data and optimization models. It needs to use benchmarking, key performance
indicators and comparing the optimization results to the benchmarking (Ratliff, 2007).

5. Adjusting

Adjusting is strongly related to the tracking. Sople (2012) states that adjusting is important because in today’s market where there is increasing variety in customer needs, companies need to quickly adjust their supply chains to meet the customer’s requirement or demand leading to a more sustainable competitive advantage. This could not be possible by only offering better customer value propositions, but the firms need to adopt a unique business system to support it (Sople, 2012)

2.5.2 Approaches to Downstream Oil Supply Chain Optimization

Deepening Integration

Researchers stress the importance of establishing integration within the supply chain. Therefore, supply chain management represents an integrated view across the supply chain players and functions (Lasschuit & Thijssen, 2004). Gainsborough (2006) states that the main obstacle in the industry is the silo mentality, meanwhile actors in the oil and any other supply chain, desire a holistic view. Integration must stand as a firm base of the supply chain management. It has to happen between the different departments horizontally and coordinates the strategy, the planning, the scheduling and the operational execution vertically (Lasschuit & Thijssen, 2004).

As optimization is very much related to the efficient management, it also has to cover the whole supply chain. Hussain et al. (2006) argue that manufacturing efficiency alone does not provide competitive advantage. An integrated process needs to be implemented all the way from procurement of crude oil to the delivery of the final product. Due to the size of the oil supply network, many individual suppliers are involved. Integrating them into the major company is very challenging because either they have different optimization tools and software which is hard to integrate into the major company or they are just simply cautious to share information (Hussain et al., 2006).

Regarding the size and complexity of the business, a large amount of data is involved in each function of the oil supply chain on a daily basis. Information from many points of the supply chain and fast access to it, are necessary to conciliate efficient operations (Ratliff, 2007). Therefore, integration and advanced IT solutions are inevitable in order to have greater visibility all the way in the supply chain. Lancioni, Smith and Oliva (2000) highlight the fact that integrating the main functions of the chain as well as cooperating with other actors within the supply network requires adequate, real-time information. Therefore Information Technology (IT) deserves more ‘privilege.’
Using Information and Information Technology

IT is identified by this thesis as a core practice of optimization of the supply chain in the oil industry. Each of the other factors for the optimization is strongly linked to the IT, actually they are built around it and without IT they lose their capabilities of optimizing. Beynon-Davies (2009) claims that information is power in terms of competitiveness and that all businesses are dependent on it. Information sharing is an inevitable necessity to facilitate communication and to link many functions in the oil supply chain such as procurement, production planning, transportation and inventory management. This includes increasing information flow and finding the best information technology to improve planning and controlling of the supply chain (Jenkins & Wright, 1998). IT also enhances the flexibility within the supply chain, which means more efficient delivery and response times, therefore, cost minimization and higher levels of customer service can be achieved (Lancioni et al., 2000; Langley et al., 2009). Through IT, fast information can be accessed quickly and shared in many different channels thus decisions can be made faster and higher customer satisfaction levels can be achieved (Rayport & Sviokla, 1995).

Hall (2002) develops the Data Flow Diagram (DFD) which provides for the smoother information flow and by this he proves how to avoid any demand distortion in the supply chain. DFD contributes to decreasing the bullwhip effect by simplifying the process of scheduling and dispatching synchronization. Anderson (2003) points out that since the expansion trend of oil companies through mergers, complexity of the globalised oil supply chain increased. To handle efficiently the evolved complexity, electronic-business (e-business) solutions need to be implemented for electronic-procurement (e-procurement) and electronic-collaboration (e-collaboration). It reduces lead time and helps to enhance the cross functional competence of the business (Anderson, 2003).

Gainsborough (2006) emphasises the need for developing, integrating and implementing appropriate software tools with the focus on a standardized refinery planning and scheduling process in order to optimize the supply chain. Below, the production planning section introduces a Linear Programming (LP) model for refinery configuration. IT software tools based on serious mathematical programming and these are the appropriate tools to handle for instance the numerous uncertainties surrounding the oil industry and to configure refinery activity or to manage a cost efficient transportation system (Carneiro, Ribas & Hamacher, 2010). Ratliff (2007) asserts that ignoring variability leads often to making errors in the model or in a worst case scenario to failure. Li and Schulze (2011) introduce two main types of optimization approaches, the robust and stochastic approaches which consider the uncertainties too. Jenkins and Wright (1998) demonstrate the beneficial use of a fleet scheduling and a supply chain model software package. Both helps to gain cost efficiency and support tactical and strategic decisions and also each optimization practice is based on an integrated IT system. Overall IT software tools represent option for optimization in order to lower the possibility of errors in the forecast under the uncertainty By using appropriate Enterprise Resources Planning (ERP) software contributes to the integration of suppliers and customers (Jasuja et al., 2009).
Enhancing Collaboration

Increased collaboration can appear in many levels within oil supply chain through integration. Therefore collaboration happens horizontally and vertically along with integration (Lasschuit & Thijssen, 2004). Mentzer et al. (2001) emphasize that cooperation has to happen at all management level involving cross-functional coordination across the supply chain. Close relationship is necessary to execute core activities in a cooperative way. Ideally collaboration covers the whole supply chain from the planning to the evaluation (Mentzer et al., 2001), therefore it is indispensable part of the optimization in order to achieve supply chain efficiency.

The global nature of the supply chain in the oil industry forces oil companies to deal with many different cultures. As many oil companies are owned by their national states, to collaborate with governments or with their petroleum authorities is common which can enhance good relationship and trust between buyers and suppliers. Through collaboration and trust, better supply chain coordination can be achieved to reduce disruption and by this profit can be maximized (Langley et al., 2009). Hussain et al. (2006) attract attention to the trend whereby using third party logistics is getting popular within the petroleum industry. Even more, collaboration with competitors to find optimal and most cost efficient solutions can be observed in the oil industry. Competing oil companies form alliances mainly for delivery reasons to decrease transportation and inventory cost as well as to improve the customer service level. This form of collaboration is called shipment swapping (Hussain et al., 2006).

2.5.3 Roles of Downstream Oil Supply Chain Functions

The five optimization activities embrace all functional areas in the downstream oil supply chain. In the time horizon the consecutive optimization activities have to apply to each function. The very first stage of the downstream supply chain is the procurement, however, each function equally is based on the demand forecasting which will launch the all supply chain process.

Demand Forecasting

Accurate demand forecasting is indispensable for the optimization (Gainsborough, 2006; Balasubramanian, 2002). It has to cover the procurement, refining and distribution which form the basis to optimize the downstream supply chain (Jasuja et al., 2009). Although marketing is the last stage in the oil downstream supply chain by selling the oil derivatives, it also have responsibility for provide forecasting information which triggers the whole supply chain process. Demand numbers usually come from historical data, forward trade data, macroeconomic indicators, Point of Sales (POS) system, marketing input and metrological input. Accuracy plays key role because a little error could cause very expensive damage on the total cost (Balasubramanian, 2002).
**Procurement**

Refineries’ optimized performance is based on the demand data but it also has an impact on the procurement of crude oil. As the choice of suppliers of crude oil are relatively limited due to dominance of oil cartels in the market, plus because of the frequent oil price fluctuation, creating long time agreement with some oil producing nation could stable secure supplies and the sudden price fluctuation (Jasuja et al., 2009). Beside Jasuja et al. (2009) asserts that procurement has to strive to minimize the material supply considering refinery throughput and inventory management. Since the crude oil mostly comes from remote location and involves many means of transport thus choosing reliable transportation mode is important for reducing lead time and stock level (Hall, 2002; Jasuja et al., 2009). Logistic management is involved in other units as well. Its further role will be explained in detail below under the heading distribution and logistics.

**Refrinery Planning and Inventory Management**

The refinery is a particularly costly and complex activity in the oil supply chain thus its process is a crucial point in the oil industry (Balasubramanian 2002). First of all operating and maintaining it is very expensive that is why for instance during low demand it stops operating. Insufficient throughput is also costly thus it requires accurate and regularly monitored data information. Moreover, the operation has to be configured based on which kind of final product and how much needs to be produced (Hussain at al., 2006). Ratliff (2007) notes, the seasonal changes also have an impact on the refinery shut downs or slow downs, therefore, it also affects the inventory and distribution planning. Balasubramanian (2002) mentions a refinery LP model and tracking system, namely SAP which plays a key role in the optimization for planning these activities in the supply chain (Balasubramanian, 2002).

An early supply arrival can result in piling the stock up which is expensive. Jasuja et al. (2009) mention lack of visibility, incorrect demand information and over production as causes for increasing stock level. Jasuja et al. (2009) claim that using reliable transportation and persistent information exchange can reduce inventory cost. Moreover, they suggest that governments have the power to set the strategic safety stock limit lower. On the other hand Hall (2002) argues that the oil industry does not strive to keep its inventory to absolute minimum low. Hall (2002) mentions that over production in the upstream stage can cause a discount on the price but oil companies rather pay more to stock pile the oil than loosing high profit. Although a higher level of inventory is more expensive, it fulfils customer needs faster (Hall, 2002).

**Distribution and Logistics**

Distribution of the final products also relies on the accurate demand forecast (Balasubramanian, 2002). Logistic management is involved both in up- and downstream supply chain. The reason why upstream has to be mentioned here is that procurement of crude oil in downstream is supplied from the upstream segment. Jenkins and Wright (1998) suggest focusing on the means of
transportation, especially on road transport and its tankers as well as drivers. It is mostly because they believe these are highly flexible elements of the inflexible oil supply chain and these could be a good area for optimization and reduce cost. As lead time is long and many variations of means of transport is possible, with an excellent IT software such as the fleet scheduling package and the supply chain management model suggested by Jenkins and Wright (1998), optimization can be achieved. They are cost effective, increase flexibility which contributes to higher customer satisfaction and they also improve planning and controlling the supply chain (Jenkins & Wright 1998). Not to mention it helps to avoid run outs and retains at the filling station (Balasubramanian 2002).

Jha and Deshmukh (2009) emphasise that the cost and level of service have to be in centre of the attention. It is also important in the downstream oil supply chain that the distribution occurs from the refinery or from the storage facilities. Mode of transportation, fleet size, shipment routes and quantity of the delivered products are the factors which determines the distribution planning (Jha & Deshmukh, 2009). A secure and reliable transportation mode and carrier gives the ability to position decoupling point which reduces the bullwhip effect, therefore, inventory could be closer to the customers (Hall, 2002).

Jasuja et al. (2009) also note that participating in port improvements should be many oil companies’ concern because it increases the capacity of the port which can eliminate waiting times therefore shorter lead time can be achieved. The long lead time also indicates the length of the supply chain which makes the transportation cost expensive. Therefore, using pipelines is suggested in order to accomplish cheaper distribution cost (Jasuja et al., 2009). Just like in refineries, in the distribution planning too, LP is commonly used in the oil industry (Balasubramanian 2002; Jha & Deshmukh, 2009). This mathematical technique helps determining the optimum allocation of resources with the focus on cost efficiency and consideration of customer satisfaction as one of its variables. It makes sure that the company achieve its primary objectives along with implying all variable production and transportation cost (Jha & Deshmukh, 2009).

2.5.4 Theoretical Framework for Optimization

The following diagram in Figure 2.3 is developed by the authors of the thesis on the base of gathered information from the literatures and researches. The diagram aims to summerize and illustrate the optimization process and its factors in the downstream oil supply chain. It helps the readers to process and interpret the information more easily through this simple schematic picture.

The vertical axle shows the steps of optimization in order of time and the horizontal axle shows the functions of oil downstream supply chain. Each of the optimization steps is linked to each functions, however the direct link has to happen at the executing steps when the plan actually materialized. The expected flexibilty can be achieved through the optimization by making necesarry changes in the plan triggered by the adjusting steps. The horizontal axle demonstrates the integrated nature of the supply chain which is achieved by IT, constant communication and collaboration between the funtions. The diagram also
highlights on the right horizontal axle the before mentioned IT, communication and collaboration has to happen between the optimization steps as well. The outcome of optimization is to achieve the ultimate goals of oil companies such as profit maximization and competitive advantage through cost efficiency and customer satisfaction.

Figure 2.3 Optimization for Downstream Oil Supply Chain (Compiled by authors from the thesis, 2012)

2.6 Summary

Before proceeding to the main topic of the thesis which deals with supply chain optimization, the theoretical framework started with the definition of supply chain management to get a deep understanding and a broader view about what supply chain is all about. After describing and explaining the meaning of supply chain management, the view of gaining competitive advantage, supply chain
management has been discussed in the literature review. Further the characteristics of supply chain in the oil industry, its nature and characteristics were briefly discussed regarding its complexity, flexibility and vertical integration. Of these three characteristics the complexity and inflexibility are the two basic elements that count for the uncertainties and therefore, many challenges can be derived from these.

The oil supply chain is divided into two major segments: upstream and downstream supply chain, where the refinery stage stands decoupling them. In the thesis, the analysis concentrated on the downstream since it is considered as the source of flexibility. The literature review further discusses supply chain optimization and its process in the oil industry which is the key and the main point of the research. Optimization means creating opportunity for value adding and getting competitive advantage. It is also the primary opportunity for oil companies to considerably minimize their cost and develop their performance. Some of the points are illustrated in this section by including the approaches of optimization for downstream oil supply chain.

Another aspect discussed in the literature review is the roles of downstream oil supply chain functions such as demand forecasting, procurement, production planning, inventory management, distribution and marketing. Finally the authors conclude the chapter by presenting a diagram that summarizes the information gathered from the literature review which gives an overview of the optimization process and its factors in the downstream oil supply chain. This diagram helps the readers to easily understand the information.
3 Methodology

This chapter presents the methodology used for the study. The chapter begins by giving brief introductory information about the meaning of research methodology including the types of research approaches. Moreover, it focuses and gives a detail explanation about qualitative research approach which is the chosen type of approach for the study. The description of the case study used, how data is collected and the types of data used are further discussed and explained in this section. Finally the chapter ends by addressing the problems encountered during the study.

3.1 Research Methodology

Kothari (2004) defines research methodology as a way of finding a solution for research problems or it can be described as a science that deals with how research is carried out scientifically. Kothari (2004) points out that research methodology is important for researchers in order for them to do research in a way that highlights and gives essential training in collecting material and arranging and putting it together for carrying out research. Kothari (2004) also adds that there are two basic approaches to research: qualitative research and quantitative research. For this research qualitative research is applied. The definition and description of qualitative research is explained in detail as follows.

'Qualitative research is the collection, analysis and interpretation of data that cannot be meaningfully quantified, that is, summarized in the form of number' (Diggines & Wiid, 2009, p.85). Qualitative research basically depends on the gathering of qualitative data (Johnson & Christensen, 2012). Neergaard and Ulhoi (2007) define qualitative research as a research that focuses on a multi method approach that includes an interpretive and naturalistic view of its subject matter. Qualitative research is concerned with qualitative observable fact, or in other words a phenomenon that contains quality or kind (Kumar, 2008). Beije (2010) illustrates that, in qualitative research the research questions are carried out in a flexible manner allowing one to get in touch with the people concerned to a degree that is essential to grasp what is being carried out within the field. Beije (2010) also adds that the definition of qualitative research contains three key components:

(1) Looking for meaning
(2) Using flexible research methods enabling contact
(3) Providing qualitative findings

According to Mariampoliski (2001), qualitative research methods offer the required and complementary viewpoint on human behavior. 'When used properly, qualitative inquiry can address numerous strategic information needs, such as creative ideation for new product development, conception and evaluation of marketing or communications tactics and insights into the culturally-based preferences of various racial and linguistic minorities' (Mariampoliski, 2001, p.8). Diggines and Wiid (2009) mention that the techniques used in qualitative research
include focus groups, in depth interviews and predictive techniques. On the other hand Wiid and Diggines (2009) also explain that the structure of qualitative research is less than that of the quantitative research. Wiid and Diggines (2009) indicate that Qualitative research is preferable when investigating or examining, attitude, perception, motivation and understanding.

As already mentioned above, to carry out this research the authors decided that qualitative research is the best applicable method for the study. The reason of using qualitative research is due to the nature of the research that is based on gathering, and analyzing of qualitative data. In other words, the study is made by investigating and interpreting individual ideas and analyzing the findings in relation to the literature review in context to the research questions.

3.2 Case Study

A case study can be defined as the study of a single case where a study is made extensively and the rationale behind the study is to at least apply partially, to a larger class of cases (Gerring, 2007). A case study is likely to grasp the complexity of a single case (Stake, 1995). Stake (1995) states that a case study deals with the particularity and complexity of a specified single case, coming to know its activities within significant situations. The case study method is a very popular form of qualitative analysis and involves a careful and complete observation of a social unit, be that unit a person, a family, an institution, a cultural group or even the entire community (Kothari, 2004, p.113). An organization or company would be another example of such a unit. Kothari (2004) explains the major phases that are involved in the case study as mentioned below:

Phase 1. Recognition and identification of the status of the facts to be examined.

Phase 2. Gathering of data, investigation and background of the specific phenomena.

Phase 3. Analyzing and finding the causal factors as a foundation for a corrective or developmental action.

Phase 4. Implementation of corrective treatments.

Phase 5. Follow up program to know the effect or the effectiveness of the applied corrective treatment.

The authors chose a case study based on the Hungarian company named MOL Hungarian Oil and Gas PLC. The reason for selecting this company is because of its high performance in terms of profitability and high number of employees in central Europe (CNN Money, 2011; Kitekinto, 2011).
3.3 Collection of Data

One of the most significant steps in writing a report is the collection of data or information. Because the report depends on the quality of the data collected, the report will be good if the data collected is good (Guffey, 2010). When collecting data in research it is important to take into account, what type of data is to be collected and what method of data collection is to be implemented. Data collection can be expensive cost wise, but depends on the nature of the project. However, data collected plays an important role in determining the research problem (Stevensens, Wrenn, Sherwood & Ruddick, 2006). The following sections give a detail description about the types of data and methods of data collection from theoretical point of view and further addresses the data used and the methods of data collection implemented for the research.

3.3.1 Types of Data

Stevensens et al. (2006) state that there are two types of data:

1. **Primary data**: Data that is gathered by a researcher for the first time for a particular ongoing research project. According to Guffey (2010), primary data is that collected through firsthand experience. Primary data can be gathered by applying either of the two basic research methods, qualitative or quantitative (Stawarsk & Particia, 2008.)

2. **Secondary data**: Data that has been formerly gathered by other researchers for other reasons. Guffey (2010) mentions that secondary data results from reading what others have experimented with and observed. In addition to these, Guffey (2010) adds that secondary data is simpler and has lower cost to develop and to use than primary data which might mean interviewing large groups and distributing questionnaires.

For this research the authors use both, primary data through interviews to get a relevant and reliable data to make a good research and secondary data from different sources, such as books and articles as a supportive data which helps in building the frame of reference for the study and gives a guidance in making analysis with the findings systematically and properly.

3.3.2 Methods of Data Collection

Philips and Stawarski (2008) illustrate that there are different ways of collecting qualitative data among these, the most commonly used ones are three: Interviews, focus groups and observations. Kothari (2004) state that for selecting the appropriate method for data collection, a researcher should keep in mind the following key factors:

1. **Nature, scope and object of enquiry**: This is the most important factor that influences or affects making a choice on the particular method to be
implemented. This factor also plays an important role in making the decisions on what type of data to be used, primary data or secondary data.

(2) **Availability of funds:** Availability of funds plays a big role for selecting the appropriate data collection method. When there is limitation of funds the researcher has to select a cheaper method for collection of data even though it might be less efficient and effective method compared to other costly methods.

(3) **Time factor:** It is important for a researcher to keep in mind the availability of sufficient time before making a decision on what type of method is to be used for the data collection.

(4) **Precision required:** Being precise is another key factor to be taken into account by researchers when selecting the method of collection of data.

Due to the nature of the research, which is based on conducting the research using qualitative research approach, which needs to make a deep investigation the authors discovered and applied interviews as the relevant data collection method. Therefore the authors used interviews as the main data collection method. Besides these, while gathering the data for the study the means of communication used with the concerned contact person of the firm chosen for the research was through internet by using Skype. This is because of the fact that the company chosen for the case study has no presence in Sweden and is located in Hungary.

### 3.3.3 Interviews

'While the interview process uncovers reaction, learning, and impact data, it is primarily used for collecting application data' (Phillips & Stawarski 2008, p.23). Phillips and Stawarski (2008) also mentioned that interviews could take a long time and needs the preparation of the interviewer to guarantee the consistency of the process. According to Lussier and Kimball (2009) there are three types of interviews: structured interviews, unstructured interviews and semi structured interviews. Lussier and Kimball (2009) explains that structured interviews use a list of preplanned questions to ask all individuals or candidates that are to be interviewed where unstructured interviews are interviews that don’t use questions that are planned in advance. Semi structured interviews are interviews where interviewers ask questions from a preplanned list of questions but also ask unplanned questions as well (Robert and Kimball, 2009). On the other hand Tenenbaum and Driscoll (2005) mentioned that semi structured interviews contains a number of questions to be explored by each of the candidates to be interviewed. Klenke (2008) mentioned that one of the major strengths of using semi-structured interview is that there is a positive rapport between the interviewer and interviewee. On the contrary Klenke (2008) adds that one of the weaknesses of semi structured interview is that it is time consuming and expensive.

For this research semi structured interviews were applied because of several reasons. One of the main reasons is that the research is based on a single case
study where interviews were made with different individuals working in the same company or involved in a project with the company. Another reason is that candidates interviewed have different posts. Therefore, questions of each interview should be different from the other candidate to prevent redundancy. In other words interview questions should be relevant with the job description of the candidates to be interviewed to get relevant information to make a better research.

3.4 Problems Encountered

The authors have encountered several problems in the data collection process: one of the problems encountered was that there were a limited number of references on the selected topic. In other words there is not enough research made on the topic which is supply chain optimization in the oil industry and this was one of the biggest obstacles the authors faced during of the study. The other problem encountered was regarding the interview. One of the respondents of the interview did not answer the interview questions as per the order which made difficult for the authors in doing the empirical study and analyzing it.
4 Empirical Study

The information of this qualitative research has been gathered through a deep interview with Szabolcs Szabó and Tamas Kenesei who work for MOL Group in the Supply Chain Management department. Szabolcs Szabó is performance analyst and Tamas Kenesei is member of the optimization and planning unit in the supply chain management department. An interview was also conducted with Csaba Paal who works as a consultant in McKinsey & Company and participated in a supply chain management related project at MOL. The empirical study is conducted on the basis of semi structured interviews and reflect the theoretical framework developed in the literature review which can be found in Appendix 6, 7 and 8 as well as in Figure 2.3 respectively.

4.1 Findings

As the Jönköping University (2011) states that in the case of qualitative research is very hard to distinguish between result and analysis because there is not really a ‘pure’ statistical result. The findings follows the main elements of literature review, therefore, the information gained from interviewees can be presented in a logical systematic way. Interviewees also demonstrate their speech with several real or theoretical examples for the better understandings. It is has to be noted that the findings about supply chain optimization at MOL Group consider only the downstream supply chain.

4.1.1 The MOL Group

Key figures of the MOL Group

The following are the 2010 MOL Group financial and operational figures:

Net sales revenue: 4,298.7 billion HUF (20,657 million USD)
Market capitalization: 10 billion USD
Number of employees: 32,601
Number of filling stations: 1,623
Gross crude oil reserves (million barrels (MM bbl)): 271.0
Total refinery throughput (kilo tones (kt)): 21,834
Total crude oil product sales (kt): 20,940
Total petrochemical product (olefin and polymer) sales (kt): 1,415 (MOL, 2012)
Brief History of the MOL Group

After the communist nationalisation the Hungarian oil industry was integrated into one entity in 1957 which was called Hungarian Oil and Gas Trust. This stood until the democratic system change when under the privatization MOL Group was founded in 1991 by the merger of nine state-owned companies. The main goal was to increase shareholder value by an expansion strategy and internal efficiency. MOL’s efficiency is reflected by having the highest net cash refinery margin and net production income per barrel in Europe since 2003 (MOL Group Investor Relation, 2012; Appendix 4 and 5). Today MOL Group consists of MOL, the largest Hungarian company, the Slovakian oil company Slovnaft, the Hungarian petrochemical company Tiszai Vegyi Kombinát (TVK), the Austrian retail and wholesale company Roth, the Italian refining and retail company IES and the Croatian retail network Tifon. MOL is also a major shareholder in INA, the Croatian National Oil and Gas Company and has shares in Czech electricity group, CEZ and in the Oman Oil Company, OOC. (MOL, 2012)

MOL Group has about 7 decades of oil and gas industry experience in Central and Eastern Europe and more than 20 years experience in an international scale. Mol’s upstream segment does exploration activities in 13 countries and production activities in 7 countries (MOL, 2012). The downstream segment, the refining and marketing operates 5 refineries on the domestic and international market with the capacity of around 21 million tonnes refined oil per year for marketing finished products in the Central and Eastern Europe region. Extensive pipeline system and depot network provide an efficient crude oil supply and distribution of finished products. The retail division operates a modern filling station network that assures a stable market for refineries within their supply radius. In the case of MOL, petrochemicals segment belongs to the downstream section of the chain and it is integrated into the refineries activities. Two plants are located in Tiszaújváros (TVK) and in Bratislava (Slovnaft Petrochemicals). The petrochemical of MOL has a significant role in the European polyolefin production and it is market leader in the Central and Eastern Europe region.

4.1.2 MOL Downstream Supply Chain Management

The interviewee asserts that MOL downstream oil supply chain management is considered as tool to gain and sustain competitive advantage for MOL (T. Kenesei, personal communication, 2012-04-20). Although the respondent adds that a good supply chain management can be developed in any oil company in the course of time. But due to the dynamics of oil industry, changes has been occurring all the time, therefore, importance of supply chain management remains and focusing on supply chain processes as well as learning from previous experiences are vital for MOL (T. Kenesei, personal communication, 2012-04-20).

The interviewees confirm that MOL downstream supply chain is similarly divided than it was mentioned in the theoretical framework. Only one slight different is that the petrochemical is part of the downstream and part of the common supply chain management, however it operates as an independent entity from the
refineries (Sz. Szabó, personal communication, 2012-04-02; T. Kenesei, personal communication, 2012-04-20; Cs. Paal, personal communication, 2012-04-25). Supply chain management stands over the different functions such as procurement, refinery, logistics and marketing (Figure 4.1). It consists of five units, namely the strategic planning, planning and optimization, refinery scheduling, supply and distribution planning and performance monitoring unit. The different functions are sharing information and cooperating with each other through supply chain management department. Supply chain management also takes action when inconsistency occurs along the chain, for instance the marketing department wants to sell so much product which cannot be handled by the logistics. Therefore, supply chain management has a cooperating, controlling and information sharing role (T. Kenesei, personal communication, 2012-04-20).

The interviewee describes the whole downstream supply chain process at MOL which needs to be clarified in order to have a bigger picture about the importance of supply chain optimization (Sz. Szabó, personal communication, 2012-04-02). The majority of the crude oil comes via oil pipeline from Russia and cross the Hungarian border at Fenyeslitke. From that point MOL owns and operates the pipeline network and the oil is transferred to the refinery in Szazhalombatta. It does not work in the same way in each country where MOL has a presence. In Slovakia the pipeline system belongs to a Russian pipeline company’s subsidiary called Transnyegte Producta, therefore Slovnaft refinery in Bratislava has to pay for the usage of the pipe. INA in Croatia buys the crude oil from tankers. Via undersea pipelines, owned by a Croatian company Janaf, the crude oil either goes to the refinery in Rijeka or from there to another refinery in north of Croatia as well, to Sisak. Of course for the usage of pipelines fee need to be paid. In Italy is the mixture of these two ways because the crude comes from the sea too but the pipeline network is owned by IES so the refinery in Mantova does not have to pay for this. Overall it can be stated that the supply of crude oil occurs either as a
service or as own solution (Sz. Szabó, personal communication, 2012-04-02). Figure 4.2 illustrates the locations of the refineries and petrochemical plants as well their connection.

![Figure 4.2 Downstream Map (MOL Group Investor Relation, 2012)](image)

The interviewee continues, after the procurement and supply of the crude oil, it is refined in the most optimal location and the refineries produce the demanded type of product in a demanded quantity. Then, products are marketed to either to wholesaler or to retailers which can be owned by own brand retailers or by other oil competitors’ retailers too. In the case of diesel, industry players are big users such as bus, logistics and agriculture companies. Petrol is usually related to the automobile industry and sold at small retailers at the filling station but interestingly, relatively small part of use of oil consumption occurs at the filling station thus the not retail targeted market are more significant. Apart from motor driving materials, refineries produce many other oil derivatives. Many of them produced by the petrochemical division, but its market are a different market segment and facing with different challenges (Sz. P. Szabó, personal communication, 2012-04-02). The complexity of the oil industry and its supply chain can be seen at MOL Group as well. It is also highlighted that optimization has a greater importance within MOL’s supply chain management due to MOL’s unique refinery network where refineries are located very close to each other giving further option for optimization. Because of the complexity and the numerous
possibilities for solution gives greater attention for optimization to find the most efficient way to manage the supply chain (Sz. Szabó, personal communication, 2012-04-02).

4.1.3 MOL Supply Chain Optimization

The meaning of supply chain optimization is described with an expression used by MOL: ‘optimization is from crude oil to the pistol’ (T. Kenesei, personal communication, 2012-04-20). The respondent asserts that the ultimate goal of supply chain optimization is the profit maximization. It is also highlighted that in the view of optimization, customer satisfaction is not considered at all, only the cost efficiency. It does not mean that customer satisfaction does not play an essential role for MOL Group but it appears more in the retail filling station than in the optimization (T. Kenesei, personal communication, 2012-04-20). The reason why optimization is inevitable is that MOL’s oil supply chain is full of constraints from procurement to marketing, not to mentioned unforeseen constrains such as a broken pipe in Russia which blocks the import of crude oil. All these factors affect the whole chain (Sz. Szabó, personal communication, 2012-04-02). The interviewees also support each other’s thoughts and explain that optimization is about translating the supply chain to mathematical language. This language is the linear programming thus the oil supply chain appears as a form of mathematical equation (T. Kenesei, personal communication, 2012-04-20; Sz. Szabó, personal communication, 2012-04-02). The optimization is used for short, middle and long term planning to identify financial opportunities and to avoid threats. Putting optimization in a simple way, it is ultimately for making money for the MOL Group by determining directions for production and sale. An optimization manager works from information and data collected from different departments and its excellence and accuracy will be as good as how good the information gathered is. The information draws an optimization range for the manager to make the highest possible profit. Afterwards, the plan will be sent back to the given departments to take action (T. Kenesei, personal communication, 2012-04-20).

All interviewees state that MOL Group is faced several challenges and constraints coming from the complex and inflexible nature of the industry. There are lots of hypothesis, data and projections thus optimization has a role of processing them and to prepare for decision making depending on how long ahead MOL wants to plan (Sz. Szabó, personal communication, 2012-04-02; T. Kenesei, personal communication, 2012-04-20; Cs. Paal, personal communication, 2012-04-25). For instance if MOL Group plans for 20 years ahead, it concerns more about strategic decisions such as opening a new plant. Short term decision deals with such issues as the yearly general maintenance, so called turnaround, and its scheduling. For the longer time MOL plans and optimizes, the greater the uncertainties and inaccuracy will be and vice versa. The short time planning is more accurate. Therefore, better decision can be made (Kenesei, personal communication, 2012-04-20). It is also noted that constraints have a maximum and minimum. Maximum includes the opportunities and minimum is meant by the obligations MOL having. Obligation can be for instance contractual obligations which need to be completed
thus these increase the inflexibility of the supply chain (Kenesei, personal communication, 2012-04-20).

Optimization is the primary task for the MOL Group’s downstream supply chain management and it is coupled with planning role which means optimization process has to start already in the planning stage. Apart from the planning and optimization unit, there is the strategic planning unit, refinery scheduling unit, supply and distribution planning unit as well as performance monitoring unit which are operates under supply chain management department. MOL’ supply chain management is build around the optimization (Sz. Szabó, personal communication, 2012-04-02; Kenesei, personal communication, 2012-04-20).

Planning in Different Time Horizon

Before describing MOL’ optimization steps and process, it has to be clarified that planning occurs in different time horizons at MOL Group (Kenesei, personal communication, 2012-04-20):

- **Strategic Planning**: it is plan for 3 years ahead setting the company’s direction. As it covers a long period of time, it has the most variable. This carried out by the strategic planning unit (Kenesei, personal communication, 2012-04-20; Sz. Szabó, personal communication, 2012-04-02).

- **Top Down Planning**: it breaks the strategic plan down into quarter years covering 1-3 years period, therefore it is more accurate than the previous one. It also contains the planned turnarounds, raw material needs and sales forecasting. This planning stage is done by the planning and optimization unit (Kenesei, personal communication, 2012-04-20).

- **Business Planning**: it also belongs to the planning and optimization unit and it breaks the first year of top down plan into monthly period. The plan optimizes raw material yearly needs the related logistics capacity needs and inventory needs considering turnarounds. It also set the feasible targets for next year (Kenesei, personal communication, 2012-04-20).

- **Rolling Plan**: it is the most accurate because it already contains actual prices. Rolling plan plans for next month and for 6 months ahead doing it every month in order to response any change. It is still the planning and optimization unit’s responsibility (Kenesei, personal communication, 2012-04-20; Sz. Szabó, personal communication, 2012-04-02).

- **Operational Planning or Scheduling**: it is controlled by refinery scheduling unit as well as supply and distribution unit. It is for executing tasks on weekly or daily basis (Kenesei, personal communication, 2012-04-20).
The Roles of Downstream Supply Chain Management Units

- **Strategic Planning Unit:** its main role is long term planning, product portfolio development and evaluation of strategy of MOL Group (Kenesei, personal communication, 2012-04-20).

- **Planning and Optimization Unit:** this unit deals mainly the optimization of the whole downstream supply chain. Their work is supported with an LP model called PIMS which was will be detailed below in section IT. Optimization includes information gathering as well as feeding information and data into Process Industry Modelling System (PIMS) on a daily basis. The unit constantly analyzes the possible business plan and rolling plan and also has the authority for approving them (Kenesei, personal communication, 2012-04-20).

- **Refinery Scheduling Unit:** their task is short term scheduling based on the rolling plan and triggers the refineries’ operation on the group level. Scheduling is the reflection of the optimized plan on a daily basis (Kenesei, personal communication, 2012-04-20).

- **Supply and Distribution Planning Unit:** the unit plans and schedules the supply chain on daily and weekly basis. It also coordinates the refinery, logistics and marketing functions. Furthermore, the unit deals with the execution of inventory plan too (Kenesei, personal communication, 2012-04-20).

- **Performance Monitoring Unit:** it evaluates the performance of whole downstream supply chain. Tracking and analyzing of any change in the plan is also their task (Sz. Szabó, personal communication, 2012-04-02). The performance analysts monitor the rolling plan monthly and create overall analysis about the previous month's performance and examines the unexploited opportunities because information gained will be adjusted to the inputs for next month plan. There is also quarterly and yearly performance measurement for the business plan. They aim at measuring the success and drawing the lessons in order to improve the performance for next period of planning and optimization. MOL Group uses KPIs and benchmarking method both internally and externally. Strategic achievement in long term as well as the own and competitor's performance for certain period of time are monitored through an own developed, sophisticated system but the elements of system and the exact KPIs was not allowed to mention by the interviewee (Sz. Szabó, personal communication, 2012-04-02).

**Optimization Process**

The process of optimization at MOL Group is the follows. Managers and experts of each department participate in forums weekly 2-3 days in order to monitor the feasibility of the rolling plan and also to assure the continuous information stream. The interviewee explains that for any employer to know what to do at the first day in each month, the rolling plan for the given month has to be approved at the latest in the second week of previous month. Marketing department provides demand information, how much from a given type of product needs to be produced and in which country as well as in what quantity these products can be marketed.
Logistics department adds what capacity is available in the different countries. Refineries give the information about the level of inventory for each product, how it can run the different refinery units and for how many days. It also adds foreseen constrains in the operation (Sz. Szabó, personal communication, 2012-04-02).

The interviewees state that the optimization and planning team gathers all the information and feed it into the same data basis. That is why the integrated software PIMS is a main tool of optimization. PIMS by considering inputs gives the optimal and most profitable solution for the next month. Supply chain management coordinates the all planning and optimization process as well as approve it by the end of the planning month (Sz. Szabó, personal communication, 2012-04-02; Kenesei, personal communication, 2012-04-20). However, every three days on the forum on different managerial level, the plans are monitored in order to avoid or reduce distortion caused by any type of change. If it is necessary, plan can be modified by building the changed variables into the plan. The communication and collaboration is essential because for instance if a diesel sulphur decontaminating plants breaks down and holds the diesel production back, than the marketing department must know about it immediately, otherwise it goes on the spot market without having the adequate product quantity (Sz. Szabó, personal communication, 2012-04-02).

Having and coordinating five refineries and two petrochemical plants makes the whole optimization process more complex. Therefore, the interviewees asserts that supply chain optimization at MOL Group must meet a very strict regulation which indicates the roles, responsibilities, what information from which department is required. On international level the communication frequently occurs through video conference to coordinate the whole chain efficiently on a group level (Sz. Szabó, personal communication, 2012-04-02).

4.1.4 MOL Group’s Approaches to Supply Chain Optimization

Integration

MOL Group but generally all oil companies strive for integrating vertically all the functions of the supply chain into the company in order to having greater control over it. The interviewee emphasises that MOL differs from the biggest oil companies in a sense that not the whole supply chain is integrated into one chain. Upstream is viewed as almost totally separated business segment of MOL from the downstream. The only link with upstream is related to the domestic, Hungarian oil production but it is insignificant since 90% of the crude oil is imported (Sz. Szabó, personal communication, 2012-04-02).

The interviewee claims that through vertical integration MOL and its supply chain management has a significant control over the whole chain including procurement, refinery, whole sale and retailing. As the majority of import comes from Russia, long term contracts assure that the suppliers are greatly involved in the supply chain. However, it cannot be said that it is full integration since MOL does not own
it unlike the before mentioned domestic production. But for instance the supply to
the Hungarian refinery from the border comes through MOL’s pipeline network.
Sz. Szabó, personal communication, 2012-04-02). MOL also posses many retailing
filling stations in national and international level and makes long term contracts
with wholesalers that integrate or involve the customers into the supply chain.
Horizontally integration supports MOL expansion strategy since MOL owns five
refineries in Hungary, Slovakia, Croatia and Italy as well as two petrochemical
plants in Hungary and Slovakia. This wide and integrated supply network needs
the management which controls it efficiently. Integrated process also creates value
by reacting quickly for changes in the market, planning costly refinery shutdowns,
having quicker information flow, making better marketing and logistics solution
(Sz. Szabó, personal communication, 2012-04-02).

**Information Technology**

MOL’s IT solution is not unique at all, it uses PIMS which is very common software
in the oil industry developed by Aspentech. The software links each function of the
chain by gathering and using valuable information from them in order to facilitate
planning. The vital role of optimized refinery operation is also emphasized (Sz.
Szabó, personal communication, 2012-04-02).

PIMS is an essential tool at MOL Group to optimize the downstream by integrating
inputs of each division in a single model. Therefore the optimum can be
determined mainly regarding the optimal configuration and harmonised operation
of refineries as well as petrochemical production but also optimal procurement,
transfer between the refineries, refinery inventory holding, distribution as well as
marketing cost and prices. The inputs are uploaded in a monthly base and also for
six months planning considering the turnarounds of refineries. Customers and
suppliers do not have direct access to feed information into the system.
Information from them or to them is the marketing division’s responsibility (Sz.
Szabó, personal communication, 2012-04-02). MOL’s supply chain management
interprets, modifies or rejects the given plan than feeds information into other
software named Orion. It is for scheduling the activities by breaking the actual plan
down into weekly and daily basis. For the efficiency the two programs are
compatible to each other thus the data is more easily imported and exported. (Sz.
Szabó, personal communication, 2012-04-02).

As the MOL Group operates in an international scale, the role of PIMS in
optimization on group level is obvious. PIMS is also able to handle changes (Sz.
Szabó, personal communication, 2012-04-02). By modifying variables and
considering possible or expected changes, PIMS gives different varieties for
optimization. For instance PIMS can examine how any price change affect the
optimum of business activity or which price change of products or raw materials
force a necessary change in the whole optimization structure. PIMS handles the
supply chain as a whole and for further analysis it prepares more options quickly
which fasten the decision making process (Sz. Szabó, personal communication,
2012-04-02). The disadvantage of PIMS comes from the linear programming
nature of PIMS thus optimization regarding the future is always for period of time.
Whether it is for six months ahead or three years ahead, is like a snapshot. Linear programming is timeless. If for instance it is for six months, this time period is viewed as a whole and something will be generated for this period. However, if something changes in it, then it becomes another snapshot. Therefore, experts have to check the feasibility for short time planning to avoid scheduling errors (Kenesei, personal communication, 2012-04-20).

**Collaboration**

Due to the integration and IT, the cooperation between actors within and out of the MOL enhanced. The interviewee asserts that collaboration inside the MOL Group occurs within the frame of supply chain management forums. These forums take place frequently in four different levels with the adequate management and experts. Based on four levels, there is strategic, executive, operative and customer service forum. These forums are basically to evaluate, analyse and approve the different plans for a given time period. They can also serve as a good platform to react to any unexpected changes or possibilities and make a quick decision. Obviously each division of the downstream segment are represented. Optimizing five refineries and two petrochemical needs also high level of cooperation between the units where some cultural gap has to be bridged as well. Since buying of Slovnaft, IES and INA, MOL has twenty years of experience in integration which has improved a good practice for that. Integration track record also reflects a successful integration practice (Sz. Szabó, personal communication, 2012-04-02).

Collaboration outside of the MOL Group with customers, suppliers and competitors is also sufficient. Partnering up with competitors for certain projects, so called shipment swapping, is a commonly used method to rationalize certain function of the supply chain and to reduce cost (Sz. Szabó, personal communication, 2012-04-02). Shipment swapping is demonstrated with a case. The Austrian oil company OMW, the biggest competitors in the region and MOL Group use shipment swapping. OMW has a refinery in the Austrian Schwechat and in the Romanian Pitesti. But OMW retail filling stations are also located in eastern part of Hungary which actually falls out of OMW’s supply radius. Supply radius means a ring around the refinery which delimits area where delivering company’s product is still efficient and the logistic cost does not exceed the profit. Therefore OMW make an exchange agreement with MOL and MOL will supply the product to this filling station in the agreed quality and quantity. For exchange, OMW will do the same for MOL at filling stations in Austria which are out of the supply radius of MOL Group (Sz. Szabó, personal communication, 2012-04-02).

### 4.1.5 Constraints and Solutions at the Supply Chain Functions

**Demand Forecasting**

Demand forecasting task is carried out by the marketing division but it can be different in another oil companies (Kenesei, personal communication, 2012-04-20).
Demand for oil has been fluctuating all the time. Whereas until 2008 there was average yearly 2-3% demand increase, after the recession for instance the Hungarian market has suffered a 7-8% petrol and 2-3% diesel demand reduction. The yearly long term contract provides a sort of protection and the quarter quotas gives further flexible solution. The quarter quotas in procurement allow having 3-4% plus and minus tolerance range which could help to handle sudden change within the year. This means that the quantity ordered can be changed without any price changing, however, two changes two months running results in penalty fee (Sz. Szabó, personal communication, 2012-04-02).

The MOL Group’s rolling planning system is the major tool for handling demand changes and other types of changes (Kenesei, personal communication, 2012-04-20). It also helps to increase the flexibility of the supply chain. The rolling plan embraces a monthly period and six months period. It provides the possibility to modify the original set up plan by frequent re-evaluation and additional input. By the time a monthly plan is about execution, it has been through several optimizations, therefore it can be assumed that it is more accurate based on new, additional information. It needs to be noted that optimization embraces a month or longer period, whereas breaking monthly plans down to weekly and daily basis is the duty of scheduling unit (Kenesei, personal communication, 2012-04-20).

The interviewee highlights that demand planning is critical point of the supply chain since it triggers the whole downstream supply chain. At the MOL Group it is made by marketing department and all over the years, MOL Group developed a well detailed demand forecasting system. Each buyer's need and possibilities has to be assessed. The time period for demand forecasting can occur in wide range, but just like planning and optimization, longer the forecasted time is, less accurate it will be. Although it does not mean that the long term demand forecast is not important, it just has less reality than for instance to know what to produce in three months based on signed contracts. However, for strategic decision making long term forecasting provides necessary information (Kenesei, personal communication, 2012-04-20).

**Procurement**

At MOL Group the procurement function is carried out by marketing department (Kenesei, personal communication, 2012-04-20). Buying and sale of crude oil or oil derivatives occurs through long agreement when a certain amount of oil with 3-4% tolerance range is traded. The other trade option is spot market when MOL takes its products onto the spot market and anyone can take it (Sz. Szabó, personal communication, 2012-04-02). Mainly because of the nature of spot market it cannot be anticipated perfectly how the sale will be exactly for a given month. However, refinery would need as accurate demand information as possible, in order to configure its production, schedule its product delivery from the depots or to know which product’s reservoir will be empty and need to be refilled. If product cannot be sold than refinery either should be held back but at least slowed down in order to avoid overproduction. Efficient refinery operation resides in the
continuity. Any shut down and restart entails around a million dollar cost (Sz. Szabó, personal communication, 2012-04-02).

The Russian crude oil comes from around 5000 km to each Central and East European country via pipelines. The capacity of pipelines is fixed and only one type of crude oil can be transferred. In Belarus it forks towards north and south to supply the European market (Sz. Szabó, personal communication, 2012-04-02). It is also noted that the five states and the eight refineries compete for this limited capacity which demonstrates how European market is dependent on Russian crude oil. To bridge the problems with the limited capacity and the long lead time, MOL Group signs long term contract for crude oil transit with Russian government and pipeline operating companies. The contract fixes the price and quantity for a year period and it is re-evaluated each year. It also contains quarter quotas which need to be completed. Prior to the month of completion the exact quantity of crude oil has to be agreed too. These mean that the contract actually allows having a minimal level of flexibility based on the usage and the price of the crude oil. Due to the fix capacity of pipelines, the importance of demand planning increases to have as accurate information for a year as possible. Within the MOL Group, INA's and Montova's refineries has a more flexible procurement system since the crude oil comes from tankers, therefore they are able to buy and schedule three weeks before the completion (Sz. Szabó, personal communication, 2012-04-02).

Refinery and Inventory Management

Refinery process is obviously a special part of the supply chain which cannot be found in any other industry. It is also a very complex process where many different oil derivatives can be produced by configuring and operate them differently. The role of optimization regarding refinery operation is to plan and schedule production as well as the tightly related inventory operation (Kenesei, personal communication, 2012-04-20). It determines the optimum regarding what, how much and when to produce at which refinery. By harmonizing these operations considering the yearly turnarounds, prices, opportunities and contractual obligations too, optimization adds value. For instance optimization considers seasonal peak of petrol when it plans the compulsory turnarounds in order to exploit greater financial opportunities. Apart from profit opportunities, the closeness of refineries gives the capability to avoid unforeseen threats. For instance, if the refinery in Bratislava breaks down, MOL can manage to increase its capacity in Szazhalombatta and serve the Slovakian refinery’s market too for a while. Semi and finished products easily and relatively quickly can be transferred between the different refineries (Sz. Szabó, personal communication, 2012-04-02).

Storing the oil meets several constraints due to many types of oil derivatives and the capacity of storage. The level of inventory is limited. The interviewee also states that MOL is able to store 400-500 kilo ton (kt) oil without influence the production activity. Without optimizing refineries and storage activities inconsistency can happen. An example could be if the stored product was not sold yet and it is still in reservoir without any spare capacity left, then refinery operation has to be held back due to lack of storage capacity. So the coordination
between marketing and refinery function are important regarding optimization. 
(Sz. Szabó, personal communication, 2012-04-02; Cs. Paal, personal communication, 2012-04-25). The way of storage of the finished product depends on the type of products. It is possible to store two different products in a tank but for instance the storage of petrol in a tank after residual fuel oil was kept there, needs an entire tank cleaning first. It is because petrol sulphur content is regulated strictly and residual fuel oil contains large portion of sulphur (Sz. Szabó, personal communication, 2012-04-02).

During refinery process many semi finished product needs to be stored too. There is also a yearly general maintenance, the turnaround when a refinery has to be shut down, checked and passes regulation criteria. Obviously, before turnaround stockpiling has to happen before the maintenance work by operating refinery on higher level in order to serve the market needs or to have sufficient quantity of a certain semi product which could be the input for making other product (Sz. Szabó, personal communication, 2012-04-02; Kenesei, personal communication, 2012-04-20). This stockpiling procedure means 2-3 months preparation and the storage reservoirs also need to be emptied giving sufficient place for the increased volume of production (Sz. Szabó, personal communication, 2012-04-02). As price fluctuation is a risk, MOL has to have different strategies for the stock to gain more profit based on current market price of a given product. For instance hedge is common used financial method to handle this type of problem. Optimization can prepare the decision makers but the taking actual action does not belong to optimization and planning unit (Kenesei, personal communication, 2012-04-20; Cs. Paal, personal communication, 2012-04-25).

**Distribution and Logistics**

The interviewee reminds that oil products have a great water of condition therefore supplying and deliver it is costly and difficult. Changing capacity of the transport is also hard, for instance shipping is not everywhere an option or building pipeline is expensive, takes time and also have fixed capacity. Therefore logistics has to consider several option and bridge any logistics constrain. For instance due to a relative sudden order, if MOL has to sell other three kt petrol for Germany, transfer could be very challenging since it would need at least 120 wagons to deliver it (Sz. Szabó, personal communication, 2012-04-02).

Logistics has to provide information to the planning and optimization unit about its capacity and possibilities and an optimal solution will be sent back for them. Based on this information returned, logistics carries out its tasks. It also gives certain flexibility to the supply chain since the unique refinery locations let MOL Group allocate different refinery configurations among the refineries, therefore, the significance of transfer of finished and semi finished products increases. Also by logistics operation between the refineries, unforeseen events can be handled more effectively (Kenesei, personal communication, 2012-04-20).
After the refinery stage, finished goods are transferred to the depots via pipe line or in some cases by rail as a second cheapest solution. For the illustration, there were 42 depots few years before, and due to optimization this number is 7 today. The finished good from the depot is either picked up by the whole seller or delivered on trucks by MOL. The scheduling and route optimization is the local logistics' responsibility (Sz. Szabó, personal communication, 2012-04-02).

**Marketing**

The interviewee states that there are two main target markets where the MOL Group supplies its products: wholesale and retail markets. Whole sale stands for business to business industrial market. Retail is business to customer which is more about satisfying individual needs. Through the own retail filling station network MOL Group reaches its customers whether they are individuals or businesses. Wholesale appears when the buyer posses its own storage capacity therefore, greater quantity can be purchased. It can be for industrial usage but it also can be other oil companies’ retail filling stations which obviously will increase the competition (Cs. Paal, personal communication, 2012-04-25). The main markets of MOL Group are within around 500 km radius ring around each refinery (Cs. Paal, personal communication, 2012-04-25). The retail filling stations has a presence in Austria, Czech Republic, Slovenia, Slovakia, Romania, Serbia, Croatia, Bosnia and Herzegovina and in Italy. The MOL name is not represented in each country under own brand name. The main products are different fuels, petrochemical products and bitumen. Two latter are exported all over to Europe and to outside of Europe, to China and United States (Cs. Paal, personal communication, 2012-04-25).

At MOL Group purchasing crude oil and selling finished products under the consideration of refinery and logistics functions is the duty of the marketing function. The goal is to achieve an optimum level where market demand can be served on the lowest cost in order to obtain the highest profit margin (Cs. Paal, personal communication, 2012-04-25). The constraints in the retail network and in the wholesale are also explained. The retail network works as a franchise system which has a high capital investment need and it bears operational risk due to demand fluctuation. On the other hand products are sold directly to the final users in the wholesale thus the profit is directly for MOL Group which is assured by long term contracts. However, there is high level of competition for these supplier contracts. In addition competition on price and services occurs between other retail networks for the customers, for cheaper supplies of product. For the profit maximization, both retail sale and wholesale has to be exploited. The price fluctuation is also a serious constraint which needs to be handled (Cs. Paal, personal communication, 2012-04-25).

The interviewee asserts that the price of the oil is determined by the demand and supply. There is an organisation, so called Platts Group which monitors the oil market, provides information and notes market price which is a starting point for further pricing. The oil trade usually is concentrated in certain region. Regarding MOL Group, the Mediterranean region's prices are relevant. Seasonal trends,
automobile industry trends, countries’ economic and political situation, speculation also has an impact on the prices. This price volatility has to be constantly analyzed for different period of time, even for decades (Cs. Paal, personal communication, 2012-04-25). The interviewee mentions that there are a few possibilities to handle price fluctuation risks by using financial instruments. Swap lets to sell and buy oil in a fix price. It is transaction where physical oil transfer does not occur. Hedge is another financial instrument which contains a swap and physical buy or sale contracts making a fix price up. It is for a future transaction on the stock market where the sale occurs on predetermined date on the given current price. After the sale the same commodity will be bought back. Whether the prices increase or decrease, it is a safety solution because either the stock transaction or the physical sale make profit and balance the loss (Cs. Paal, personal communication, 2012-04-25).

MOL’s every refinery optimizes with the purpose of maximizing profit (Cs. Paal, personal communication, 2012-04-25). However to achieve this, the production has to be aligned to the market needs. Types of products and their quantity need to be produced in such optimal way which provides the greatest profit margin. The product price and logistics cost have to be considered in each market as it could show differences. Through optimization many other constraints are considered such as refinery configuration, crude oil quality, logistics capacity. Marketing also adds information to the supply chain optimization. It follows the market trends, noted prices, indicates obligations based on contracts and assesses further possibilities. Considering any input, PIMS gives the maximized profit from the purchase price and sale price (Cs. Paal, personal communication, 2012-04-25).
5 Analysis

Following Jönköping University’s (2011) guidelines, analysis has to be based on the literature review and findings. It examines the theories and concepts introduced in the literature review in view of the empirical study, in a systematic manner. It compares and contrasts the theory and findings with a constant linkage back to the purpose and research questions (Jönköping University, 2011). It needs to be noted that both the literature review and the empirical study devote greater attention to the downstream oil supply chain but, in few contexts, the upstream cannot be totally excluded.

5.1 Downstream Oil Supply Chain Management and Optimization

At the MOL Group supply chain management along with its optimization practice, communicates, collaborates and controls its vertically integrated chain and its divisions through its IT system (Kenesei, personal communication, 2012-04-20). This statement also could be a description of the diagram about optimization framework (Figure 2.3) developed in the literature review. The diagram illustrates the optimization process in the downstream oil supply chain and shows their connection. It also refers to the interaction of the different functions of the supply chain and optimization process. The diagram sets a good, simple base for optimization of downstream oil supply chain and highlights those options which are necessary for the optimization. Therefore, it fulfils the purpose of the thesis and serves as an answer for the first research question. However, after the analysis of the MOL Group it can be seen that it is really a simplistic framework for a very complex process which can miss factors regarding optimization. It does not consider possible time horizon regarding how long ahead the optimization and planning is for. At MOL, optimization includes preparing decision making but it depends on how long the period of time is, for which planning is made up because it raises different strategic issues. Also the detailed rolling planning system is a very important part of optimization since this is the main antidote for the high level of uncertainties and the source of creating a flexible supply chain (Kenesei, personal communication, 2012-04-20).

Hall (2012) and Ribas et al. (2011) argues that supply chain management in the oil industry has a key role to gain competitive advantage. The interviewees support the importance of supply chain management and state that MOL Group’s strives to improve its supply chain management philosophy as it is considered as a main source of gaining and sustaining competitive advantage through cost efficiency (Sz. Szabó, personal communication, 2012-04-02; Kenesei, personal communication, 2012-04-20; Cs. Paal, personal communication, 2012-04-25). It is not a coincidence. The oil industry is a very profit orientated business which involves billions of dollars. Since supply chain management focuses on how to be cost efficient and any type of savings means a large amount of money, it is especially significant in the oil industry (Anderson, 2003; Gainsborough, 2006). Optimization is considered as ‘tool’ to cost efficiently manage the supply chain in the oil industry.
(Gene & McDougall, 1998; Anderson, 2003; Hussain et al., 2006). The findings also show that the primary goal of optimization at MOL is to generate as high profit as possible (T. Kenesei, personal communication, 2012-04-20). However, supply chain management and optimization in the oil industry is not just for profit maximization, it also helps to avoid threats (T. Kenesei, personal communication, 2012-04-20).

It is an absolutely necessary function since the literature review reveals that oil industry it is full of constraints. The oil market is volatile and filled by many uncertainties which are due to two main characteristics, its complexity and inflexibility (Hussain et al., 2006; Gainsborough, 2006). This raises several other issues as well such as price fluctuation, long lead time, rigid procurement processes (Jenkins & Wright, 1998; Ribas et al., 2011). To handle these problems oil companies tend to integrate their different supply chain functions vertically (Stabell, 2001; Hall, 2002; Gainsborough, 2006). It is justified the necessity of vertical integration by allowing the MOL Group to have a greater control over the supply chain. That is why efficient supply chain management through optimization has a main role (Sz. Szabó, personal communication, 2012-04-02).

The literature review’s and interviewees’ approach to the problems shows a little difference but the key issues remain similar. The before mentioned constraints are introduced by the interviewees too but through the different functions of the supply chain such as demand forecasting, procurement constraints, refinery constraints, logistics constraints and marketing constraints. Also a few differences can be found in the way how the downstream is divided. MOL Group’s supply chain is introduced in detail, for instance marketing is categorized as wholesale and retail sale which have very different constraints.

Regarding supply chain management, Ratliff (2007) states that optimization provides the greatest opportunity to improve cost efficiency. Hasini (2008) adds that optimization serves as a practise to use efficiently the resources. The interviewees also puts optimization in the centre of the MOL Group’s supply chain management. The organisation structure of MOL Group’s downstream supply chain underpins this statement as illustrated by interviewees. The interviewees listed the different units of supply chain management department at MOL: strategic planning, planning and optimization, refinery scheduling, supply and distribution planning and performance monitoring. Even though the name of these units appear with a slight difference, their function covers the optimization steps identified in the literature review proving the significance of optimization at the MOL Group and that its downstream supply chain management is built around it. The optimization steps are based on Bryan and McDougall (1998) who names these steps as follows: planning, scheduling, executing, tracking and adjusting.

5.2 Approaches to the Optimization

Hussain (2006) emphasizes that integration has to happen from procurement to the delivery of the final product. Also suppliers and customers should be integrated into the supply chain. It is noted that the MOL Group is different in a
way from the biggest oil companies where the upstream segment of the chain is integrated too. At MOL, upstream supply chain is a separate business segment (Sz. Szabó, personal communication, 2012-04-02). The interviewee also notes that MOL has control over the chain through integration which creates additional value by having the ability for quicker response for any change. Lancioni, Smith and Oliva (2000) and Ratliff (2007) state that a company cannot work without proper information sharing. Therefore, an adequate IT solution is inevitable regarding optimization.

Whereas Jenkins and Wright (1998) state that IT is to improve the planning and controlling of supply chain. Almost a decade later Gainsborough (2006) already talks about it as a necessity for a standardized refinery and scheduling process. The interviewees mention IT as an inevitable tool for optimization (Szabó, personal communication, 2012-04-02; T. Kenesei, personal communication, 2012-04-20). They also argue for linear programming which was suggested by Gainsborough (2006) too. MOL Group uses PIMS which is actually commonly used software in the oil industry with a main focus on refinery configuration and production of most profitable product set by the marketing (Sz. P. Szabó, personal communication, 2012-04-02). It also considers other variables such as price fluctuation which obviously modifies the options for optimization (Cs. Paal, personal communication, 2012-04-25; Kenesei, personal communication, 2012-04-20). If any change occurs, and change has to be made in the optimization, then the role of collaboration enhances too.

Collaboration’s importance is stressed in the literature review. However, the actual implementation within an oil company is not mentioned. The interviewee bridges this gap by explaining the role of forums at MOL Group. It serves as second platform beside the PIMS for information sharing but it is mainly for decision making and approving plans (Sz. Szabó, personal communication, 2012-04-02). It is a very important element of optimization. Since MOL’s refineries are located much closer to each other compared to other oil companies, it gives the MOL Group a good potential and more option for optimization, but in the meantime, a more complex supply chain has to be managed. The frequent forums assure a way for communication and collaboration in order to increase flexibility and reduce complexity of supply chain (Sz. Szabó, personal communication, 2012-04-02).

5.3 Functions of Downstream Oil Supply Chain

The different divisions in the supply chain identified in the literature review and in the MOL case study are roughly covering each other. Only a few differences can be found such which function is carried out by which department, and it could vary in every company. The literature stands more like a frame work for identifying issues, sometimes suggests broad solutions but the empirical study demonstrates what constraints the different functions are faced with in the case of MOL and gives deeper answers and practical solutions.

The importance of demand forecasting is emphasized by both the literature review and interviewees since this triggers the whole process starting with procurement
(Balasubramanian, 2002). The main issue here is the inaccuracy of forecasting. The interviewee highlights the importance of the rolling plan which can handle demand fluctuation (Kenesei, personal communication, 2012-04-20). Jasuja et al. (2009) and the interviewee mention that the procurement method based on long term contracts actually serve as a sort of protection against price fluctuation which affects the demand. Demand planning and procurement function is carried out by marketing department at the MOL Group. Apart from this information little literature is found about activities of marketing, therefore it remains overlooked in the theoretical framework. However, its significance in the optimization is highlighted. It has very tight linkage to refinery operation regarding setting direction for them, such as which crude oil, in which quantity and what derivatives need to be produced to get highest profit margin (Cs. Paal, personal communication, 2012-04-25).

The costly and complex refinery activity stands in the centre of the optimization. Planning its configuration and aligning the production with inventory management is crucial for both cost savings and generating profit. Its importance is emphasized both in the literature review and in the empirical study. Distribution is identified as one of the flexible elements by the literature review (Jenkins & Wright 1998). Jenkins and Wright (1998) find logistics as an area to reduce cost and achieve customer satisfaction since oil supply chain has a long lead time and many means of transport can be involved. In the case of the MOL Group, the attention is devoted to the logistics regarding the unique refinery locations where the transfer between them in the interest of optimization, is important.

It can be seen that all elements of optimization are in mutual synergy. They all meet in one focal point which is the supply chain management. It strives to optimize the chain by coordinating the different functions in order to achieve effectiveness and higher profit.

5.4 Summary

The analysis compares the literature review and the findings of the empirical study. It can be seen that the supply chain management and optimization is at the centre of the oil industry in order to maximize profit and achieve competitive advantage. The MOL case study shows that optimization is also used for avoiding threats and it is illustrated how the uncertainties and constraints can be effectively handled. The theoretical framework of the optimization in the downstream oil supply chain, showed in the diagram (Figure 2.3), is simplistic compared to a very complex optimization process demonstrated by MOL case study. However it provides a very good basis for the analysis. Each factor of optimization such as the optimization steps and approaches is examined through the MOL Group, then finally the similarities and differences are analysed.
6 Conclusion

In the conclusion the outcome of analysis is summarized in the view of the research questions addressed by the thesis. The structure of the thesis is based on a funnel approach where the broad problem of the oil industry is introduced, then gradually narrowed down to supply chain optimization which stands at the centre of oil companies since it is recognised as the major tool to gain competitive advantage. It is noted several times that the analysis focuses on the downstream oil supply chain. The conclusion also contains discussion at the end of this section.

The literature review shows the main characteristics in the oil industry which are responsible for the high level of uncertainties. Complexity and inflexibility of the oil supply chain raises numerous constraints and challenges such as long lead time, involvement of many modes of transportation, rigid procurement and fixed shipping capacity. Uncertainties also include the impact of economic and political situation on the oil industry which are reflected by price and demand fluctuation. Seeing the several constrains involved in the oil industry, it is understandable that oil companies’ common characteristic is settling in a vertically integrated way in order to handle complexity and have a better control over the chain.

Regarding the supply chain, the refinery function stands as an unique stage particular to oil industry. It also increases the complexity and tightly operates together with the marketing and logistics. The size of the oil industry and the amount of money involved in the oil business justify the significance of managing a very efficient supply chain which focuses on cost efficiency and profit maximization. Achieving these goals the optimization plays a key role which is based on very sophisticated mathematical programming and IT solutions. Optimization is not just used for increasing the profit but it is used for efficiently using the resources and avoiding threats by handling uncertainties. Uncertainties set not only constraints but increase the options for solutions. Therefore, optimization aims to find the best possible solution for handling any constraints. Supply chain optimization at the MOL Group stands as a primary tool to operate the everyday business process and to maximize profit. The MOL Groups’ refineries are also located in a very unique way compared to other oil companies which gives opportunities to gain and sustain competitive advantage by optimizing the refinery network. The MOL Group exploits this opportunity very well since it has a leading position within oil companies in Europe regarding net cash margin ($/ barrel) (Appendix 4; Appendix 5).

The analysis is based on the set theoretical framework illustrated in the diagram (Figure 2.3). It shows the factors which are necessary for the whole optimization process, although at a few points it can be modified after examining MOL Group’s solution for optimization. Of course a few differences derive from basic reasons such as geographical position, resource capacities and governmental regulations. It also can be assumed that in other oil companies the organisation might be structured in a different way, for instance some of the functions of the supply chain belong to different divisions or stand as a separate division. But there are some important points which are necessary to conclude.
First of all, satisfying customers is mentioned by the literature review as one of the ways to achieve profit maximization and competitive advantage. The analysis shows that customer satisfaction is considered secondary regarding optimization. Optimization focuses more on cost efficiency and on achieving the highest possible profit. Optimization is also much more complex than only 5 steps showed by the diagram. The MOL Group’s optimization process demonstrated in the analysis is much more sophisticated. The downstream supply chain management is already structured into units which are matched to the optimization steps. Planning also plays a greater role triggering the whole optimization process and considering many time horizons depending on how long ahead the optimization is for. The importance of the rolling plan is very important for the everyday operation and also to handle uncertainties. Therefore, it is identified as a main opportunity to increase the flexibility of the downstream oil supply chain at the MOL Group. Furthermore, the case study helps to understand the importance of IT and how important it is to feed the supply chain with adequate information which develops high levels of cooperation and collaboration between the functions. Therefore the integration also can be deepened. The analysis elaborates and explains in depth on the different constraints in each supply chain function through practical examples provided by interviewees.

The literature review serves to find options and a main factor for optimization of the downstream oil supply chain and also provides a framework to elaborate these options in the view of the MOL Group. Overall the analysis contributes to having a very well detailed picture about supply chain optimization, about its importance and its process at MOL Group. It is clear that the many factors identified are in strong synergy, and cannot work without each other. However, apart from this tight interaction and with not having the intention to degrade other factors’ role, it can also be concluded that planning, marketing, refinery and IT have a dominance to fulfil the final achievement.

One of the reasons for choosing this topic was that supply chain optimization in the oil industry can be overlooked, even though the economic importance of oil, the size and profitability of oil companies are well known. There are two ways to approach this subject. One of them is from a software development side which is more common. In this case the focus is more on the mathematical programming. Another type of approach which is used is more theoretical and views supply chain optimization as a whole where IT takes place only as a part of the optimization. This is the type of approach which is less common, however, due to the above mentioned reasons it is worth to look at. Since optimization in the oil industry has a central importance, it has been constantly developed year by years to achieve the most profitable solutions. Therefore, investigating this topic in depth could be in use for other industry too.

In the delimitation it was mentioned that the thesis could be improved by analyzing more than one company. In addition, petroleum companies usually have gas and petrochemical profile too. Due to the time limit of thesis would have degraded the quality of the work to carry job out considering all aspects. At the beginning we also considered comparing two oil companies but after finishing the work, we believe that it would not have been a good idea. Otherwise we could not have made
such a detailed empirical study due to limitation. Even now, the thesis would be more complete if at least one interview from each division and unit from the downstream supply chain could have been made at MOL Group. Therefore, there are still many places for further researches on this topic.
References


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Appendices

Appendix 1

Oil Consumption (2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>Bbl/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>18,690,000</td>
</tr>
<tr>
<td>China</td>
<td>8,200,000</td>
</tr>
<tr>
<td>Japan</td>
<td>4,363,000</td>
</tr>
<tr>
<td>India</td>
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<tr>
<td>Russia</td>
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<tr>
<td>Brazil</td>
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<tr>
<td>Germany</td>
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<tr>
<td>Saudi Arabia</td>
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</tr>
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<tr>
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<tr>
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<tr>
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</tr>
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<td>United Kingdom</td>
<td>1,669,000</td>
</tr>
<tr>
<td>Italy</td>
<td>1,537,000</td>
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</table>

(Nation Master, 2009)
Appendix 2

Oil Consumption (2010)

<table>
<thead>
<tr>
<th>Country</th>
<th>Bbl/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>19,150,000</td>
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<tr>
<td>European Union</td>
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<tr>
<td>Saudi Arabia</td>
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<tr>
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<td>Russia</td>
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<tr>
<td>Mexico</td>
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<tr>
<td>United Kingdom</td>
<td>1,622,000</td>
</tr>
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</table>

(CIA, 2010)
Appendix 3

**Biggest Oil Exporters (2010)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Bbl/day</th>
</tr>
</thead>
<tbody>
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<td>Russia</td>
<td>10,270,000</td>
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<td>United States</td>
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<td>Iran</td>
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<td>United Arab Emirates</td>
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<td>Brazil</td>
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<td>Nigeria</td>
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<td>Kuwait</td>
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<tr>
<td>Venezuela</td>
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<td>European Union</td>
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<tr>
<td>Norway</td>
<td>2,134,000</td>
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</table>

(CIA, 2010)
Appendix 4

Net cash margin ($/barrel) in Europe by refineries (2007)

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Refinery</th>
<th>Net Cash Margin (US$/bbl)</th>
<th>Country</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Duna</td>
<td>11.2</td>
<td>Hungary</td>
<td>MOL</td>
</tr>
<tr>
<td>2</td>
<td>Bratislava</td>
<td>10.8</td>
<td>Slovak Republic</td>
<td>MOL</td>
</tr>
<tr>
<td>3</td>
<td>Schwedt</td>
<td>10.5</td>
<td>Germany</td>
<td>BP/ENI/Shell/Total/PV</td>
</tr>
<tr>
<td>4</td>
<td>Leuna (Mider)</td>
<td>10.3</td>
<td>Germany</td>
<td>Total</td>
</tr>
<tr>
<td>5</td>
<td>Porvoo</td>
<td>10.2</td>
<td>Finland</td>
<td>Neste Oil</td>
</tr>
<tr>
<td>6</td>
<td>Puertollano</td>
<td>10.0</td>
<td>Spain</td>
<td>Repsol YPF</td>
</tr>
<tr>
<td>7</td>
<td>Plock</td>
<td>9.8</td>
<td>Poland</td>
<td>PKN Orlen S.A.</td>
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<tr>
<td>8</td>
<td>Omsk</td>
<td>9.6</td>
<td>Russia</td>
<td>Gazprom</td>
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<td>9</td>
<td>Pernis Shell</td>
<td>9.4</td>
<td>Netherlands</td>
<td>Shell/Statoil</td>
</tr>
<tr>
<td>10</td>
<td>La Coruna</td>
<td>9.0</td>
<td>Spain</td>
<td>Repsol YPF</td>
</tr>
</tbody>
</table>

(BME, 2012)
Appendix 5

Net cash margin ($/barrel) in Europe by companies (2007)

*Source: WoodMackenzie – European and Russian refiners, Net Cash Margin in 2007*
Appendix 6

Interview 1

Interviewee: Szabolcs Szabó, Performance Analyst at Supply Chain Management Department

Interviewers: Daniel Szucs and Kedir Hassen

Date: 2012-04-02

Questions

MOL’s Supply Chain Management and Optimization

How does the downstream supply chain of MOL look like? (Departments and their functions?)

Why optimization is important for MOL?

What are the main steps and options used by MOL for optimizing its downstream supply chain?

How optimization process works in practice at MOL?

How does planning trigger the whole optimization process regarding the scheduling, executing and performance measurement?

How does MOL adjust its optimization activities in the supply chain when any change occurs? What actions need to be taken in these cases?

Do you think that optimization would work without integration, IT and collaboration? (what else?)

Integration

How does integration work in practice at MOL:

-vertically: between different units (procurement, refinery and distribution), suppliers and customers? How much control does MOL have in the supply chain? Why is it beneficial?

-horizontally?
Information Technology

IT triggers integration and enhances information sharing. This also contributes to a better communication, collaboration and measuring performance. What IT software (Enterprise Resources Planning - ERP) does MOL use for and how does it help the integration and optimization (planning, scheduling, executing and performance measurement)?

What are advantages and disadvantages of this software?

Many individual supply chain partners, suppliers and customers use their own IT software which makes it hard to integrate information and data into the main company or they are just cautious to share them. What solution does MOL have for solving this problem?

How MOL’s IT solution handles the many uncertainties surrounding the oil industry such as price fluctuation, demand fluctuation, political change, long lead time and the complex and inflexible nature of the oil supply chain?

Collaboration

How collaboration work within MOL Group between different departments? (IT?)

As MOL is international and has a wide supply network, MOL needs to build trust with the players of the supply chain in order to bridge cultural differences and enhance collaboration and information sharing. What is MOL’s strategy for this?

Does MOL have any permanent or temporary alliances with any competitors in order to achieve a better cost efficiency and customer satisfaction? (For instance shipment swapping)

Demand Forecasting

Which department's task is the demand planning?

How does MOL make sure to gather accurate demand information? (How accurate are they normally?)

Does the demand change quickly and frequently? How MOL prepare for this? (Solutions)
Procurement

How long ahead does MOL have to make the order for procurement?

What does MOL base the decision on where and which raw material needs to be acquired?

Refinery Planning and Inventory Management

How does MOL decide where, how much and when to produce?

Where does MOL store its crude oil and its finished products?

How much safety stock does MOL have to keep and how this decision is determined? How does MOL retrieve from the storage? Is there any governmental regulation?

Distribution and Logistics

How distribution can be optimized?

What mode of transport does MOL use for delivering from refinery? Why this mode? (Fleet size, routes)

What mode of transport does MOL use for delivering from storage? Why that mode and how much?

What mode of transport does MOL use when it ships products to distribution centres or to retailers? Why this mode? Does cost efficiency or customer satisfaction have greater preference?

Performance Measurement

How and in what timeframe does MOL measure its performance?

What are the Key Performance Indicators used by MOL?

Does MOL use benchmarking for performance measurement?
Appendix 7

Interview 2

Interviewee: Tamas Kenesi, Planner and Optimizer at Supply Chain Management Department

Interviewers: Daniel Szucs and Kedir Hassen

Date: 2012-04-20

Questions

What are the main goals and roles of optimization in MOL’s Downstream SCM?

What does MOL mean by optimization?

Why is optimization important? What are the drivers for optimization? The followings are identified by the thesis:

- Competition (competitive advantage: being more cost efficient and customer focused)

- Complexity (long lead time: hard to meet customer’ requirements; complex refinery process; various modes of transportation)

- Inflexibility (fixed shipping capacity, take or pay contract because of the storage capacity; purchasing crude oil 9 month before actual sale)

- Uncertainties-market volatility (price fluctuation; political changes; demand and supply change; break down; natural disaster)

Apart from the above mentioned, what else could set constrains for MOL and what solution does MOL have for solving them? Especially regarding:

- Procurement (Choice of suppliers are limited? Why? Risk management in the case of disturbance in supply?)

- Refining

- Inventory (it is costly but to meet customers’ needs under high level of uncertainties might be necessary. Does MOL strive to decrease its stock or rather keep it on higher level for satisfying its customers in a case if some-
thing unforeseen happens? What is the minimum level of safety stock?
What information does inventory management needs from whom?

- Logistics (how does MOL optimize it, what IT program does Logistics use for optimization, does it focus on level of service for customer or cost efficiency? What modes of transportation are preferred? What are the factors which determines the distribution planning (fleet size, shipment routes and quantity of the delivered products)

- Marketing (accurate demand forecast? Where and how is the demand information gathered? How great can demand changes be? How does MOL handle the changes?

What are the flexible elements in the supply chain which could increase responsiveness to any change? (E.g. logistics; what else?)

Optimization steps identified by the thesis work: planning, scheduling, executing, tracking, and adjusting. What are the optimization steps at MOL?

How the optimization procedure does work at MOL and which department what duties do have to do in a time order? What information is needed from each department for the optimization?

How does MOL respond to any change occurred in order to make the supply chain more flexible? How do the changes influence the optimization process?

How does collaboration work from planning to evaluation? How MOL does it do on international level? (Forums)
Appendix 8

Interview 3

Interviewee: Csaba Paal, McKinsey & Company Consultant

Interviewers: Daniel Szucs and Kedir Hassen

Date: 2012-04-25

Questions

Which project did you participate at MOL?

How does downstream supply chain look like at MOL Group?

What are the main functions of marketing department?

What are MOL’s target markets?

What are the constraints of marketing division?

How MOL handles these constrains?

How does marketing contribute and add value to the supply chain optimization?

Why marketing function is important?