Supply Chain Practices in the Petroleum Downstream
By Fidel Santos Manzano MLOG 2005

This thesis is part of Phase I of the Supply Chain 2020 Project (SC2020), a research effort analyzing the supply chain in different industries. The SC2020 initiative studies current practices and the essential factors for the successful design and operation of supply chains. This work covers the petroleum downstream industry and starts by performing a general industry overview. Moreover, a major player in the industry (ExxonMobil) is used as a case study. This thesis is based on different literature sources and interactions with industry practitioners and consultants.

Petroleum Industry

The petroleum industry is significant from different points of view and involves major economical flows. According to the World Trade Organization, the total value of the trade of crude oil and products in 2002 was $615 billion, representing 9.8% of the total global merchandise trade and 44.9% of the World exports of primary products. The majority of the crude oil flows comes from the Middle East towards the consumer countries in the more developed areas of the World.

The industry is usually divided between the upstream and the downstream activities. The first part covers the exploration, production and transportation of crude oil and gas to the point of transformation into final products (i.e., refineries). The
downstream activities deal with the processing of crude oil in refineries, the distribution and the marketing activities of all the oil derived products.

**Petroleum Downstream Supply Chain**

The petroleum downstream supply chain can be characterized as a global supply-driven structure with the main following participants:

- **Suppliers of crude oil:** as a natural resource, crude oil is located in certain areas of the World that usually are far from the main consuming countries, mostly the OECD (Organization for Economic Co-operation and Development) members. An important part of the crude oil supply and reserves is concentrated in the hands of a cartel: OPEC (Organization of Petroleum Exporting Countries).

- **Refiners:** they have plants located all over the world and closer to final consumers. The main reasons for this fact are the economies of scale of transporting crude oil in big supertankers versus transporting the final product in smaller lots, and the strategic value of the refining assets, which makes governments prefer having some of the refinery operations in their territories.

- **Consumers:** the final users of petroleum products, either small consumers (e.g., car owners buying gasoline) or wholesale consumers (e.g., power stations using heavy oil, petrochemicals plants receiving feedstock).

These participants are involved in the main activities that configure the downstream supply chain:

- **Oil Supply & Trading:** these activities deal with the procurement of raw materials and other commodities bulk trading. In the case of crude oil, for
each of the available sources, it is necessary to assess the price, quality, timing, and distance to the refinery in order to decide the optimal acquisition. Additionally, the refiner has to carefully monitor the price risk and manage the inventory.

- **Manufacturing:** the procedure of designing and building the appropriate technical configuration of a refinery is vital. Moreover, the refiner needs to plan and schedule production levels, and finally manage the efficiency and safety of all operations.

- **Distribution:** similar to the refinery case, the network must be designed in an optimal way and set up. Likewise, transportation of fuels throughout the network (either by truck, tanker, rail, pipeline or barge) needs focused planning and scheduling.

- **Sales & Marketing:** in the last step of the supply chain, managers are confronted with pricing decisions, the use of efficient tools for demand management, and the seizure of market opportunities in an increasingly competitive environment.

### Supply Chain Challenges and Opportunities

The downstream oil business as a whole faces a series of challenges that surfaced through different interviews with industry experts and are widely cited in the literature. Among the major ones we could highlight:

- **High volatility in the prices of the raw materials and the final products when compared to other commodities.**
The industry is highly capital intensive (a medium-sized refinery may cost up to $3 billion) and is usually subject to cycles of profitability, yielding frequently lower returns on investment than other petroleum businesses. This creates periods of unbalanced investment.

The supply chain decisions are conditioned by some industry-specific factors:

- frequent “make versus buy” decisions that change continuously as a function of prices and transportation costs
- a supplier base (mainly crude oil producing countries) with extensive negotiation power
- complex inventory decision-making

The product quality issues are becoming especially constraining as the new fuels specifications demand more complex processing and expensive investments in new equipment. These investments do not always provide an attractive return, but are in many cases required to keep the refinery operating.

The environmental regulations and compliance rules (greenhouse effect gases emissions, soil pollution, etc) are also becoming increasingly severe, making the operation of the existing refining facilities or the construction of new ones even more expensive and intricate. Moreover, the liabilities in case of environmental damage and public image vulnerabilities are becoming big hurdles for the industry.

On the other hand, the industry has the opportunity of taking advantage of the volatility in the prices by using the forward contracts and futures markets. Additionally, the constant growth in the oil products demand and the potential introduction of non-oil
fuels (e.g., hydrogen or biofuels) also offer opportunities for the further exploitation of the petroleum companies supply chains.

**Evolution of the Industry**

The industry has seen a wave of consolidation in the last ten years and has led to the current panorama of big oil majors, mainly ExxonMobil, BP, Royal Dutch Shell, ChevronTexaco, Total, and ConocoPhillips. Further consolidation is still possible and will probably be centered around the acquisitions of smaller companies by the big majors or the combination of medium-size regional players to compete in the global arena.

In the case of the downstream, oil companies have been significantly reducing operating costs for the last 25 years as can be observed in Figure 1.

![Figure 1 (Source: Energy Information Administration)](image-url)
However, this cost reduction has not been reflected in better net margins as there has been a continuous and nearly parallel pressure also in gross margins. As a result, the net margins have remained consistently below $2 per barrel in the US until 2001, even during periods of high oil prices.

The industry had continued efforts in cost reduction and increased efficiency but has been limited until now by some characteristics of the downstream supply chain operations:

- Limited flexibility as (for example) the raw materials lead times are long (typically a crude oil cargo will take several weeks to arrive to the refinery) and the planning process spreads over several months.
- The integration of the complete supply chain from crude oil supply to marketing at the pump is still missing as a result of a long-established silos approach. Generally, the optimization tasks (typically using linear programming tools) are focused around refinery scheduling as an island.
- The stock decisions are rarely based on a global supply chain optimization, but dictated by constraints of storage, and the minimization of the huge working capital and risk involved.

In order to improve the profitability of the industry and go into a new era of significant efficiency improvements, a more integrative supply chain is essential. Moreover, the transition to a more holistic supply chain view will need paradigmatic change and a modification of the incentives and metrics used to measure the success of supply chains. The industry’s progress will be based on the creation of more efficient business processes, the use of more relevant and efficient information systems, and a
large investment in human capital to perform the activities that make supply chains successful. Finally, we would like to highlight that some estimations by supply chain management consultants quantify the potential additional savings through supply chain improvements as an average margin gain of fifty cents per barrel.

**Case Study: ExxonMobil**

ExxonMobil is currently the world’s largest non-public oil company in terms of sales ($291.3 billion in 2004), profits ($25.3 billion in 2004) and market capitalization ($380 billion in February 2005). The company is the result of the merger of Exxon and Mobil in 1999 and counted 85,900 employees at the end of 2004.

ExxonMobil is a vertically integrated oil company present in the entire oil supply chain, including the upstream and the downstream. Its main strategy focus is on the segment of the business offering the highest returns, the upstream. On the other hand, the downstream activities are seen as valuable cash generators and as instruments to control the full value chain of oil from production to the final consumer.

As stated in its strategic statements and presentations, after the merger of Exxon and Mobil the preference of the company is centered on organic growth, and the main strategic objectives of the company are:

- Growing by focusing on the upstream and gas & power business units
- Pursuing a higher integration and enhancing the efficiency of the downstream activities
- Increasing its business presence in Asia and particularly in China
ExxonMobil’s downstream business units focus on providing finished products and feedstocks to their customers, mainly through its distribution and marketing organizations. The refining is done using an asset base that includes an ownership interest in 45 refineries, located in 25 countries, with distillation capacity of over six million barrels per day and lubricant base stock manufacturing capacity of 145,000 barrels per day.

A global supply organization coordinates and optimizes the supply of crude and feedstock to the refineries, the mix of products manufactured, and the working inventory levels. The supply organization also manages a global logistics system that includes an ownership interest in 32 crude oil and petroleum product tankers, more than 25 thousand miles of pipelines, and over 300 major petroleum product terminals.

ExxonMobil identifies its existing downstream competitive advantage in four areas:

- Scale: being the largest downstream operator in the world and having the largest refineries.
- Integration: creating a global functional organization and leveraging the scale via integration: among the different units in the refining sites; between refining and petrochemical plants (80% of plants are now integrated); among neighboring refineries (clusters); and with other business segments.
- Technology: focusing on the development and application of proprietary technology and the reduction of capital and operating costs.
- Brand: creating and maintaining superior brand identities.
As part of the assessment of ExxonMobil’s supply chain, this thesis also studies fuel retailing activities applying the Porter Five Forces model. Fuel retailing is an area traditionally controlled by a limited number of players competing in a highly regulated environment with high barriers to entry. However, the analysis shows that the rivalry in fuel retailing is progressively increasing and the traditional barriers to entry are progressively being softened even if it is not probable that they will be completely removed.

As a result of the analysis of ExxonMobil’s supply chain, we have confirmed the alignment of the company downstream supply chain strategy with the overall company strategy. Furthermore, we have also found in ExxonMobil the predominant silos culture of the industry in the organization of the different parts of the supply chain, even if a progressive shift towards an integrative supply chain perspective is occurring.

**Conclusions**

As shown in the analysis of the industry in general and confirmed in the case of ExxonMobil, the mentioned silos approach still prevalent in the petroleum downstream has been generating local suboptimal structures in the supply chain of this industry. Even if much advancement has been made in the development of a true supply chain management culture, there is still much room for improvement. The industry cannot only rely on technology investments even if they are a basic condition of success. A more developed “pull” paradigm leading to more demand-driven operations will be needed to achieve significant profitability gains from supply chain enhancements.
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Following this route, the industry will need to carefully align the supply chain structures and processes with the overall company strategy. As part of these efforts, a successful supply chain strategy development will need to carefully establish plans for process re-engineering, change management, and information technologies design and implementation.

The actual progress will be dependent on a combination of the mentioned business processes improvements and the channeling of existing expertise of industry professionals into a common effort for value creation.