

# Dynamic Supply Chain: A Study in Oil and Gas Industry

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**Abstract.** The motivation of this study is to understand the environment of dynamic supply chain on oil and gas industry in Malaysia by looking into the dynamic supply chain capabilities and dynamic supply chain performance. Oil and gas enterprise-wide optimization span a large spectrum in a supply chain, from the strategic to the tactical to the operational level and other various functions in the supply chain network, from purchasing of the raw materials through the refinery activities to the distribution and sales. Integrated and coordinated decision making across various geographically distributed refinery activities and storage sites also offers additional challenges to refinery operations optimization. While refinery facilities management is an integral part of enterprise-wide optimization, transportation logistics and finished product distribution management remain important parts of the oil and gas supply chain. Although, technical advancement and time were the core values aiming only for fast exploration and higher production of oil and gas, supply chain in the oil and gas industry can either make or break the project if careful attention and precautions are not taken seriously by players in an industry. Increasing economic volatility has severely disrupted the supply chains of companies across industries. Rapid swings in the availability and price of key commodities, major currency fluctuations, disturbance in financial markets, disruptive geopolitical events and continued development of customer channels on a global basis have conspired to place unique pressure on the way these companies source, manufacture and distribute products. Therefore, this study is to identify and understand the dynamic supply chain capabilities and dynamic supply chain performance as a whole perspective of dynamic supply chain on the oil and gas industry practices. Specifically, the dynamic supply chain capabilities and dynamic supply chain performance will be discussed in this study are the firm's capabilities in the dynamic supply chain of oil and gas industry.

**Keywords:** Dynamic capabilities, dynamic supply chain, oil and gas industry, supply chain management

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## 1. Introduction

Supply chain management (SCM) has received in recent years a great deal of attention by researchers and practitioners. Effective SCM will lead to a lowering of the total amount of resources required to provide the necessary level of customer service to a specific segment and improving customer service through increased product availability and reduced order cycle time [1]; engage in information exchange (forecasting techniques, inventory management, delivery) and structural collaboration (just-in-time system, outsourcing, vendor-managed inventory and co-locating plants) [2, 3]; relationships with downstream supply chain partners to create end-customer value [4] and maximize benefits and minimize costs along the supply chain [5]. Thus, the nature of SCM becomes visible to participating companies with successful implementation in the ever changing global environment of the business world, risks abound and it greatly affects the decision making processes of the business management.

According to Jain, Wadhwa and Deshmukh [6], a supply chain is a dynamic process and involves the constant flow of information, materials, and funds across multiple functional areas both within and between chain members. Members in the chain need to cooperate with their business partners in order to meet customer's needs and to maximize their profit. However, it is a very difficult task in managing the multiple collaborations in a supply chain because there are so many firms involved in the supply chain operations with its own resources and objectives. The interdependence of multistage processes also requires real-time operation and decision making across different tasks, functional areas, and organizational boundaries in order to deal with problems and uncertainties. The strategic move of focus for mass customization, quick response, and high quality service cannot be achieved without more complex cooperation and dynamic structure of supply chains.

Teece, Pisano and Shuen [7] identified a dynamic collaboration capability should help a company access, shift and leverage supply chain resources to rapidly respond to a changing competitive environment. A dynamic process also involves the simultaneous acquisition and continuous re-evaluation of partners, technologies, and organizational structures. Firms may encounter the same problems but they may have different awareness and potential solutions due to differences in their engagement of stakeholders. The more flexible and open of the firms to the issues there is more likely for them to explore, create, and invest in the dynamic capabilities [8, 9]. Therefore, firms that possess a dynamic collaboration capability should be able to sustain high performance levels over time.

Uncertainty arises in realistic decision making processes and has a huge impact on the dynamic supply chain activities [10]. Environmental uncertainties in oil and gas industry lead to a need for higher reliability and flexibility within the production systems and the planning and control systems in the supply chain. Reducing these uncertainties will be achieved by understanding the root causes and how they interact with each other. Change in markets, products, technology, and competitors are occurring at an increasingly rapid pace [4, 11]. As a result, managers must make decisions on shorter notice, with less information, and with higher penalty costs. Therefore, a reliable yet flexible system is fundamentally needed to assist the management in making decisions that might prove to be the make-or-break decision for their companies.

The purpose of this study is to understand the environment of dynamic supply chain on oil and gas (O&G) industry in Malaysia by looking into the dynamic supply chain capabilities and dynamic supply chain performance. O&G industry span a large scale in a supply chain, from the strategic to the tactical to the operational level and other various functions in the supply chain network, from the purchasing of the raw materials through the refinery manufacturing to the distribution and sales [10, 12]. Integrated and coordinated decision making across various geographically distributed refinery manufacturing and storage sites also offers additional challenges to refinery operations optimization. While refinery manufacturing facilities management is an integral part of enterprise-wide optimization, transportation logistics and finished product distribution management remain important parts of the O&G supply chain. Hence, this study is to identify and understand the dynamic supply chain capabilities and dynamic supply chain performance as a whole perspective of dynamic supply chain on

the O&G industry in Malaysia practices. Specifically, the dynamic supply chain capabilities and dynamic supply chain performance will be discussed in this study are the internal firm's and external firm's capabilities and controlled by the environmental uncertainty in the dynamic supply chain of O&G industry. The internal firm's capabilities representing the focal organization meanwhile the external firm's capabilities representing the upstream and the downstream organization in the O&G industry.

### **1.1. Problem Statement**

Supply chain in the O&G industry for quite some time was not taken seriously by players in an industry where technical advancement and time were the core values aiming only for fast exploration and high production of O&G. Mohammad [13] stated that it was initially considered a "soft issue" in the industry until players beginning to realize that 80% of all operating expenses were spent on the supply chain system. They also noticed that they can either make or break the project if careful attention and precautions on the procurement or supply chain system were not taken seriously especially when the business environment was demanding while exploration and production were challenging and pushing them to their limit.

There are many ways to look at the O&G industry. From a personal perspective, O&G provide the world's 6.9 billion people with 60 percent of their daily energy needs [14]. As fuels and as petrochemical feedstock, O&G are the raw materials used to manufacture fertilizers, fabrics, synthetic rubber and the plastics that go into almost everything people use these days, from toys to personal and household items to heavy industrial goods.

From a business perspective, O&G represent global trade on a massive scale. Over 200 countries have invited companies to negotiate for the right to explore their lands or territorial waters, hoping that they will find and produce O&G, create local jobs and provide billions of dollars in national revenues [14].

Finally, from a health, safety and environmental perspective, there is a continuous concern for safety in O&G operations, the impact that new projects have on surface environments, the possibility of oil spills and the effect of pollutants such as CO<sub>2</sub> (carbon dioxide, a product of hydrocarbon combustion) on global climate change and air quality [14]. The O&G business is clearly a multifaceted, global industry that impacts all aspects of one's lives. And yet it is one that tends to take for granted until a crisis emerges-a tanker runs aground, a hurricane damages a refinery, a country changes political leaders or revises its energy policies.

It was therefore not surprising that not many articles are published on dynamic supply chain specifically in an O&G industry to the related journals. Many of the articles found in the supply chain in journals or other publications prior to this have done research on the dynamic supply chains referring to the manufacturing, retailing and using modelling techniques as a method in deliberating the decision [2, 15-17].

Based on the previous studies conducted in Malaysia, several studies on the supply chain issues includes: value changes and multicultural complexity [13]; collaborative supply chain [18]; outsourcing [3] sustainability and environmental control [19]. Although there are many new technological breakthroughs in exploration and production [10, 20, 21], there has been insufficient development in dynamic supply chain strategies and methods. Many ideas have simply been taken on those used in other sectors or industry rather than considering the specific need of the O&G industry. Thus, this study will be focusing on exploring the dynamic supply chain capabilities and dynamic supply chain performance on the O&G companies in Malaysia.

### **1.2. Research Objectives**

Generally, the research objective is to examine and understand the dynamic supply chain capabilities and dynamic supply chain performance in the organizations specifically for O&G industry in Malaysia environment. The focus will be at the internal firm's (focal) and external firm's (upstream

and downstream) capabilities of dynamic supply chain capabilities and dynamic supply chain performance and controls by the environmental uncertainty of the O&G industry.

The research specific objectives are as follows: 1) To identify any association of internal firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia. 2) To identify any association of external firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia. 3) To explore environmental uncertainty factor control the internal firm's and external firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia. 4) To explore dynamic supply chain capabilities associate to dynamic supply chain performance of the O&G industry in Malaysia.

### **1.3. Significance Of Research**

From the theoretical perspectives, this study utilizes dynamic capabilities, industrial system, resource-based view and organizational learning theory. These theories discuss the importance of information and materials as unique resources in SCM for the competitive advantage. It will represent an exploratory study on dynamic supply chain capabilities and performance of the O&G industry in Malaysia. Furthermore, it will provide information to develop a better understanding of dynamic supply chain capabilities and dynamic supply performance towards strategies and decision made in the internal and external firm's capabilities.

From the managerial point of view, this study will benefit them in several ways. The results of this study will be expected to show the performance of dynamic supply chain on O&G industry. This will help the players in the industry to understand the progress and future actions that could improve the SCM competitiveness in of Malaysia.

## **2. Literature Review**

The petroleum industry can be characterized as a typical supply chain where all levels of decisions (strategic, tactical, and operational) may arise in it. Management of the petroleum supply chain is a complex task due to the large size of the physical supply network which dispersed over vast geography, complex refinery production operations, and inherent uncertainty. Shah, Li, and Ierapetritou [10] identify that uncertainty arises in rational decision making processes and has a vast impact on the refinery planning activities. Three major uncertainties that should be considered in refinery production planning include: market demand for products; prices of crude oil and the saleable products; and product or production yields of crude oil from chemical reactions in the primary crude distillation unit

Gattorna [22] identifies the dynamic supply chain as a concept of supply chain agility and flexibility. The two concepts define people is the most important in delivering the value. One need to change way of thinking from one functional specialism to the belief that the principles and practices embodied in supply chain and value networks type thinking. It should become a philosophy that permeates the enterprise owned and contributed to all functions.

The dynamic capability viewpoint has had a significant impact on strategic management research in general and in research regarding organizations and the natural situation in particular. It offers the potential to extend and complement the Resource-based view (RBV) to create a more thorough understanding of the process by which firms undertake sustainable development strategies. The dynamic capabilities perspective, with its emphasis on variation within uncertain and dynamic markets, is particularly well suited to the study of supply chain management strategies. This is because the perspective in which firms develop capabilities to deal with these issues is highly complex and unclear [9].

### **2.1. Oil and Gas Supply Chain Management**

Petroleum companies, also known as Oil and Gas (O&G) companies have formed a key part of the global economy for the last decade since petroleum or crude oil has become the main fuel source. By 2020, Malaysia will have a more diversified oil, gas and energy sector that remains vital to the nation development, and that builds on the nation's competitive advantages. A key thrust not only to intensify

exploration and enhance production from domestic reserves but also to develop a strong regional oilfield services and equipment hub and a stronger presence in the regional midstream logistics and downstream markets [23].

Malaysia's national O&G Company, *Petroleum Nasional Berhad* (Petronas), holds exclusive ownership rights to all O&G exploration and production project in Malaysia. As Malaysia's oil fields are maturing, the government is focused on enhancing output from existing fields and from new offshore developments of both O&G, which are expected to increase aggregate production capacity in the near- to midterm [24]. Among other major players in Malaysia O&G industry are *Esso Malaysia Berhad* and *Shell Malaysia Limited*.

The majority of the country's reserves are located off the east coast of Peninsular Malaysia and tend to be of high quality. Several new oil production projects have come online during the last few years, although Malaysia's oil output declined somewhat in 2006. Average production for 2006 stood at 798,000 barrels per day (bbl/d), down 7% from 2005 levels. In 2006, Malaysia consumed an estimated 515,000 bbl/d of oil, with net exports about 283,000 bbl/d. According to *Oil and Gas Journal*, Malaysia had about 545,000 bbl/d of refining capacity at six facilities as of January 2007. Malaysia's state-owned national oil company, *Petronas*, dominates upstream and downstream activities in the country's oil sector. *Petronas* operates three refineries (259,000 bbl/d total capacity), while *Shell* operates two plants (200,000 bbl/d), and *ExxonMobil* one (86,000 bbl/d) [25, 26].

Shah, Li, and Ierapetritou [10] state that, a typical petroleum industry supply chain is composed of an exploration phase at the wellhead, crude procurement and storage logistics, transportation to the oil refineries, refinery operations, and distribution and transportation of the final products. The upstream activities (exploration, development and production of crude oil or natural gas) and downstream activities (tankers, pipelines, retailers and consumers) are two important activities in the petroleum industry [19]. SCM in O&G industry requires the company to integrate its decisions with those made within its chain of customers and suppliers. This process involves relationship management of the company to their customers and suppliers. A firm can create long-term strategic relationships with their suppliers and in most cases there is a collaborative process between the oil and gas company with its suppliers [5]. Generally, O&G companies view their supply chain configuration and coordination systems as worthy of improvement. Making necessary improvements over time allows the firm to gain competitive advantages in the marketplace.

In the oil refinery industry, the supply-chain network is composed of shipping via vessel, oil tankers, and pipelines that may run across multiple countries. This network is used to transport crude from wellhead to refinery for processing, to transport intermediates between multi-site refining facilities, and to transport finished products from product storage tanks to distribution centers and finally to the customers. Any disruptions arising in the global supply chain can have tremendous adverse effects in achieving operational efficiency, maintaining quality, profitability, and customer satisfaction. The adverse events may happen due to uncertainty in supply of crude, demand, transportation, market volatility, and political climate. Hence, Shah et al. [10] identify that to effectively model a supply-chain design problem, the dynamics of the supply chain ought to be considered and data aggregation techniques for the extensive data set should be employed.

## **2.2. Scope and Limitation of Research**

This study will be focusing on exploring issues on dynamic supply chain capabilities and dynamic supply chain performance on O&G industry only, thus the generalization cannot be done in other organizations and industry throughout Malaysia.

The assumption of this study is that the major players in the O&G industry are doing the similar practices in managing their supply chain. In the exploration and production sectors of the oil and gas industry, the product is exactly the same for all competing firms with very narrow product differentiation. Thus, exploration and production companies can only differentiate themselves based on the ability to economically find and produce O&G more efficiently than their competitors. Even

though exploration and production companies are unique in many fields, a differentiating factor can lie in the ability to adapt an SCM program.

### **3. Research Methodology**

This study will be an exploratory since not much is known about the situation of dynamic supply chain capabilities and performance in oil and gas industry in Malaysia environment. An in-depth study will be undertaken to better comprehend the nature of the problem, since very few studies have been conducted in the dynamic supply chain capabilities and performance [27-29].

In addition, when the phenomenon of interest is new, dynamic or complex, relevant variables are not easily identified and extant theories are not available to explain the phenomena. In this situation, a qualitative approach is often preferred in order to build understanding grounded in a detailed description of the phenomenon generated by collecting field data. It provides researchers with access to a deeper level of understanding of new or complex phenomena by yielding a high level of details [30, 31].

Yin [32] and Eisenhardt [31] give useful insights into the case study as a research strategy, but leaves most of the design decisions for further discussion for both the strengths and the weaknesses. It's because it allows tailoring the design and data collection procedures to the research questions. On the other hand, this approach has resulted in many poor case studies, leaving it open to criticism, especially from the quantitative field of research. The fact that the case study is a rather loose design implies that there are a number of choices that need to be addressed in a principled way [33].

#### **3.1. Research Sample**

The concept purposive sampling will be employed for the study because the researcher will select individuals and sites for the study. The decision need to be made about who and what will be sampled, what form the sampling will take and how many people or sites need to be sampled [28, 30, 34]. Since this study will be conducted in the O&G industry, gaining an in-depth insight into advanced practices which will later set the ground for the generation of proposition [35]. The snowball or chain case selection technique will be employed with the procurement and supply chain function in the focal organization as the unit of analysis [30].

#### **3.2. Case study Protocol**

Gimenez [36] identifies the case study protocol as follows. The first step in the case methodology is to define the research questions. As stated before, the research objectives of this exploratory phase were: (1) To identify any association of internal firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia, (2) To identify any association of external firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia, (3) To explore environmental uncertainty factor control the internal firm's and external firm's capabilities and dynamic supply chain capabilities in the O&G industry in Malaysia and (4) To explore dynamic supply chain capabilities associate to dynamic supply chain performance of O&G industry in Malaysia.

The following steps refer to the process of determining the unit of analysis. As supply chain management involves the integration along the supply chain, the most appropriate approach in the study would have been considering all elements in those chains such as retailers, third party logistics providers, refiners, purchasing centers, etc. But, due to the need of limiting the scope of the study, the study will focus on the upstream and downstream from the oil and gas industry in Malaysia. The most appropriate approach to analyzing these relationships will be to analyze particular upstream-focal-downstream organizations triad, but this approach was not possible due to the discretion of the interviewees to identify the supply chain partner they were talking about.

In order to increase the reliability of the case study, an interview protocol and a case study database will be developed. With respect to how to link the data to the research questions, a chain of evidence will be established in order to allow any external observer to follow the derivation of any evidence from initial research questions to ultimate case study conclusions.

After establishing the interview protocol and how to link the data to the research questions, interviews with five companies (two upstream, one focal and two downstream companies) will be conducted. Companies among the leaders in different product categories, and selected upstream and downstream companies will be selected among the top supply chain in O&G industry.

Data collected will be introduced in the case database, which will be analyzed to obtain the conclusions. Other sources of evidence such as newspaper clippings and articles also will be used to corroborate and augment evidence.

#### 4. Conclusion

As a summary, since this is a conceptual paper, studies on dynamic supply chain capabilities and performance of O&G industry will be identified in several elements such as internal firm's capabilities, external firm's capabilities and environmental uncertainty. As previous studies looked at the variables separately few attempts were made to link between dynamic supply chain capabilities and dynamic supply chain performance. This study also will integrate the internal firm's and external firm's capabilities as they are considered crucial in ensuring the dynamic supply chain capabilities are well practiced. Having the environmental uncertainty as control to build dynamic supply chain capabilities as it will modifies dynamic supply chain performance and helps in any competitive advantage in the O&G industry in Malaysia.

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