

# "Supply Chain Optimization approaches and Market Demand Analysis of Petroleum Industry: A Case Study of ONGC"

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## ABSTRACT

**Problem discussion:** Supply chain management plays very important role in petroleum industry to solve many problems like long lead time, transportation problem, operational management issue, supplier selection problem and service satisfaction at the different level. In this thesis the main focus is on finding options for optimization of the supply chain management in petroleum industries.

**Purpose:** To study supply chain management in the petroleum industry and finding options for optimizing the supply chain in the petroleum industry by literature review and investigate previous literatures.

**Method:** In this thesis ONGC Limited (headquartered in Dehradun, India) is taken consider for the case study. Qualitative research technique is implemented in this research. Primary data is collected via cell phone by communicating with organization's employee and secondary data is taken from various research articles and books to make the theoretical frame of reference for the thesis.

**Scope of the study:** The scope of this thesis is limited to the supply chain management optimization in the petroleum industry.

**Conclusion:** Supply chain management Optimization is recognized as the main tool for the petroleum industries to achieve aggressive success in global competitive market. Analyzing ONGC Limited gives a realistic approach that how to optimize and manage its supply chain efficiently and effectively. The planning process, Information technology, marketing management and integrated operation management are the main strength of supply chain optimization.

**Key words:** Supply chain management, ONGC, Operations, optimization and petroleum industry

## 1.INTRODUCTION

**1.1 Supply chain management:** In the year 1982, **Oliver and Webber** describe the term supply chain management in financial time article. They explained the process of procurement of raw materials and their operational and managerial activities. Supply chain management became very popular in the mid 1990s across all the industries at global level. Supply chain management also focus on new product development, marketing, finance, operations, distribution and high level of customer satisfaction. According to **Jones and Riley (1985)** Supply chain management is the total flow of assets from the supplier to the customer. The main objective of supply chain management is profit maximization and customer satisfaction (**Stevens, 1989**). Supply chain management focus on all the resources (man, money, materials and machines) for the

effective utilization of resources and to optimize the profitability and customer satisfaction at different stages.

According to **Chopra and Meindl (2001)** the main purpose of supply chain is to increase the efficiency of the distribution channel to optimize the profit of any business organization. Supply chain management deals with material flow, information flow, financial flow and commercial flow. Commercial flow represents the change in ownership.

The strategy for purchasing should be main focus of any industry. Supply chain network can be affected by purchasing policy, (**Ellram, 1994**). According to **Trent (1998) and Wisner (2000)**, supply chain management must focus on the satisfaction level of customers and purchasing strategy. They discussed about the relationship between the purchasing strategy and supplier selection. Supplier and manufacturer are connected with procurement cycle, manufacturer and distributor are connected with manufacturing cycle, distributor and retailer are connected with replenishment cycle, and retailer and customer are connected with customer order cycle. Supply chain represents the push view and pulls view also. Push view includes procurement cycle, manufacturing cycle, replenishment cycle, while pull view include customer order cycle only.

Supply chain management concept by few notable author(s) is given below:

Authors	Definition of supply chain	Findings
Ellaram, (1991)	Integrated approach of material flow and information flow to satisfy the customer needs without waste.	Focus on waste reduction technique of JIT
Lee and Billington, (1992)	Production and distribution process of goods with customer satisfaction.	Focus on customer satisfaction
Christopher, (1998)	The management of relationship with supplier and customer by providing good quality of product in less capital investment.	Customer relationship and cost reduction techniques.
Cooper, (1993)	The management of total movement of distribution channel from supplier to customer.	Focus on integrated approach within supply chain.
Berry <i>et al.</i> , (1994)	Supply chain deals with information sharing, new product development and maintaining long term relationship	Relationship management to achieve the objectives of supply chain.
Patricia <i>et al.</i> , (1996)	Starts with supplier and finishes with customers.	Focus on supplier-customer value chain and relationship.

Table 1.1: Supply chain concept by researchers

**1.2 Supply Chain Management in petroleum industry:** Supply chain of the petroleum industry is divided into two parts: Upstream and downstream supply chain. Upstream supply chain is very essential for oil and gas companies, it deals with the acquisition of crude oil and Delivering crude oil from wells to refineries. The main function of the upstream supply chain is Exploration, production, forecasting and logistics management. Downstream supply chain deals with the manufacturing process of petroleum products and also the distribution process of petroleum product from refineries to end customer. The main function in the downstream supply chain is manufacturing, forecasting, and logistics management. Distribution channel management is related to the downstream supply chain. Transportation is done by ships, trucks, pipelines and rails generally. In petroleum industry supply chain management may be affected with the complex nature of business practices and environmental issues and also high levels of uncertainty and complexity of the operational activities. Due to very high demand of petroleum products, the competition among oil industry business leader increases very much at global level, (**Jenkins & Wright, 1998; Himola, 2011**). According to **Johnson, Scholes & Whittington (2009)**, all the petroleum industries want to attain competitive benefit. Due to this competitive success, the organization can focus on product quality and the high level of customer satisfaction. The total distribution channel must work effectively to maintain their aggressive lead at global market. With the help of supplier-buyer integration and cooperation, supply chain management must consider the high level of customer satisfaction, (**Christopher, 2011**). The petroleum industry has to face many problems in logistics and operational activities. Due to a huge amount of investment private sectors making a very strong competitive global market, (**Gainsborough, 2006**). The supply chain management of petroleum industry is very complex in nature; the whole management is divided into two parts, before refining stage activities and after refining stage activities. The supply chain management of petroleum industry is very complex and it needs a huge capital investment in logistics and operational activities, (**Gainsborough, 2006; Ribas, Leiras & Hamacher, 2011**).

**1.3 Objective of the study:** The main objective is to study and analysis of the supply chain management in the petroleum industry and finding options for optimizing the supply chain by literature review and investigates previous literatures.

## **2. BODY TEXT**

**2.1 Research in supply chain management:** According to **Stein and Voehl (1998)**, supply chain management is a organized effort, from supplier to customer to fulfill the customer requirements and expectations. Logistics is an important part of supply chain management. Supply chain management and logistics are different. Supply chain management is the combination of operational and managerial activities by which any industry provide value added services to their customers. Supply chain also focuses on management information system, new product development and commercialization. **Tompkins and Jernigan (1997)** said that that supply chain management is not a correct term to define all the operational and managerial activity and he proposed that it must be replaced by demand flow leadership. He explained

that the word supply indicates the push concept while the word demand indicates the pull concept of product flow for high level of customer satisfaction, he said that the word chain should be replaced by flow as it indicates the continuous movement and the word leadership is better than management, because it deals with various activities and requires a lot of coordination and team work. **Sherman (1998)** defines supply chain management as a dynamic process of managing the material flow and information flow across the distribution channel. Supply Chain Management is a association of services which deals with raw materials, transform that raw materials into final product and distribute that final product to end customers.

According to **Lee & Billington (1995)**, the main function of supply chain management is to make efficient distribution channel. Ellram (1990), said that Selection of supplier in supply chain management is a very crucial decision. Delivery of product, quality of product and cost of product are the main factors in supplier selection. According **Carr and Pearson (1999)**, Long term relationship can affect the entire supply chain network and competitiveness.

**2.2 Research in SCM of petroleum industry:** The petroleum industries play a very crucial role in the economic growth of any country. The supply chain management activities in petroleum industries are very complex in nature. Exploration is the first stage, which include seismic, geophysical and geological operations. The production of crude oil with the help of drilling operations is the second stage of supply chain in petroleum industry. Refining is the third stage and deals with very complex operations.

The last stage is marketing, which includes the sales and product distribution activities of petroleum product like gasoline, petrol, diesel etc. In each and every stage transportation activities plays a very important role, because in the case of petroleum industry, the raw materials are crude oil and natural gas, (**Hussain et al., 2006**).

According to **Hall (2002)** the quality of petroleum product, quick delivery of the petroleum products with a very economic price create a huge competition among the oil industry leaders and to sustain in the market aggressively, they must focus on their supply chain management. **Hussain et al. (2006)** explained the supply chain in this industry as very complex. Every petroleum industry wants to be more effective, more profitable and market leader, so there is a huge competition at global market. Marketing and advertising of petroleum products and customer service also plays a very important role in global competition. In petroleum industry, there must be effective strategy for partnership and business collaborations. It can be horizontal and vertical integration, (**Lasschuit & Thijssen, 2004**). There must be multi functional coordination in supply chain network. Business collaborations, cross functional coordination is a very essential part of supply chain optimization in petroleum industry, (**Mentzer et al., 2001**). Demand forecasting plays a very crucial role in optimization process of supply chain management, (**Gainsborough, 2006; Balasubramanian, 2002**). In demand forecasting, generally the historical data, point of sale systems, forward trade data are being used to get accurate forecast. If there will be forecast error, then it will damage the financial budget of oil industry. It is not possible to run regular operations, especially during the low demand period, because of high cost of

manufacturing process, (Hussain at al., 2006). The cyclic changes in operational and logistics can affect the refinery working condition. It can also affect the distribution channel and inventory management. According to accurate demand forecast data, industry must plan the logistics and product distribution strategy, (Balasubramanian, 2002). Jenkins and Wright (1998) proposed that for supply chain optimization in petroleum industry, we must focus on cost effective techniques.

We must improve our production planning and controlling activities in supply chain and also focus on high level of customer satisfaction. Hall (2002) discussed about safe, secure and reliable mode of transportation is a very essential part of supply chain by which we can reduce the bullwhip effect.

### 2.3 Overview of Indian petroleum industry:

- Total reserves of crude oil were 763.476 MMT (Million Metric Tons) up to April, 2015.
- The production of crude oil is decreased by 0.87 %. During 2013-2014, it was 37.788 MMT, but during 2014-2015, it was 37.461 MMT.
- The refining capacity was 215.066 MMTPA up to April, 2015. The refining capacity is expected to reach 307.366 MMTPA in 3-4 years.
- During 2013-14, the petroleum products production was 220.756 MMT. While during 2014-2015, it was 221.059 MMT. It indicates a small increment in the production of petroleum products.
- Our country exported 63.928 MMT of petroleum products and imported 20.423 MMT of petroleum products, during 2014-2015.
- The consumption of petroleum products increased by 4.15 %, during 2013-14, it was 158.407 MMT and during 2014-15, it was 164.987 MMT.
- The retail outlet of oil marketing companies has gone up to 53419 as on 31<sup>st</sup> march, 2015. While it was 51868 on 31<sup>st</sup> march, 2013.
- LPG consumers of public sector oil marketing companies were 181902266 as on 31<sup>st</sup> march, 2015. It was 166258759 as on 31<sup>st</sup> march, 2014.

(Source: INDIAN PETROLEUM AND NATURAL GAS STATISTICS 2014-15)

**2.4 Collection of Data:** Data collection is the very important part of research activities. The quality of research depends upon the quality of data collection. It is also useful to understand the research problem. It is very essential to know that how we are collecting the data and how we are going to make analysis. Collection of data also depends on nature of project. It may be expensive, (Stevensens, Wrenn, Sherwood & Ruddick, 2006).

In research paper we can use primary and secondary data.

- Primary data: It is collected by the researcher during the project through firsthand experience.

- Secondary data: The data which is collected from research journals, books, research articles and internet sources etc. According to **Guffey (2010)**, secondary data is less expensive and very easy to use.

In this research, secondary data is gathered from different sources like research articles or journals, books, internet source etc.

**2.5 Case Study:** The case study method is a very trendy in research activities because it helps in qualitative analysis and includes complete observation. In this research ONGC Limited is chosen for the case study, because of its dynamic performance in terms of productivity and profit maximization and high number of workforce in India.

### 3. RESULT AND DISCUSSION

#### 3.1 Brief introduction of ONGC:

- ONGC is the leading company of India in energy sectors. It is ranked as 1<sup>st</sup> in India, 5th in Asia and 21<sup>st</sup> globally as per Platt's Top 250 Global Energy Rankings; In E&P Company list, it is ranked as 3<sup>rd</sup> in world.
- ONGC is the only Indian company (energy sector), in Fortune's Most Admired List 2014 under 'Mining, Crude Oil Production' group.
- ONGC has produced 851 Million Metric Tonnes (MMT) of crude and 532 Billion Cubic Meters (BCM) of Natural Gas, from 111 fields.
- It produces over 1.24 million barrels of oil equivalent per day & it contributes over 64% of India's domestic production.
- One tenth of the total Indian refining capacity is acquired by ONGC.
- An exclusive energy industry in world to have all operative offshore and onshore installations.

**3.2 ONGC Supply Chain Management:** In ONGC, all important and essential operations are planned in advance. Logistics management deals with delivering crude oil from distantly located oil wells to refineries. Seismic, geophysical and geological operational activity deals with exploration. The activities in Production are related to drilling operations. Marketing & sales operations deals with the downstream supply chain management. Acquisition of Onshore and offshore for exploration, Forecasting & market demand analysis plays very important role to achieve the goal of effective & efficient supply chain management of ongc.

**UP-STREAM SCM:** The upstream division of the SCM is also known as the (E&P) sector. It includes the activities related to searching and producing crude oil & natural gas.

ONGC makes the strategic plans related to well, for example: Where to locate, how deep and how far to drill, how to design, construct, operate and manage them effectively & efficiently Wells can be drilled



on land or in miles of water. It can be less than 30 meters deep and totally vertical, or 6,000 meters deep and horizontal. There are hundreds of different types of **crude oil** that come out of the ground. It can be light or heavy and sweet or sour.

**Mid-stream SCM:** Manufacturing of oil and gas liquids into petroleum products is the beginning of the midstream supply chain management of petroleum industry. Fractionation plants are also a part of mid-stream supply chain, which remove the natural gas liquids (NGL) from the produced oil and gas. After manufacturing, the treated oil and gas is delivered through a complex transportation and distribution process. Land transportation mainly includes pipelines, truck and rail. Natural gas is most often transported in large-diameter pipelines called transmission lines, because it flows at much higher pressure than crude oil. While pipelines are the safest and most professional way to transport oil and gas. The most ordinary NGLs are methane, ethane, propane, butane.

**Down-stream SCM:** Downstream supply chain management deals with sales & distribution operational activities of petroleum Products. Petroleum products can be classified in two different ways: (a) familiar products: which includes mainly gasoline, lpg, diesel, jet fuel, heating oil etc and (b) unfamiliar products: which includes mainly lubricants, plastics, fertilizers, synthetic rubbers, pesticides etc. Refineries manufacture crude oil into a variety of valuable petroleum products. The petroleum products can be light, medium, or heavy. Light products include LPG, gasoline, naphtha, etc. Medium products include diesel fuels, jet aircraft fuels & kerosene etc. Heavy products include fuel oils, lubricating oils, paraffin wax, petroleum coke, asphalt & tar, etc.

**3.3 Optimization approaches of SCM in ONGC:** The prime goal of every oil and gas industry is to achieve optimum exploration, production and revenue generation with customer satisfaction.

**Increasing supply chain visibility:** Supply chain must be smooth & visible to eliminate the bullwhip effects. In petroleum industry operational activities need complete tracking and monitoring. It can help in inventory management, controlling the supply and demand, logistics and transportation issues etc. supply chain visibility can be increased by investment in technology and open lines of communications among all parties.

**Strategic Planning:** Long term planning is essential for competitive advantage and success of the organization. The petroleum industries require long-term strategic planning to survive in global competition. Strategic planning is essential to maintain the correct chain of information, financial and material flow.

**Enhancing supplier collaboration:** Supplier collaboration plays a vital role in the optimization of supply chain management. By enhancing supplier collaboration cost will decreased, cycle time will be reduce, stability within the supply chain will be increased and a mutual beneficial relationship will be established for the better future of business.

**Effective use of information technology:** The role of information technology is very crucial to gain competitive advantage. Many petroleum industries have recently accepted that sharing of information in

their supply chain can lead to major reduction in the overall cost. It helps in transportation and logistics, inventory planning and it also increases the speed of material, financial and information flow.

**Logistics management:** Logistics management is a very essential for petroleum industry. Remote locations and continuously varying freight costs can have a major impact on profit boundaries and it makes logistics management more demanding. Efficient logistics management maximizes the profit of the industry. Overall transportation cost will reduce and customer services will also improve.

### **3.4 MARKET DEMAND ANALYSIS OF PETROLEUM INDUSTRY:**

**GLOBAL MARKET:** Global oil and gas market shrank by 1.6% in 2014 to reach a value of \$ 3073.4 billion. In 2019, the global oil & gas market is forecast to have a value of \$2,196.7 billion, a decrease of 28.5% since 2014. The global oil & gas market grew by 1.1% in 2014 to reach a volume of 46,792.5 million barrels equivalent (BOE).

In 2019, the global oil & gas market is forecast to have a volume of 49,097.2 million barrels equivalent (BOE), an increase of 4.9% since 2014. All the activities of exploration and production of gas is related to oil & gas market. Forecasting of global oil consumption is likely to grow significantly. Developing countries like China and India where oil consumption rate is expected to increase by 3.79 % and 2.39 % respectively in few years, while global oil consumption will increase by 1.39 %. Investments in the exploration and production (E&P) sector is facing new challenges like ,high cost of operations, high service costs, logistics management and scarcity of technical manpower. Developing countries like, China and India are rising very fast as refining hubs. They jointly cover a very big global market for refining and petrochemicals business. Natural gas has been recognized as fuel of the 21st century. It is very difficult to predict what will be the oil and prices after 5 years, but current market demand analysis shows that oil and gas prices will remain high. It will create a huge impact on the global economical growth policy. In present scenario the impact of high oil prices on the world economy has been compensate by industrialized countries. High oil prices will ultimately create macro-imbances in the global economy. China, India and Japan are the one of largest consumers of energy in world. In Japan, the energy policy objectives are based on “3 Es”: Energy security, Economic development and Environmental sustainability. Japan’s aim is to achieve these three goals all together but it is very difficult to achieve these three goals for any country including Japan. In future, the countries like China, India & Japan must focus on how to reduce energy consumption, how to reduce oil consumption and how to use natural gas over coal, how to increase the use of nuclear energy and take advantage of renewable resources. Exploration and Production activities play a vital role in crude oil and natural gas prices in global market. New challenges for exploration and production industries are increase in supply and demand gap, shortage of rigs, seismic survey crews and availability of technical manpower. The solutions of these problems will increase the costs of exploration and production. But the rise in crude oil and natural gas prices is forcing petroleum industries to find hydrocarbons in logistically difficult areas including deepwater.



**INDIAN MARKET:**

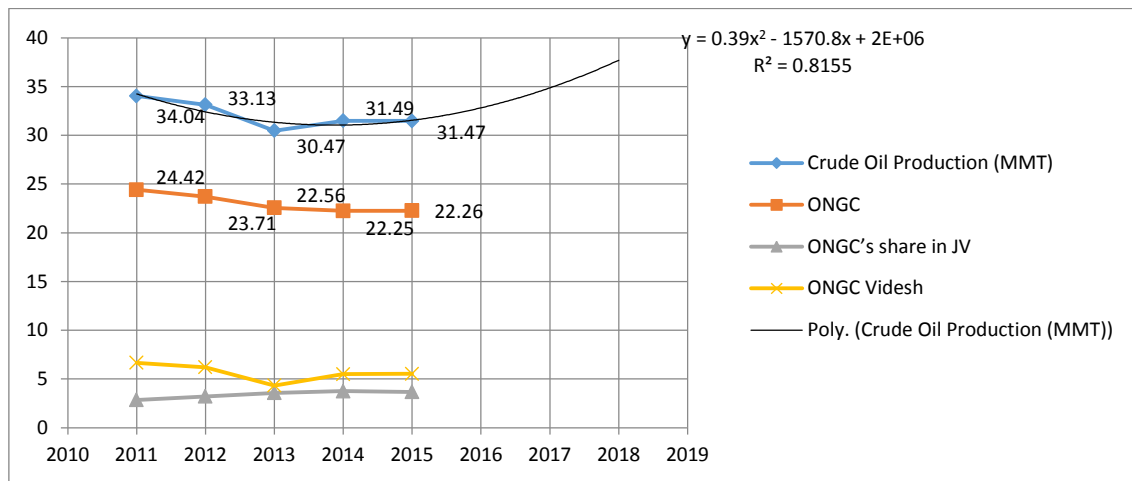
Government of India has taken lots of initiatives to enhance investment in oil and gas industries. 100% FDI is allowed for natural gas, refineries, and petroleum products. Government of India has introduced New Exploration Licensing Policy (NELP) during 1997-98, to increase exploration activity in the country, but apart from policies, use of advance technology is also very essential for enhancing domestic oil and gas production.

Crude oil is produced onshore and offshore in our country. Onshore fields are located in Arunachal Pradesh, Nagaland, Tamil Nadu, Gujarat and Andhra Pradesh. OIL and ONGC have the onshore field for crude oil production. Offshore fields are located at Bombay High, operated by ONGC and Joint Ventures of ONGC. For natural gas, onshore fields are located at Assam, Gujarat, Tamil Nadu, Andhra Pradesh and Rajasthan, while at the Western area of Bombay High, Offshore production of natural gas occurs. There is a dominant market of Public sector corporations in the Indian exploration and production sector. ONGC has the highest share in total production of Oil and Natural Gas. Oil India Limited is the second most important player in the sector is also a public sector undertaking. Both of these undertakings has for more than 70% share of the total market. The rest of the share is contained by different private sectors of oil and gas sector. ONGC, OIL, HPCL, IOCL, BPCL, GAIL, Reliance petrochemicals, Essar Oil Ltd, Adani Gas, Cairn Energy, and BP are the main petroleum industries in India. Indian petroleum industries have increased the demand for drilling rigs, seismic survey and logistics facilities of oil and gas from oil wells to delivery points. India is also growing as a potential refining hub, because of reduction in capital cost with respect to other Asian countries. The demand for oil and gas in the country is driven by energy, power and fertilizer sectors.

Table 3.1: Production data of ONGC group

(Source: ONGC annual report 2014-2015)

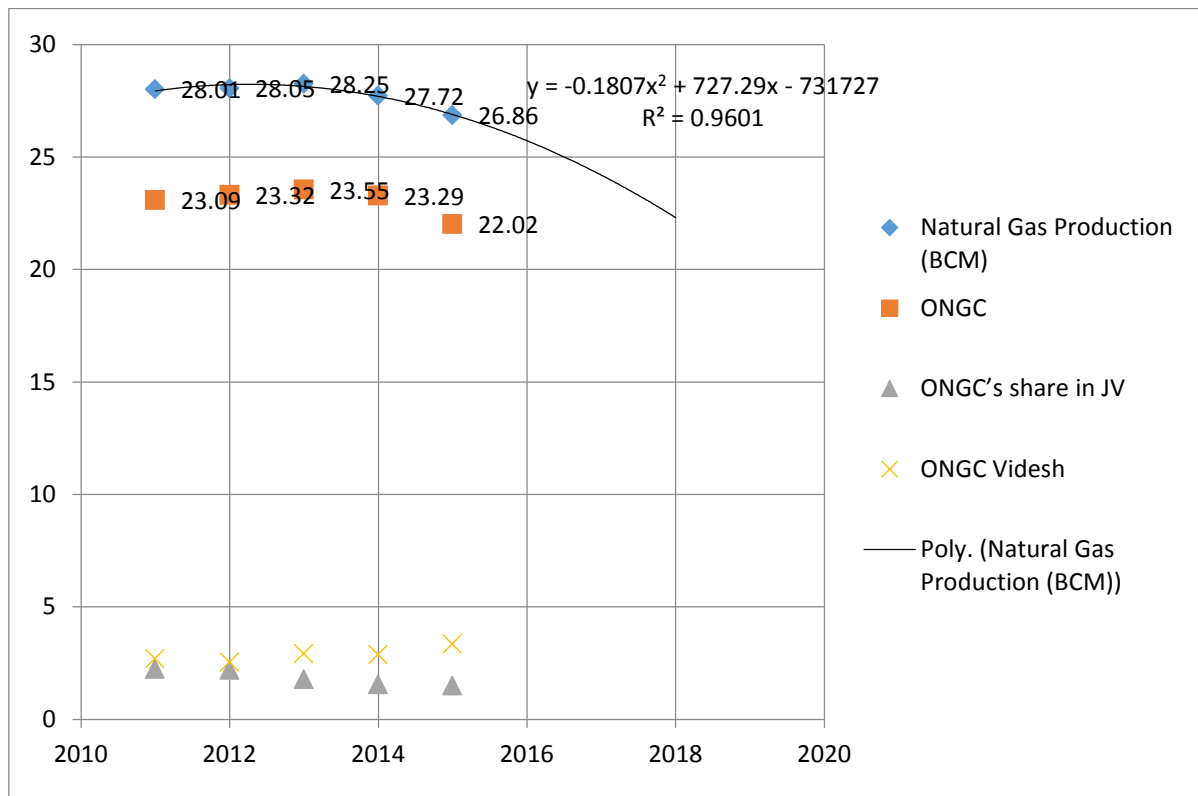
Oil and gas production(Year)	2015	2014	2013	2012	2011
<b>Crude Oil Production (MMT)</b>	<b>31.47</b>	<b>31.49</b>	<b>30.47</b>	<b>33.13</b>	<b>34.04</b>
ONGC	22.26	22.25	22.56	23.71	24.42
ONGC's share in JV	3.68	3.75	3.57	3.21	2.86
ONGC Videsh	5.53	5.49	4.34	6.21	6.67
<b>Natural Gas Production (BCM)</b>	<b>26.86</b>	<b>27.72</b>	<b>28.25</b>	<b>28.05</b>	<b>28.01</b>
ONGC	22.02	23.29	23.55	23.32	23.09
ONGC's share in JV	1.5	1.56	1.78	2.19	2.23
ONGC Videsh	3.34	2.87	2.92	2.54	2.69



**Fig. 3.1: Crude oil production of ONGC Group (forecasting for year 2018)**

Crude oil production decreases marginally in 2014-15, because of the complex process of exploration & production. To commence the exploration and production process, government permission is required.

Crude prices are globally determined and are highly dependent upon geopolitical events, demand factors of oil markets, economical growth and policies. Thus barriers are higher. The Government of India has started policies such as new exploration licensing policy (NELP) to promote investments and competition among the petroleum industries. The petroleum industries are going for upgradation and value additions of their refineries, which is increasing the more competition. New government policies in energy sector are also a very big factor to increase the level of competition. However, in the current scenario, companies may hesitate in making fresh investments in exploration, but since the market demand is more, so the production will increase in near future.



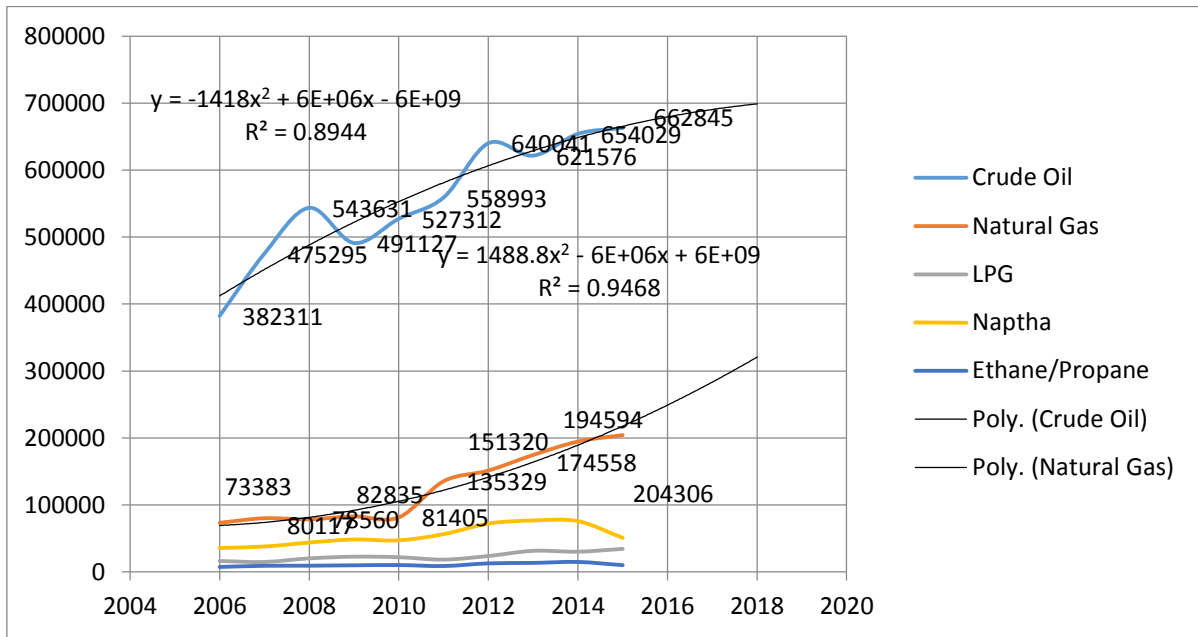
**Fig 3.2: Natural gas production of ONGC Group (Forecasting year 2018)**

Natural gas production also decreases marginally in 2014-15, because it is not a renewable source of energy and India has very limited reserves of natural gas, though further discoveries are being made from recent explorations.

Natural gas contains a very high percentage of methane, which makes it highly combustible. The extraction technique of natural gas creates large cavities in the earth. Natural gas requires extremely complex treatment plants and pipelines for its transportation and delivery. Natural gas occupies 4 times the space of a gasoline equivalent energy.

Sales (year)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Crude Oil (Rs. In millions)	382311	475295	543631	491127	527312	558993	640041	621576	654029	662845
Natural Gas (Rs. In millions)	73383	80117	78560	82835	81405	135329	151320	174558	194594	204306
LPG (Rs. In millions)	16279	14867	20169	22752	21924	18368	23711	31484	30145	34380
Naptha (Rs. In millions)	35679	37907	43848	48406	47137	56342	72167	76805	75743	50835
Ethane/Propan (Rs. In millions)	7401	9095	9291	9890	10249	8796	12741	13440	14837	10064

**Table 3.2: Sales Revenue of petroleum products of ONGC**



**Fig. 3.3: Sales Revenue of petroleum products of ONGC (forecasting year 2018)**

Consumption of petroleum products in India increases in recent years. The national and international market price of these petroleum products depends on the production and price of crude oil. According to the report of ministry of oil and natural gas, Except Naptha, Ethane/Propane, all other major petroleum products have recorded positive market growth during 2014-2015. The increase in global crude oil prices and the expected rise in retail prices during the 2014-15 lead retailers to keep high inventories. Petrol prices were also increased during these periods. The rise in demand created the logistics and transportation challenges in oil & gas sector. LPG consumption continued to grow very rapidly in recent years. Low oil prices have created a positive environment for the economical growth of country. The cost effective refining in India is attracting the concentration of several global oil and gas key players. India is considered to be one of the most important and biggest markets for petroleum products and crude oil. The crude oil from Middle East is very easily transported to India by water transportation (i.e by sea routes). Petroleum products and crude oil prices affects the whole economy, especially because of its utilization in transportation of goods and services. If oil price increases, then it leads to an increase in prices of all goods and services, and as a result, inflation rises. A high inflation is not good for growth of economy. It also affects petroleum industry directly, consumer demand decreases, because of high value of manufacturing and operational costs. This is why the decrease in global crude oil prices is a positive sign for Indian oil & gas market.

#### 4. CONCLUSION

**4.1 Findings of the study:** The level of uncertainty is very high, in supply chain management of petroleum industry. The problems like long lead time, transportation and logistics management, inventory procurement creates lots of challenges. The supply chain activities should be very effective and efficient and must focus

on cost effective policies, because of a huge amount of capital investment. There should be balanced approach for profit maximization and high level of customer satisfaction. Optimization is not only the profit enhancement, but it deals also with managing all the resources effectively and efficiently. Supply chain optimization plays a very important role to achieve the main objective or goals for petroleum industry. Customer satisfaction is one of the best techniques to get competitive benefit and profit enhancement. Supply chain optimization must focus on cost efficiency to increase profitability. In supply chain management of petroleum industry demand forecast is very important. There must be accurate forecast for product demand. By using mathematical models or time series forecasting techniques, we can get the accurate forecast almost. The crude oil is just like the raw materials for petroleum products. Hence the selection of crude oil should be based on LPP models. For ship scheduling, there must be simulation techniques. There should be separate planning model for in-bound, in-house, out-bound logistics. The role of information technology is very crucial in supply chain activities. Due to demand and price fluctuation oil industry is affected at global level. It is also affected by the government economical and political policies. In petroleum industry, there must be vertical integration approach in supply chain management for the better productivity and profitability.

**4.2 Limitations of the study:** Supply chain management of petroleum industry is very different and complex from other industries.

The main limitations are availability of time, availability of fund, and complex infrastructure of petroleum industry, because it is very difficult to consider each and every factor in such a complex structured organization.

## ACKNOWLEDGEMENT

It is my privilege to thank all the people, who have helped me in moulding and shaping my project.

I am thankful to all the respected faculty members of Department of Management Studies, ISM Dhanbad and my project guide **Dr. MRINALINI PANDEY** for providing me the essential information and support. I thank almighty for their abundant blessing.

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