

A PERSPECTIVE ON CHALLENGES AND OPPORTUNITIES OF SUPPLY CHAIN MANAGEMENT

Kavitha Jayakumar and B. Valarmathi

Department of commerce, Christ University, Bangalore-560029, India

Corresponding Author: Kavitha.arjunan@christuniversity.in

ABSTRACT

The global demand for oil and its derivatives such as petrochemicals has enabled companies providing these products to reach more customers and increase their market share and profitability. Supply Chain Management in petroleum industry contains various challenges in logistics area as an opportunity for cost saving by swap practice which is referred as 'Systematic cooperative reciprocal barter'. The unpredictability in oil prices, refining margins and the long lead times associated with vital functions like crude buying and product trading make the entire process challenging. The objective of this paper is to shed some light on the supply chain challenges and opportunities in the petroleum industry and on swap practices that have been employed as excellent supply chain practice by petroleum industry. The major segments are upstream and downstream supply chains. The upstream supply chain involves the acquisition of crude oil which is the specialty of the oil companies. The upstream process includes exploration, forecasting, production and logistics management of delivering crude oil manufactured into consumable products that are the specialty of refineries and petrochemical companies. The downstream supply chain involves the process of forecasting, production and the logistics management of delivering the crude oil derivatives to customers around the globe.

Key words: Supply Chain Management, Logistics and SWAP practice.

INTRODUCTION

The steadily increasing global demand for oil and its derivatives such as petrochemicals has enabled companies providing these products to reach more customers and increase their market share and profitability. This boom in global demand along with the ease of international trade and the inflexibility involved in the petroleum industry's supply chain has made its management more complex and more challenging (Bianchi, 2003). Despite the importance of supply chain management and its growing complexity, the petroleum industry is still in the development stage of efficiently managing their supply chains. However, even with the inflexibility and complexity involved in the industry's supply chain, there is a lot of room for improvement and cost reduction, specifically in its logistics area. By the end of 2004, world-wide demand for oil reached 75 million barrels per day and has been projected to increase at a rate of 2 percent per year over the next ten years. Due to recent political unrest in the Middle East, which is the largest oil producing region, sustainable oil supply has become highly unpredictable (Jenkins and Wright, 1998 and Alshalan, 2004). Oil and petrochemicals companies are forced to maintain higher safety stocks and search for alternative sources of supplies. Commodities such as oil, gas, and petrochemicals require specific modes of transportation such as pipelines, vessels or tankers, and railroads. These commodities are produced in specific and limited regions of the world, yet they are demanded all over the globe since they represent an essential source of energy and raw material for a large number of other industries. Several weeks lead-time from the shipping point to the final customers'

location is very common in this type of industry. For example, it takes five weeks for the Persian Gulf's oil to make its way to the United States and up to another three weeks for it to be processed and delivered (BP, 1993; Coia, 1999; Hull, 2001 and Ikram, 2004). Opening new production sites or distribution centers closer to dispersed customers is one way to reduce the lead time and transportation costs. These factors are pushing oil and petrochemicals companies to either absorb the increase in costs or pass the costs on to customers who are already facing increasing prices (Collins, 1999; Guimaraes *et al.*, 2002). Companies therefore have recognized that improved supply chain efficiencies represent a huge area for cost savings, specifically in the logistics area; they are estimated to be an average between 10 and 20 percent of revenues.

Scope of Supply Chain Management in the Petroleum Industry: The objective of this paper is to shed some light on challenges and opportunities in the petroleum industry's supply chain management. It will focus on a practice that has been saving companies millions of dollars but has long escaped the attention it deserves from academia. The practice is referred to as systematic cooperative reciprocal barter also called "swaps".

Supply Chain Management in the Petroleum Industry: The supply chain of the petroleum industry is extremely complex. It is divided into two different major segments: the upstream and downstream supply chains. The upstream supply chain involves the acquisition of crude oil, which is the specialty of the oil companies. The upstream process includes the exploration, forecasting,

production, and logistics management of delivering crude oil from remotely located oil wells to refineries. The downstream supply chain starts at the refinery, where the crude oil is manufactured into the consumable products that are the specialty of refineries and petrochemical companies. The downstream supply chain involves the process of forecasting, production, and the logistics management of delivering the crude oil derivatives to customers around the globe. Challenges and opportunities exist now in both the upstream and downstream supply chains.

Limitations in the Supply Chain Management:

The logistics network in the petroleum industry is highly inflexible, which arises from the production capabilities of crude oil suppliers, long transportation lead times, and the limitations of modes of transportation. The oil and petrochemical industries are global in nature. The long distance between supply chain partners and slow modes of transportation induce not only high transportation costs and in-transit inventory, but also high inventory carrying costs in terms of safety stocks at the final customer location. The great distances between supply chain partners present a high variability of transportation times that can hurt suppliers in terms of service levels and final customers in terms of safety stock costs. Moreover, the transportation process is carried out either by ships, trucks, pipelines, or railroads. In many instances, a shipment has to exploit multiple transportation modes before reaching the final customer's location. Such constraints on transportation modes in this type of industry induce long lead times from the shipping point to the final customers' location compared to other industries. Hence, considering the amount of inflexibility involved, meeting the broadening prospect of oil demand and its derivatives while maintaining high service-levels and efficiency is a major challenge in the petroleum industry. The logistics function is only one of many areas that affect supply chain performance in the petroleum industry. Integrated process management, information systems and information sharing, organizational restructuring, and cultural reorientation are as equally important. The need for integrated processes all the way from procurement of raw materials to the delivery of the final product is crucial for a company's success. The industry lags behind in using integrated planning across the supply chain. This type of disintegration in the supply chain can increase the cost of acquiring crude oil, which will eventually affect gas prices for consumers. Also, due to the globalization of the petroleum industry supply chain, sophisticated information technology is essential for smooth information flow considering the complexity of the logistics network in such an industry. Companies' relationships in supply chain networks are directly related to the effective use of information

technology. Data flow diagram (DFD) was developed by Hull in 2001 to improve supply chain information flow reliability. The DFD helped to realize the importance of the relationship between scheduling and dispatching. Sophisticated information technology is also essential for petroleum industries due to security needs. Petroleum companies ship a great deal of hazardous products, and supply chain partners (suppliers and customers) must be aware of the locations of each shipment at any point in time. Another challenge in the petroleum industry supply chain is the attitude and anxiety regarding collaboration and information sharing between supply chain partners. While collaboration and information sharing represent a crucial factor for supply chain efficiency, companies in the petroleum industry are sometimes cautious when it comes to sharing their demand/costs information. Improved supply chain efficiency in the petroleum industry, therefore, needs a new philosophy in collaboration, even if this means working with competitors. Collaboration, information sharing, and asset optimization require the greatest mind change because chemical producers and LSPs would have to work with their competitors, as well as with other operators in the supply chain. The acquisition of sophisticated information technology, although necessary, can only do so much if it is not supported by a cultural change.

Opportunities in the Supply Chain and Swap

Practices: In an effort to manage their supply chain and reduce costs, oil and petrochemical companies are outsourcing their logistics functions. As the trend in outsourcing has grown, these companies have become increasingly reliant on the services of third-party logistics companies for managing their supply chains. Companies in the petroleum industry, however, took the outsourcing idea one step further and found that one way of outsourcing their logistics functions is to ally and collaborate with competitors. This form of collaboration is referred to as a systematic cooperative reciprocal barter (also called "swaps" or "exchanges") of supplies, assets, market share, or even the entire business among competitors. However, despite the significant advantages this practice has generated for companies, a defined model for making such decisions does not exist. The subject has barely received any attention in the operations management literature. An interview with supply chain directors in two international petrochemical companies that have been involved in swapping with their competitors for the past few years revealed that the only methods used are judgmental methods and spreadsheets. Although judgmental approaches may improve accuracy in many decision-making problems, they should not be the only methods employed. The use of only such approaches cannot guarantee an optimal solution.

The Swap Practice: In a commodity-type industry such as oil and petrochemicals, the source of the commodity is often of no interest to the final customer as long as the commodity adheres to its required specifications and the delivery of that commodity is made by the promised due date. Therefore, competing oil and petrochemical companies form supply chain alliances when delivering commodities to customers in order to reduce transportation and inventory costs and improve customer service. In return, cost savings for transportation in the overall supply chain are shared among participating companies. This form of collaboration is referred to as shipment swapping. The swapping technique is currently applied by oil and petrochemical companies around the world in all of its different forms: asset swapping, business swapping, and shipment swapping. However, because of the absence of any general analytical discussion of swap practices in the literature, we first provide examples from the oil and petrochemicals industry for each form of swap practice being used.

Asset Swapping: In 2001, BP became the largest olefins producer in Germany after an asset swap with E.ON, a German utility company. Following the deal, BP took over Veba Oel, E.ON's oil, refining, and petrochemicals business, and E.ON bought BP's 25 percent stake in Ruhrgas, Germany's largest gas distributor. The deal gave BP 2.1 million tons of ethylene capacity in Germany, which is about 40 percent of the country's total, and gave E.ON control of one of the largest gas distribution networks in Germany. In 2003, BASF, a leading German chemical company, and Honeywell signed a long-term deal under which BASF will supply Honeywell with nylon chips and Honeywell will supply BASF with specialty nylon and nylon co-polymers. Since Honeywell has a strong presence in electrical and tooling applications and BASF is strong in the automotive sector, the deal has benefited both companies in their business specialties. For example, in 2003 the deal raised BASF's market share in nylon from 9 percent to 35 percent and gave Honeywell the chance to concentrate on carpet, apparel, and fabrics for automotive upholstery. Honeywell plans to eventually sell the nylon business. More recently, the Kuwait Petroleum Company (KPC) and the Iraqi Oil Institute (SOMO) signed a comprehensive memorandum of understanding related to exchanges of shipments of Kuwaiti benzene and diesel with Iraqi natural gas. The swap will be implemented in two phases. Thirty-five million cubic feet of Iraqi natural gas will be supplied daily to Kuwait for about one year at an estimated cost of U.S.\$24 million during the first phase. Then, 165 million cubic feet of natural gas will be supplied daily to Kuwait for about two years at an estimated

cost of U.S.\$700 million dollars during the second phase. Meanwhile, Kuwait will supply Iraq with oil derivatives, benzene, and diesel, ranging from two to three million liters of benzene and 1.3 to 1.5 million liters of diesel daily. The outcome of this agreement is expected to significantly benefit both countries. Kuwait produces a relatively modest volume of natural gas (around 293 billion cubic feet—Bcf—in 2002), the vast majority of which is "associated gas." Prior to the 1990-1991 Gulf War, Kuwait received significant volumes of natural gas from Iraq. The gas came from Iraq's southern Rumaila field through a 40-inch, 100-mile, 300 Mmcf/d pipeline to Kuwait's central manifold at Ahmadi. The gas was used for the production of petrochemicals, electricity, and water through desalination processes. With such uses of natural gas, the Kuwaiti-Iraqi swapping deal could free up a substantial amount of oil to Kuwait, possibly 100,000 barrels per day (bbl/d) for export by 2006, which is presently used for similar purposes. For example, 65,000 bbl/d of fuel oil is currently used to generate electric power in Kuwait. Throughout most of the 1990s, Iraq generally did not have access to the latest state-of-the-art oil industry technology. Saybolt International reported that Iraq oil companies, NOC and SOC, were able to increase their oil production through the use of short-term techniques not generally considered acceptable in the oil industry (i.e., "water flooding," the injection of refined oil products into crude reservoirs). In addition, a U.N. report in June 2001 stated that Iraqi oil production capacity would fall sharply unless technical and infrastructure problems were addressed. Moreover, Iraq's southern oil industry was decimated in the 1990-1991 Gulf War, with production capacity falling to 75,000 bbl/d in mid-1991. The Gulf War resulted in the destruction of (a) gathering centers and compression/degassing stations at Rumaila; (b) storage facilities, including the 1.6 million bbl/d (nameplate capacity) Mina al-Bakr/Basra export terminal; and (c) pumping stations along the 1.4 million bbl/d (pre-war capacity) Iraqi Strategic (North-South) Pipeline. Seven other sizable fields remain damaged or partially mothballed. These include Zubair, Luhais, Suba, Buzurgan, Abu Ghirab, and Fauqi. Generally speaking, oil field development plans were put on hold following Iraq's invasion of Kuwait, with Iraqi efforts focused on maintaining production at existing fields. At the present time, problems with Iraq's refineries—stemming largely from post-war looting and sabotage in addition to power outages—continue to force the country to import gasoline, diesel, liquid petroleum gas (LPG), and other refined products from neighboring countries (Iran, Jordan, Kuwait, Syria, and Turkey). As of October 2004, Oil Minister Ghadban said that Iraqi gasoline imports were running around 40,000 bbl/d (mainly by truck), costing the country U.S.\$60 million per month in direct costs. This does not include the

additional cost of steep government subsidies on the consumer price of gasoline, which runs around 10 cents per gallon. It is estimated that overall direct and indirect oil subsidies cost Iraq U.S.\$8 billion per year, with no indication as to when this problem might be resolved. As a result, both countries are expected to benefit from the swapping agreement; Iraq will secure current and future needs of oil, benzene, and diesel and Kuwait will use the natural gas for the production of petrochemicals, electricity, and water while freeing up a substantial amount of oil for exportation.

Swapping Businesses: In 1997, PPG Industries, a specialty chemical company, exchanged its surfactants business for BASF's packaging coatings business. This swap resulted in the growth of PPG's portfolio and led to the expansion of geographic opportunities for the coating business. Moreover, this swap enabled PPG to become one of the world's largest suppliers of package coating for food, aerosols, and other container and packaging applications. On the other hand, this business swap made it possible for BASF to expand its surfactants offerings for the food, personal care, and coatings industries. Similarly, BP swapped its polyethylene glycol (PEG) ether brake fluid business for the butyl glycol ether (BGE) solvents operation belonging to Clariant, a Swiss specialty chemical company. However, this swapping deal was restricted only to the exchange of customer lists and contracts. No manufacturing units, staff, or cash transfer between the two companies took place. Clariant discontinued production of BGE at Gendorf, Germany, and BP discontinued manufacturing brake fluids at Lavera. The deal broadened the range of products that Clariant supplied to the automotive industry and enabled BP to better utilize the Lavera BGE plant.

Swapping Shipments: During 2000, a swapping arrangement of liquid natural gas took place among Spain, Algeria, and Trinidad. Spain's Gas Natural became the first European LNG buyer to resell LNG to the U.S. market. This gas had been sold to Gas Natural by Atlantic LNG of Trinidad. At the same time, Algerian LNG dedicated to the United States was delivered to Spain, reducing shipping charges for all parties. In 2001, these swaps developed into a more permanent arrangement with the signing of a contract between Sonatrach of Algeria, Gas Natural of Spain, Tractebel LNG North America in the United States, and Distrigas of Belgium. Companies with interests on both sides of the Atlantic gained an advantage over others, enabling them to react faster to any market opportunity. Moreover, Nova Chemicals, a Canadian chemical company, and BASF entered a swap deal for styrene in which Nova supplied BASF in North America and BASF supplied Nova in Europe. This agreement provided each company with a stable supply of

styrene without committing either one to significant investments. The deal also gave each company a low-cost styrene position for their PS. Another swap example is between world-class Indian polymer manufacturers Haldia Petrochemicals Ltd. (HPL) and GAIL Ltd., India's principal gas transmission and marketing company. The two companies entered into a product swapping and sharing arrangement that forced other polymer sellers in eastern and northern India to retreat from the market. Under this swapping agreement, both companies gained substantial savings on freight costs. Gail supplied HPL's customers in northern India from its plant in Uttar Pradesh, and HPL served Gail's customers in eastern and southeastern Asia by supplying them from the Haldia plant.

CONCLUSION

More efficient and cost effective supply chain practices in the petroleum industry represent important factors for maintaining continuous supplies of crude oil, the reduction of lead times, and lowering of production and distribution costs. Due to the inflexibility involved in the petroleum industry's supply chain network, logistics represent a great challenge. However, it is only one of several challenging factors. Integrated process management, information systems and information sharing, organizational restructuring, and cultural reorientation are equally important. Despite the great challenges in the petroleum industry's supply chain, opportunities for improvements and cost savings do exist along the supply chain. One major area for improvement and cost savings lies in the logistics function. Companies in the petroleum industry have become increasingly reliant on the services of third-party logistics companies to manage their supply chains. Companies in the petroleum industry took the outsourcing idea a step further to collaborate with competitors and found shared solutions to their supply chain challenges. This form of collaboration is referred to as a systematic cooperative reciprocal barter, or swaps. Collaboration among competing companies in the form of swaps is a practice that can offer companies huge savings and introduce new opportunities. However, despite its wide use and benefits, especially in the oil and petrochemical industries, the subject has not received the attention it deserves in the operations management literature. Currently, judgmental methods and the aid of spreadsheets are the only approaches utilized when attempting swap decisions. Although great savings are realized by companies using swap practices, the approaches used for making such decisions cannot guarantee an optimal solution, and hence, opportunities to utilize the full capability of swap practices are not fully exploited. Therefore, the next step would be the utilization of management science techniques, presumably

mathematical/simulations models. These methods will significantly enhance the capability of such forms of collaboration and will represent valuable tools for practitioners to use.

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