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Oil and gas service companies adapting procurement and sourcing to the volatile oil and gas market

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Abstract

The purpose of this paper is to address the increasing importance of supply chain agility for oil and gas service companies. In a highly volatile and complex oil and gas industry, service companies are increasingly competing on supply chain effectiveness to reduce costs and improve operational efficiency to sustain growth in a changing business environment. The oil price fluctuation is a key indicator for oil and gas service companies in terms of activity and profitability. It generates significant challenges with suppliers and risks harming the company's ability to cope with the market volatility. The business performance in a fluctuating market is linked to the capability of the supply chain to cope with changes in volumes, secure supplies, and manage risks. Hence, there is a need to understand the business environment and come up with proactive solutions to gain a comparative advantage over the competition.

The paper presents the environment in which oil and gas service companies operate by looking at the historical fluctuations of the oil price and market perspectives. Then, an empirical study on a major oil and gas service company highlights the impact of oil price fluctuations on revenue, activity, and cost and demonstrates the main challenges and risks encountered during an oil crisis. It includes real examples to demonstrate the importance of addressing and anticipating the supplier challenges and corresponding risks looming the company's business performance. The paper also presents a general literature review on how supply chain agility can accommodate to cyclic businesses, including academic discussions and practices implemented by other industries.

This study gathers knowledge on the oil and gas service industry and an overview of the existing literature on supply chain agility to explore empirically the application of greater agility for oil and gas service companies. It provides evidence that within the procurement and sourcing function there are ways for oil and gas service companies to overcome the looming risks and successfully operate in an increasingly volatile and complex market. The analysis and literature review permit to come up with case-by-case recommendations for supplier managers to contribute to greater supply chain agility.

Keywords: Sourcing, Procurement, Agility, Flexibility, Volatility, Oil and Gas, Service Company

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1. Introduction

The world economy is becoming increasingly globalized and integrated, creating a more **complex** and **connected** environment for all industries. The reduction of technological boundaries is expanding innovations faster and at a larger scale. Companies need to work harder to meet customer's requirements (McKinsey & Company, 2011). Large multinationals are striving to leverage on their size and global presence to improve the way of doing business. This evolving environment inspires companies to compete further on supply chain effectiveness to reduce costs and optimize operations to stay ahead of competition. Supply chain covers the organization, processes, people, physical resources (ex: machinery), and operations moving a product or service from supplier to customer and accounts for a large share of a company's value. Since cost reduction, operational efficiency, and leverage are linked to the procurement and sourcing function. Hence, the function has become a target for greater efforts to develop the ability to address the oil and gas volatility and become a competitive advantage.

For oil and gas service companies, in addition to complexity and connectivity, **volatility** has become a growing and recurring challenge to address. Service companies provide field development services (covering the entire oilfield life cycle) to production companies selling oil to end-users. As oil producers adapt their activity level to the oil price, fluctuations in the pricing creates turbulences and uncertainties in the supply chain. Hence, the necessity to develop the agility to prepare for impending oil shocks and take action when they occur, has set procurement and sourcing agility at the forefront. This allows reducing costs and protecting margins in **downturns** (recessions), while maintaining capabilities and capacity to benefit and take advantage of **upturns** (upward shift in an economic-cycle).

Moreover, companies are operating in a complex environment where the fiercer **competition** is pushing companies to reduce costs with suppliers to "do more with less" (Trebilcock, 2015) to respond to customers' needs. Service companies are interacting with a large **panel of suppliers**

making it challenging for the supply chain to manage and monitor the numerous relationships efficiently.

To address the challenge of the external environment and account for the complexity of the panel of suppliers, the following two research questions will be considered in this study.

(1) What are the challenges of the oil and gas industry?

(i) What are the main drivers affecting the oil and gas industry?

(ii) What are the oil and gas market perspectives?

(iii) With the increased complexity and volatility, what is the role of the supply chain?

(2) How can Schlumberger master oil price fluctuations to stay ahead of competition?

(i) How is Schlumberger impacted by the oil price fluctuations?

(ii) What are the main challenges encountered with suppliers?

(iii) Where and how should procurement and sourcing target efforts to avoid risks and improve performance?

The first section of this paper offers an understanding of the environment in which oil and gas service companies operate. It includes a macroeconomic portrait of the oil and gas industry looking at the historical evolution of the oil price, assessing drivers, and providing a short, medium, and long-term outlook on the industry's perspectives. This section also presents a literature review on supply chain agility gathering discussed ways and practices from other industries to improve the supply chain capability to respond to market changes.

The second section is an empirical study on a major oil and gas service company, Schlumberger (SLB). Building on SLB's implemented and planned methods to improve procurement and sourcing (P&S), it offers an analysis of the impact of fluctuating oil prices on service companies. The analysis looks at (1) SLB's reaction in terms of revenue, activity, and cost, (2) case studies on challenges encountered with suppliers and risks looming SLB's business performance. Finally, the section offers recommendations to P&S managers to enhance the company's capability to cope with the market volatility.

2. Oil and gas background

The oil and gas industry is mainly dedicated to the extraction of natural resources (natural gas and crude oil) for energy consumption. It is composed of equipment and service providers and production companies (referred to as **operators**) selling oil and natural gas to end-users (table 1). The actors rely on the supply and demand of these natural resources determining the market pricing.

Table 1: Oil sectors and corresponding actors

Sectors	Definition	Actors	Customers
Upstream	Exploration and production (E&P)	• Manufacturing Companies • Service companies	Operators
Midstream & Downstream	From field to final consumption (transportation, storage, refinery…)	• National Oil Companies • International Operators	End-users

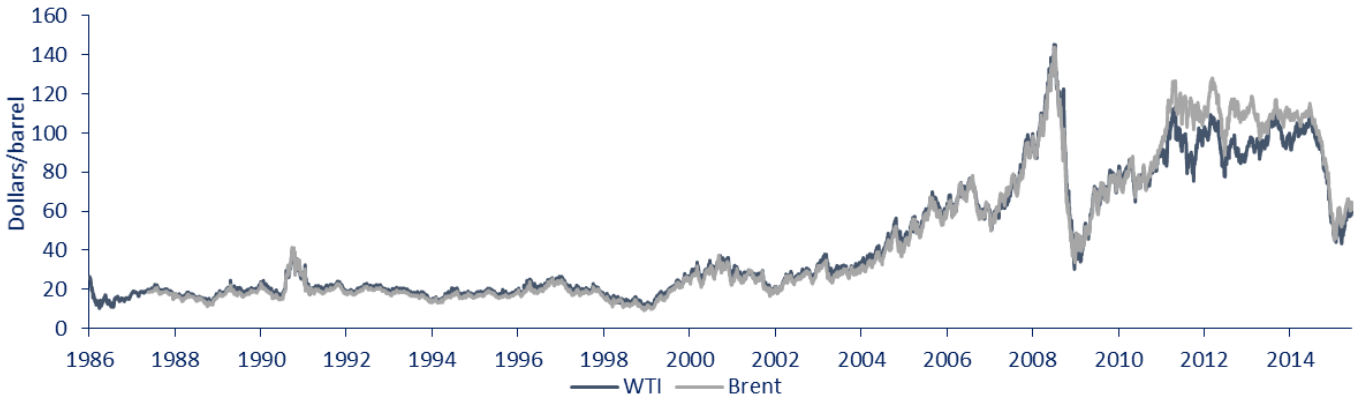
First, an overview of the commodity prices will present the best market volatility indicator. Then, a review of main historical events will present the main oil price drivers. Finally, market projections from various companies and organizations will provide information on key elements expected to govern the future of the oil and gas industry, essential when discussing ways to drive future performance.

2.1. Market volatility

Since crude oil and natural gas can be extracted from the same reservoirs using similar technologies, companies usually operate within both commodities. Therefore, the price of crude oil and natural gas are indicators of the market volatility, referenced by different indexes across the world:

- The Brent Crude (Brent) and the West Texas Intermediate (WTI) are major oil price benchmarks, used as worldwide references for the purchase of crude oil. Because of minor gaps between both benchmarks, the WTI spot price is often used to reflect the volatility in the oil market (figure 1).

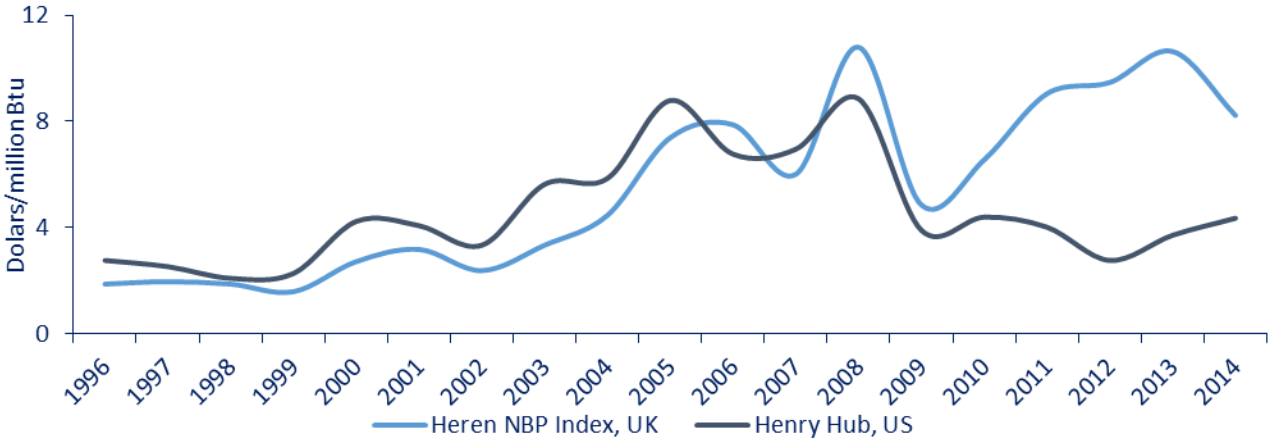
Figure 1: Daily spot prices of crude oil between 1986 and 2015



Source: International Energy Agency (IEA, 2015)

- Henry Hub in the United States (US) and Heren in the United Kingdom (UK) are the major natural gas benchmarks. Since natural gas requires heavy infrastructures for transportation (pipelines) or installations (liquefaction factories), prices present larger discrepancies from one region to another (figure 2).

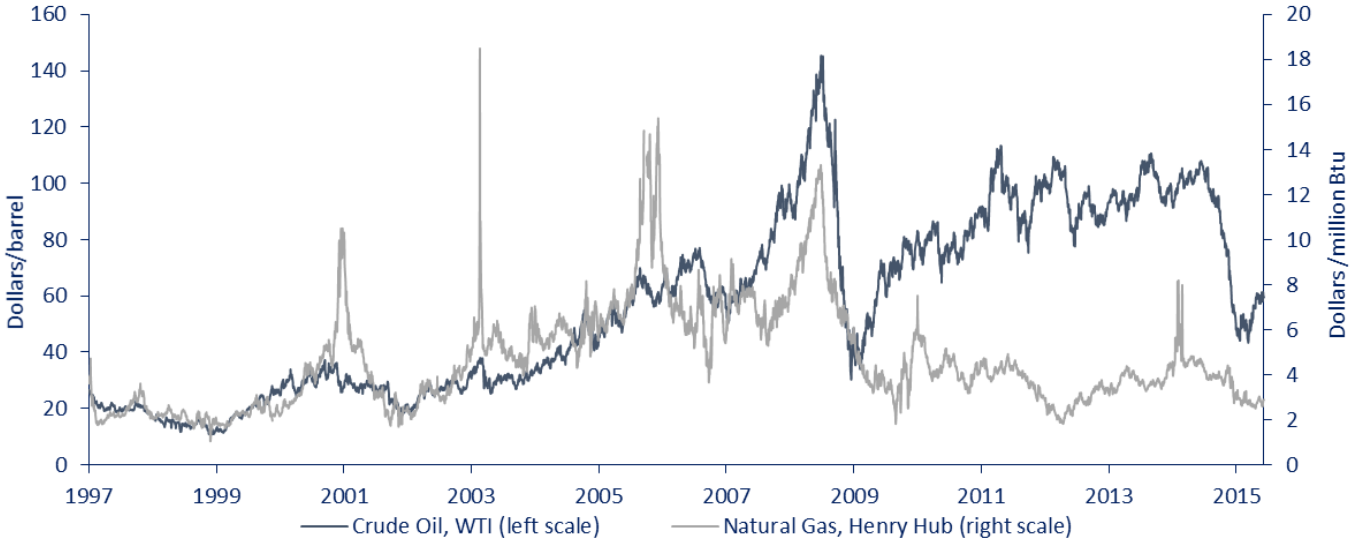
Figure 2: Daily spot prices of natural gas between 1996 and 2015



Source: British Petroleum (BP, 2015a)

Historically crude oil and natural gas prices changed in the same direction, but recently the correlation seems to have faded because of the development of shale gas in the US, holding the price of natural gas down (figure 3). However, as natural gas requires large investments to grow as an energy source, the price of crude oil is considered a stimulus in the development of natural gas.

Figure 3: Correlation between natural gas and crude oil daily spot prices



Source: IEA (2015)

As per the small gaps between crude oil benchmarks and the link between crude oil and natural gas pricing, this study will use WTI as the indicator for oil and gas market volatility.

2.2. Historical context

Crude oil prices have always been subject to fluctuations punctuated by large peaks referred to as oil crisis. A study of these historical episodes brings an overview of the drivers influencing the oil price. This is important to understand the environment in which oil and gas service companies operate. Since 1970, the industry has been subject to four major downturns (table 2). Differences and similarities between these price drops in terms of duration, magnitude, drivers, and actors reactions reveals a complex industry affected by numerous domains.

Table 2: Major oil crisis since 1970

Dates	Nov 1985 to Mar 1986	Nov 1990 to Feb 1991	Jul 2008 to Feb 2009	Oct 2014 to Sep 2015 (ongoing)
Duration	82 days	71 days	115 days	> 250 days
Price drop	66%	48%	79%	55%
Volatility	4.69%	5.18%	4.86%	2.87%
Fundamental drivers	Increase in non-OPEC oil supply (Alaska, Mexico & North Sea)	First Gulf war (Iraq invasion of Kuwait)	Financial crisis	Increase in non-OPEC oil supply (US shale oil)
OPEC Strategy	Raise production to protect market share	Raise production to keep oil market well-supplied	Cut production to target a price range	Raise production to protect market share

Source: World Bank (2015c)

The Organization of the Petroleum Exporting Countries (OPEC) is a cartel of 12 member countries with a substantial net export of crude petroleum, contributing to more than 30% of global oil production. Saudi Arabia (SA), the world largest producer, is the leading member of the organization (BP, 2015a). In addition, the difference between conventional and unconventional oil (including shale and sand) lies in the required methods and techniques used to produce or extract the oil from the reserves.

- In **1985-1986**, the price drop was mainly driven by new supply conditions, with an increased oil production from unconventional sources in the North Sea and Mexico. This generated a long period of low oil prices, encouraged by OPEC's strategy to raise its production to protect its market share (World Bank, 2015c).

- In **1990-1991** and **2008-2009**, the price drops were caused by external events the First Gulf war and the Great Recession respectively. These events triggered a global economic slowdown accompanied by falling commodity prices, such as grains (corn, flour), energies, and metals. Thereafter, markets failed to rebound rapidly, leading to a modest recovery.

- In the **mid-2014**, like in 1985, the downturn was driven by changes in the supply conditions. The oil crisis followed a period of high oil prices, which enabled non-OPEC countries to increase production, mainly shale oil (US), oil sand (Canada), and biofuels. Again, OPEC's loss of market share encouraged the organization to rethink its strategy and role as a swing producer (World Bank, 2015c). Although the magnitude of the price drop is slightly lower than during previous oil crisis, the 2014-downturn is long lasting (exceeded 250 days of falling oil prices).

To conclude, the 2014 price drop seems to share similarities with past episodes of falling oil prices, mainly a higher-than-expected supply from unconventional sources and a lower-than-expected demand engendered by voluntary cutbacks and a global market slowdown (World Bank, 2015c). However, the 2014 drop is unprecedentedly long lasting.

2.3. Main drivers

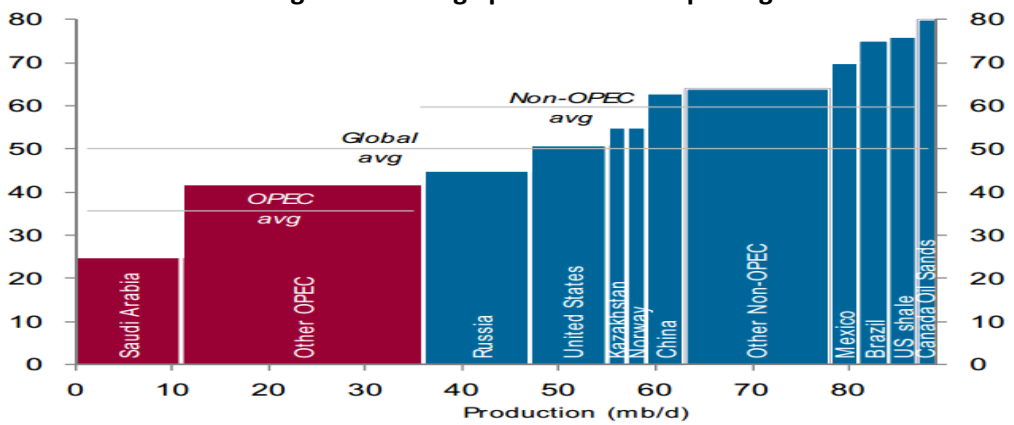
A review of the oil price fundamentals, namely oil **supply** and **demand**, outlines the interconnectivity and complexity between oil prices and multiple domains shaping the world economy.

(a) Oil supply and technological breakthroughs

Oil supply can be defined as the amount of **oil produced** and **proven oil reserves**. History shows that as consumption increases, investments are constantly undertaken to increase oil production and reserves to assure future supply. High oil prices encourage operators to produce more and explore for additional sources. Low oil prices reduce operators' exploration investments to preserve reserves and be able to sell oil in the future at higher prices. The long-lasting 2014 downturn has set a boundary on many oil producers and threatened the viability of large oil projects, weakening the budget of governments relying on oil revenues. It is estimated that an oil price at $50 a barrel puts at risk a $150 billion of upstream investment (Martén & Whittaker, 2015). Hence, as the main clients of oil and gas service companies are operators, the activity level is highly impacted by the oil price.

Oil production cost varies from one region to another (figure 4). The global average for worldwide oil producers lies around 50$ per barrel. Some regions benefit from easily accessible oil reserves of higher quality, like in the Middle East, while other regions require larger investments and treatments, like oil sand in North America. OPEC countries have an average production cost around 45$ per barrel, while for non-OPEC countries the cost is closer to 60$ per barrel. This discrepancy between regions makes it nearly impossible for some high-cost areas to invest in projects deemed unprofitable during an oil-crisis (Martén & Whittaker, 2015).

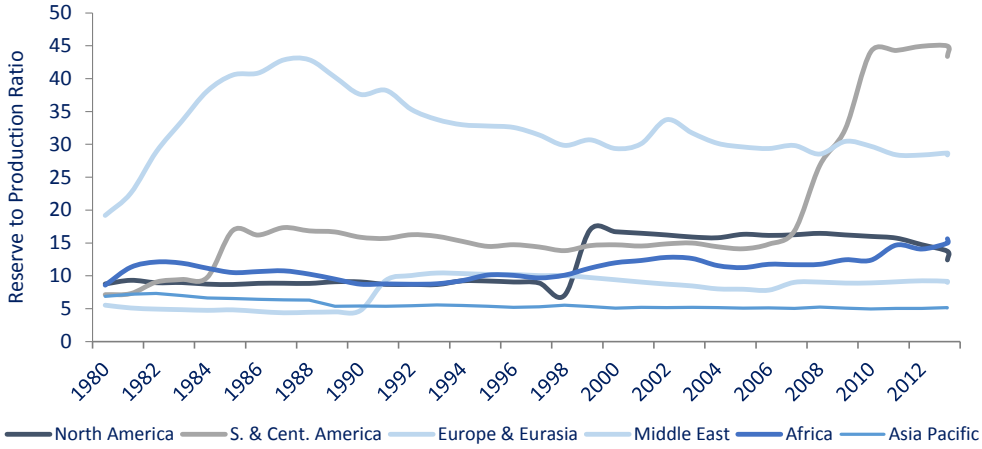
Figure 4: Average production cost per region



Source: Mallinson (2015)

Reserves have continuously increased over the years, with the Middle East accounting for the largest share followed by North and South America. Since 1980, the Middle East holds between 46% and 64% of global reserves, depending on the year. However, the region is facing a falling reserve to production ratio as reserves are depleted and not renewed (figure 5). In 2014, North and South America's reserves reached close to 20% of global reserves respectively (BP, 2015a).

Figure 5: Crude oil reserve-to-production ratio per area



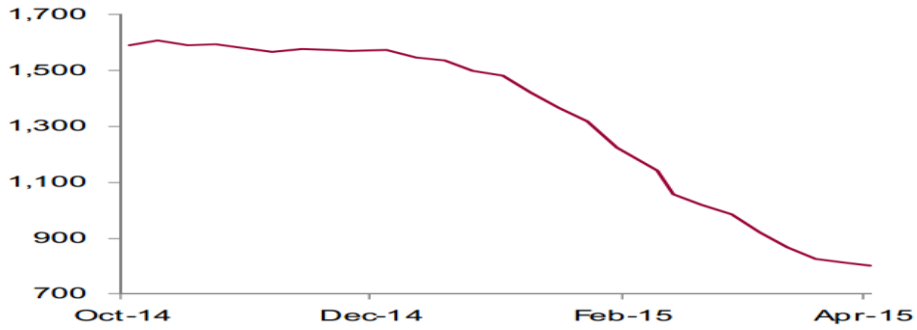
Source: BP (2015a)

The rising quantity of oil extracted is highly linked to **technological developments**. Innovative solutions have increased production in existing fields and developed new fields in previously considered unviable areas. Water injection and fracturing are examples of technologies that have changed the supply side with regions contributing further in supplying the market and new regions producing oil. However, international oil and gas companies are slow to adopt new

technology, taking twice the time compared to the medicine sector (Mitchell, Marcel, & Mitchell, 2012).

The recent expansion of oil production from **shale formation** was mainly triggered by investments in fracturing technologies. Shale oil projects are considered short-lived, between 2.5 and 3 years from the start of development to full extraction (Baffes, Kose, Ohnsorge & Stocker, 2015). For shale projects production declines by about 45% a year, as opposed to conventional oilfields where production declines by 5% on average annually (Cunningham, 2014). Major players have always dominated the oil production, with the top five producers, including US, SA and Russia, representing about 50% of total crude oil production (BP, 2015a). The nature of shale oil projects and its rising market share seems to alter the market power of major oil exporters. In addition, shale oil may transform the industry's response to price volatility, as it can rapidly alter production when oil prices fall or recover by adjusting investment (Statoil, 2015). As an example, the number of US shale oil rigs (a structure for drilling an oil well) fell from above 1,500 rigs to below 900 rigs, between October 2014 and April 2015 (figure 6).

Figure 6: US oil rig counts



Source: Mallinson (2015)

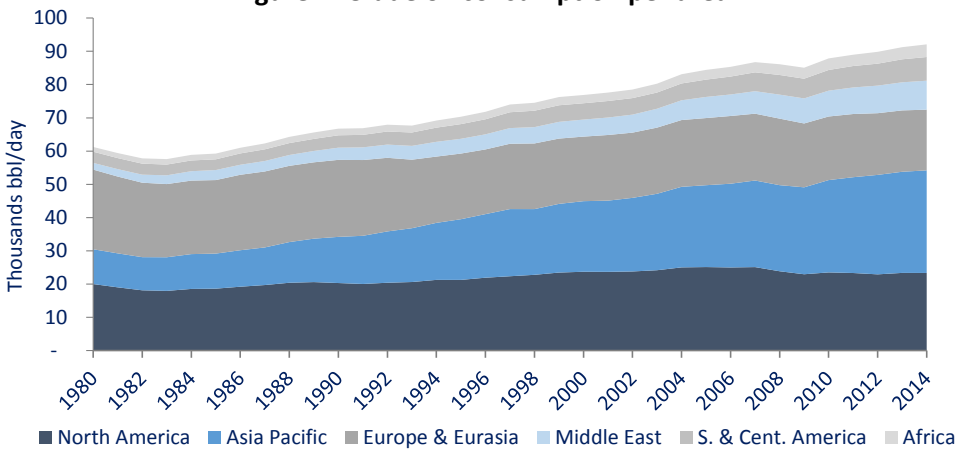
To conclude, reserves are unevenly distributed across the world, with only a few areas benefiting from the possibility to adjust their production quickly to falling oil prices. The production cost and investment necessary to operate in the different areas varies widely. Moreover, technological developments have made available reserves that were previously deemed non-accessible, challenging the historically dominating regions.

(b) Oil demand and an evolving energy mix

Oil is a worldwide energy source, with the transportation and manufacturing sectors accounting for a large share of consumption. This dependency on the oil industry makes the demand in the **short-run** very **inelastic**, meaning that a small shift in demand generates a large effect on oil prices (Hannesson, 2015). This influence has been observed during the financial crisis in 2008 and the economic growth slowdown in developing economies in 2014, where a global recession led to a large drop in oil prices. In the **longer-run**, the market is presumed to be **less inelastic** with the possibility to develop oil substitutes or reduce the global oil usage with energy efficiencies.

Like for supply, demand varies largely from one region to another, with Asia accounting for the largest oil consumer over the last years (figure 7). Observations suggest that past oil price drops were subject to a **rebound effect**, like in 2008, when lower oil prices offered cheaper energy boosting demand for oil (Statoil, 2015). However, experts estimate this effect to be lesser with efforts to reduce oil consumption and consumers preference to retain the additional savings. The development and expansion of potential oil substitutes (natural gas, electricity, or biofuels) and the growing adoption of alternative vehicles (electric, hybrid, and other combustibles) are likely to transform areas that currently account for 70% of total oil demand (Martén, 2015).

Figure 7: Crude oil consumption per area



Source: BP (2015a)

Besides, some observed **megatrends** are likely to shape the future of energy demand. These trends include *urbanization* leading to greater energy efficiency by encouraging a joint use of

energy, *political efforts* encouraging cleaner energies by taxing dirty energies, or *technological breakthroughs* developing viable alternatives to oil, like a wider use of batteries (Statoil, 2015). The political efforts also include the abolishment of fuel subsidies in oil-producing countries (Janssens, Nyquist, & Roelofsen). Hence, political efforts and innovation could change the global fuel mix gradually and have a significant impact of the future oil demand (Statoil, 2015).

To conclude, demand is closely affected by the price of oil, as the economy has been highly dependent on oil as a source of energy. However, the 2014-downturn is indicating a shift in the reactions to lower oil prices, with no rebound effect and a motivation to shift the energy mix toward cleaner sources.

After debates on **peak oil**, based on the challenge of limited supply, a movement has emerged stating that the new trajectory is closer to **peak demand**, putting an end to the link between economic growth and demand for oil. Nevertheless, even if technology and policies may reduce the importance of oil in the energy mix, the transition toward cleaner energy sources is not likely to happen overnight (Nyquist, 2015). Only a few large players dominate the procurement and consumption of the oil worldwide. Hence, the uncertainties threatening the future of the industry, including geopolitical instability, human behaviour, and technology (alternative energy sources and a shift of the energy mix), may change the picture of the worldwide supply and demand.

2.4. Oil and gas market perspectives

The combination of various drivers influencing the evolution of the oil and gas industry founds a complex and hardly predictable environment. Market outlooks from different companies and organizations can help to be aware of the expected market developments to make long-term strategic decisions in accordance with the industry's future.

The market outlook is based on the reports from **British Petroleum** (BP), **Statoil**, **International Energy Agency** (IEA), and the **World Bank**. BP and Statoil are well-established international

operators, investing heavily in market analysis for strategic planning. Both companies are strongly engaged in discussions on the evolution of the oil and gas industry. Every year, they publish complete reports on their perspectives to contribute to the public debate on the industry's future. IEA is a widely used data source providing historical data on all aspects of the energy market. The organization provides reports on world energy outlooks or specific energy markets used by numerous players in the energy industry for strategic planning. Finally, the World Bank brings a more general perspective on the oil and gas industry. The combinations of these various perspectives enable to build a complete picture of the market outlook.

(a) Market outlook approaches

The companies and organizations adopted different approaches when looking into the oil and gas market perspectives:

- BP opted for a 2015-2035 market outlook based on a "most likely" scenario taking into account the major trends observed and likely to shape the market's future (BP, 2015b).
- Statoil adopted a scenario analysis presenting three possible futures framing the market outlook going to 2040. (1) **Reform** reflects a future based on greater energy and climate policies. (2) **Renewal** presents a worldwide effort to reach the 2-degree target (a goal to keep global warming less than 2 degrees above pre-industrial levels). (3) **Rivalry** exposes the worst-case scenario, where the world is under geopolitical conflicts with various sanctions and disagreements (Statoil, 2015).
- In the Energy Technology Perspectives 2015, IEA also looks at three scenarios but focuses mainly on the impact of governmental policy. (1) **Current policy** considers no additional policies. (2) **New policy** includes the implementation of policies currently planned and under discussion. (3) **450** scenario considers a 50% chance of reaching the 2-degree target (IEA, 2014).

(b) Short-medium term outlook

In the short-medium run, the market perspectives converge toward the fact that it will take time for the supply to adjust its production and for demand to pick-up and increase oil consumption.

On the one hand, organizations and operators expect supply to adjust with lower level of investments in production. Statoil (2015) emphasizes the impact of the recent oil price drop on operators' investments and the expected further cuts in 2016, according to company announcements. In 2015, upstream investments were reduced by up to 40% and the number of US shale oil rigs fell by 50% (Statoil, 2015). BP (2015b) agrees with the likelihood that US oil production growth will slow down and the World Bank (2015b) recognizes a reduced investment in new exploration as a cyclical result of low oil prices. However, the interaction between low-cost OPEC production, price sensitive shale production, and non-OPEC production could be highly determined by OPEC's market share ambition (Statoil, 2015).

On the other hand, oil demand is projected to gradually pick-up, with mainly China and India leading the oil consumption increase. For the 2017-2020 market outlook, Statoil (2015) agrees that demand will be driven by India, and that demand growth in OECD countries is likely to stagnate or even decrease. However, demand growth in China and other emerging markets is uncertain and might even slow down (Statoil, 2015). Besides, the World Bank (2015b) identifies cyclical and structural developments on the demand that could affect the market outlook: weak growth prospect and limited support from monetary policy.

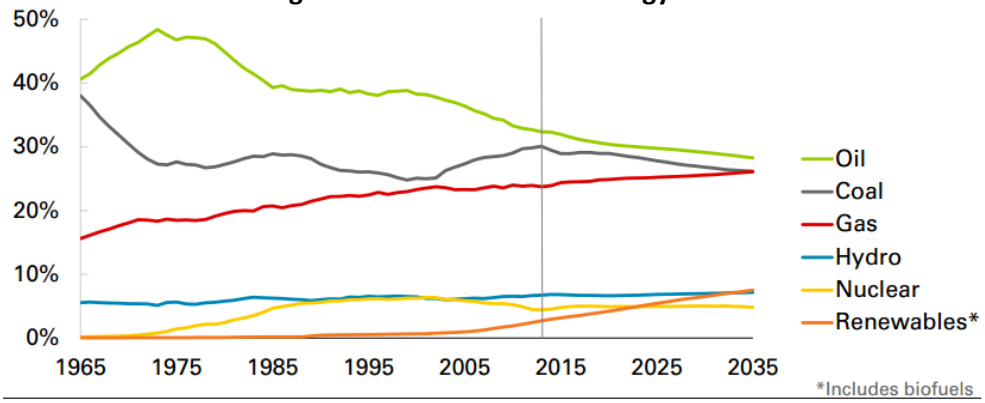
The recovery rate of oil prices will depend on the speed at which supply will adjust to weaker demand conditions or the required time for demand to pick-up in developing countries. In the short-run, low oil prices are likely to persist while the current factors weakening the oil price slowly fade away. In the medium-term, the oil price should recover gradually but remain below the recent peaks. Most recent oil price forecast envisage oil prices to remain low over the 2015-2016 period, with a range between 50$ and 70$ per barrel (Baffes et al., 2015). In the medium-term the oil price is projected to be around 70$ and 85$ per barrel (Statoil, 2015).

(c) Long-term outlook

In the long-term, the effects of the main drivers are expected to play a more significant role, especially with the evolution of the energy mix and the rise of new oil sources.

On the supply side, the energy mix is likely to evolve with a slower growth in oil and coal and a faster growth in lower carbon fuels, essentially gas and renewables. As a result, the 2035 energy portfolio is estimated to be more diversified and balanced between sources (figure 8). Moreover, the rise of liquefied natural gas (LNG) is likely to provide a greater mobility of natural gas across the world instead of relying on pipeline and lead to a convergence of natural gas prices across regions.

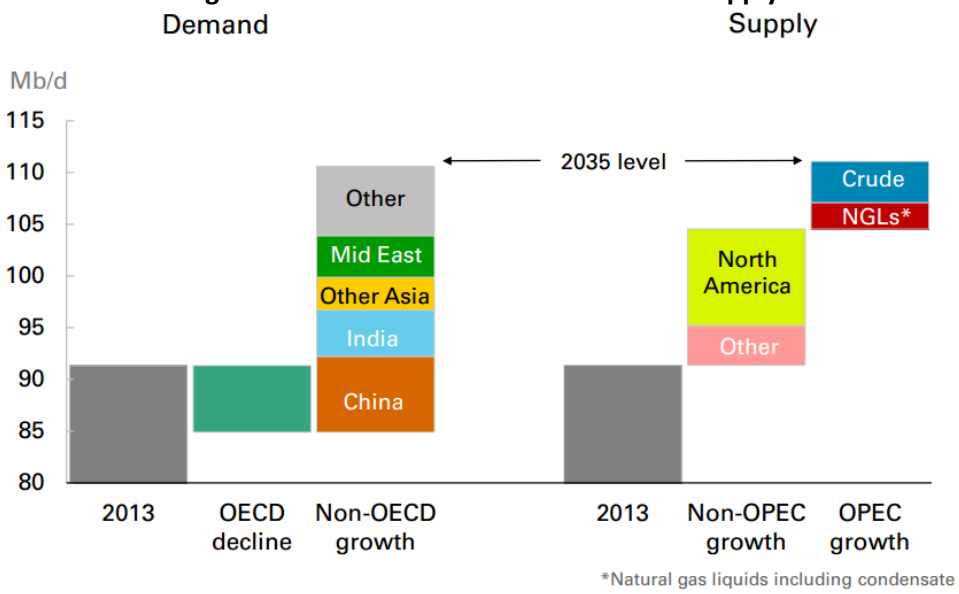
Figure 8: Forecasted 2035 energy mix



Source: BP (2015b)

For oil, US shale oil is likely to gain market share, covering the major increase in energy consumption (figure 9). Hence, the ability of shale oil to respond quickly to oil price fluctuations is likely to lead to a more volatility market where OPECs long-term position as a cartel may not sustain (World Bank, 2015a). Since unconventional oil supply can adjust faster than conventional oil supply to the market conditions and especially if OPEC maintains its current strategy of low prices, unconventional oil producers could become the new swing producers (Baffes et al., 2015). As a result, the oil and gas market could be subject to greater volatility around a new equilibrium level (World Bank, 2015b).

Figure 9: Forecasted 2035 oil demand and supply

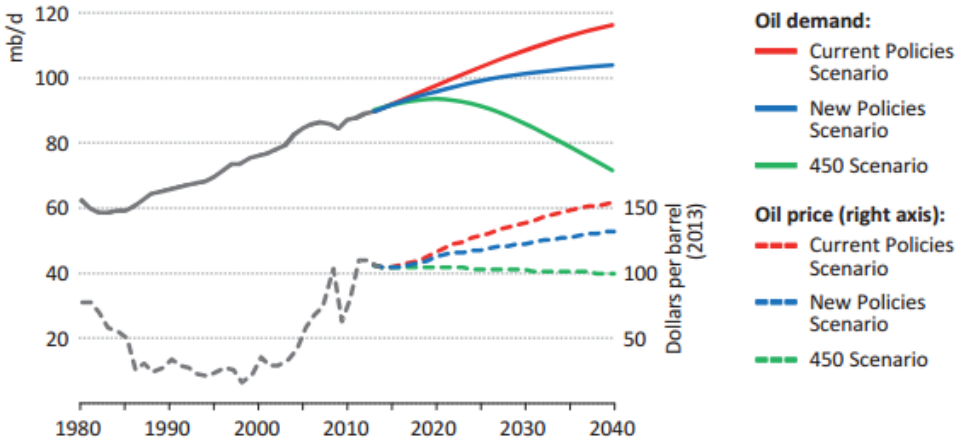


Source: BP (2015b)

On the demand side, BP (2015b) believe that by 2035, demand will mainly grow in Asia where its gross domestic product and population growth will stimulate the energy demand. As an example, by 2035 the number of vehicles is expected to double in China. Nevertheless, energy efficiency technologies might compensate for the growing demand for oil. Other aspects may also contribute to a reduced oil dependency including (1) a shift from a manufacturing to a more service and knowledge intensive sector, (2) the continuation of the urbanization and development of megacities, (3) the political efforts to focus further on environmental sustainability, and (4) technological developments. As a result, these trends may reduce OECD's energy demand and limit the growing demand for oil in other parts of the world (Statoil, 2015).

A more diversified energy mix, with the West starting to supply the growing demand in the East, is likely to shape the long-term outlook of the oil industry. Yet, this transition is not likely to take place over night as the worldwide demand is expected to continue to increase. According to IEA (2014), in 2040, the oil price is expected to be between 100$ and 105$ per barrel in the 450 scenario, as greater political efforts (additional taxes and removed subsidies) may cause a fall in oil demand. In the Current policies scenario higher prices ($150/barrel) are required to keep supply in line with higher demand while considering the depleting reserves and the development of less accessible oil sources requiring higher investments (figure 10).

Figure 10: Forecasted 2040 world oil demand and oil price



Source: IEA (2014)

The market outlooks conducted by major institutions in the oil and gas industry seems to agree that the oil price has hit its lowest. The world is not expected to run out of oil as at least a trillion barrels of conventional oil still reside beneath the earth's surface and several trillions could be extracted from unconventional sources (Janssens et al., 2011). The speed at which the balance between demand and supply is reached will depend on the technology improvements (and adoption) and regulatory standards on fuel efficiency standards and fuel subsidies (Janssens et al., 2011). However these changes might take years so the oil price is only expected to reach higher levels in the medium (2020) and long run (2040). In addition, unpredictable geopolitical risks or financial uncertainties may alter these outlooks and have an important impact on the oil price in the near future.

To conclude, the oil price swings do not last forever (Martén et al., 2015) but the future appears challenging. The long period of falling oil prices and the persisting period of low oil prices reflect an unprecedented **long-lasting** downturn. In addition, the rise of unconventional sources (especially short-term shale oil projects) is likely to lead to a more **volatile market**. Hence, oil and gas service companies need to make efforts to cope with this increased uncertainty.

3. Portrait on supply chain agility

A review of the existing literature framing the general knowledge on supply chain agility should open managers' eyes on opportunities to reach a superior supply chain flexibility (Geissbauer & Householder, 2011). The literature gathers definitions, case studies from various industries, and findings from surveys conducted on companies considered to have excellent supply chains. A preliminary investigation on supply chain *agility*, *flexibility,* and *risk management* enabled to understand the terminology and identify the most relevant and interesting elements for oil and gas service companies to increase supply chain agility. The conducted empirical study confirms the relevance of the chosen elements.

After presenting the conceptual framework of the different dimensions of supply chain agility, the focus will be on achieving greater agility through (1) information systems and Big Data, (2) establishing suitable relationships with suppliers, (3) different contractual alternatives, and (4) complementary domains of supply chain agility.

3.1. Conceptual framework

Companies are increasingly competing as supply chains rather than independent entities making it important to describe and understand the various concepts framing the existing knowledge in the field (Gligor, Holcomb, & Stank, 2013). Agility is rooted from the Latin term "*agilis*", the ability to move about quickly and easily. In supply chain management, the terminology reflects the capability to respond to changes. Manufacturing companies were the first to adopt the concept by improving the degree of manoeuvrability to master uncertainty (Lau & Hurley, 2001). They used flexibility as a tool to accommodate uncertainty and absorb fluctuations in demand economically (Beach, Muhlemann, Price, Paterson, & Sharp, 2000).

The adaptation of the supply chain relative to these uncertainties and fluctuations is discussed through various concepts. The literature does not seem to reach a consensus on the exact

definition of agility. Therefore, multiple definitions enable to gather complementary dimensions of this complex term:

- **Alertness** defines the ability to read and detect changes. This dimension focuses on the monitoring of data and the use of environmental scanning to sense trends, threats and opportunities for both demand and supply (Gligor et al., 2013). The notion reflects the ability to address unexpected challenges, survive unprecedented environmental threats, and transform changes into opportunities (Swafford, Ghosh, & Murthy, 2008).
- **Accessibility** describes the importance of relevant data and information systems to share data across the supply chain for a better integration (Gligor et al., 2013). Access to real-time information with the implementation of virtual supply chains could become key to quickly detect and react to market changes (Gligor et al., 2013).
- **Decisiveness** designates the ability to make decisions with determination and certainty. The term refers to the ability to influence the speed at which a company can change direction (Gligor et al., 2013).
- **Quickness** is the ability to complete an activity as quickly as possible (Gligor et al., 2013). The term involves the speed and responsiveness of implementing decisions to respond to economic upswings and downswings while spending less time managing the crisis (Geissbauer & Householder, 2011). The emphasis is on the proactive aspect of an agile supply chain permitting to recover effectively from market fluctuations (Lin, Chiu, & Chu, 2006).
- **Flexibility** or adaptability relates to the ability to implement different processes and tactics to the required needs. It is often used as the main characteristic of an agile organization (Lau & Hurley, 2001). Flexibility combines the robustness of a supply chain, meaning the ability to change the existing capabilities, and the re-configuration potential to re-align or reinvent the supply chain in response to market changes (Stevenson & Spring, 2007).
- **Leanness** is assimilated to the elimination of waste, meaning the removal of non-value adding activities. The notion can be viewed as a stepping-stone to rapidly reconfigure the

supply chain (Yusuf et al., 2014). Leanness is suggested to apply where demand is relatively stable with little variety, whereas agility works in less predictable environments with multiple customers' requirements (Christopher, Peck, & Towill, 2006).

The six agility dimensions can be separated into two groups. The **cognitive group** covers the *information* processing dimensions including alertness, accessibility, and decisiveness. The **physical group** covers the *action*-taking dimensions including quickness, flexibility, and leanness. The distinction between information and action dimensions permits to identify the capabilities that need to be enhanced or reduced to achieve the desired supply chain agility and eliminate vulnerabilities (Gligor et al., 2013).

The multidimensional concept of supply chain agility embraces many interrelated company aspects: the organizational structure, the information systems, the logistic processes, the culture, and the mind set (Lau & Hurley, 2001). This vast scope emphasizes the importance of exploring and developing supply chain competencies to master uncertainties and outperform less agile competitors (Yusuf et al., 2014). Moreover, the evaluation of the current agility capability can reveal possible synergies to enhance the agility of the supply chain (Swafford & al., 2008). Hence, the combination of the agility dimensions can permit to thrive in an evolving environment with speed, dexterity, nimbleness and flexibility (Khan & Pillana, 2008).

3.2. Information systems and Big Data

With the implementation and integration of information systems across the entire supply chain, companies can collect larger amounts of data, referred to as **Big Data**. The data is often unstructured and immense (table 3) but the transformation of Big Data into business intelligence (called **data mining)** can increase alertness with real-time insights and visibility for better decision-making (Milliken, 2015). According to Waller and Fawcett (2013), data-driven companies perform better on financial and operational results being on average 5% more productive and 6% more profitable than the competition. Thus, the transformation of mass data

into relevant information can help the supply chain become a competitive advantage (Lidong & Cheryl, 2015).

Table 3: Big Data "6Vs" characteristics

Characteristics	Definition
Volume	Large amount of data
Velocity	Quickly generated data
Variety	High disparity in the data
Value	"Golden" information can be extracted from the data
Variability	Changes in the data related to processing and lifecycles
Veracity	Consistency and confidence in the data

Source: Lidong and Cheryl (2015)

For oil and gas service companies dealing with uncertainty, Big Data analytics can provide greater visibility through forecasting and scenario analysis. A **forecasting** model based on the analysis of current and historical data can enable better predictions (Milliken, 2015). As an example, since the oil price can be a strong indicator of the activity level a forecast of the oil price can offer service companies greater visibility to manage the required capacity to meet customer's demand (Milliken, 2015). Another example is the prediction of other commodity prices, like steel, widely used as a raw material for equipment purchased by oil and gas service companies. As the steel price is reflected in the equipment price at a later date (usually 3 months), a forecast of the steel price can enable cost reduction by determining the best time to buy the equipment. The access to more data and the additional tools available for analytics can also facilitate the use of **scenario analysis** for better decision making. A company could use scenario analysis to test different transportation routes or means (plane or shipping) to evaluate alternative outcomes. Hence, Big Data can provide greater **visibility** (favouring alertness, accessibility, and quickness) to better plan and anticipate capacity and expenditure.

Besides, powerful information systems have the capacity to process tremendous amounts of data using **optimization**-like data analysis on defined objectives. As an example, an optimization model can maximize the usage of resources (human and physical) within a certain capacity constraint and inventory limit (considering available equipment and skills) (Milliken, 2015). The model can help managers track assets and propose optimal storage locations or logistic routes

for further cost reductions and operational efficiency. Hence, Big Data analytics can offer a better monitoring and utilization of assets. Likewise, Big Data analytics can contribute to the improvement of the supply chain function in various ways (table 4).

Table 4: Big Data contribution to supply chain management per function

Functions	Big Data contributions
Procurement	Organizations can make better procurement decisions according to more factors
Supply chain collaboration	Greater understanding of partners and how they respond to an event or to each other
Supply chain execution	Combine multiple data sources to ensure that supply chain execution is effective & efficient
Supply chain planning	Improve demand forecasting & supply planning with advanced performance variables & "what if"-scenarios
Inventory control	Improve analysis on transit times & shipment routings to reduce in transit inventory, safety stocks, etc.
Marketing & Sales support	Apply analytics to improve the effectiveness of sales forces by segmenting customers
Tracking locations	Predict future traffic conditions by matching current & historical data, weather forecasts, traffic patterns, etc.
Personalized service	Leverage on Big Data with analytics to improve predictions of individual consumer behavior

Source: Lidong and Cheryl (2015)

A wider usage of Big Data analytics also brings new challenges, including training programs and audits to assure the contribution of all employees (Milliken, 2015). In addition, it generates both a technical challenge with data management, storage and security breaches, and an intellectual challenge with making sense of unstructured data (Lidong & Cheryl, 2015). However, the most important challenge is **data quality**, namely *accuracy* (no errors), *timeliness* (up-to-date) *consistency* (same format), and *completeness* (no missing data) (Hazen, Boone, Ezell, & Jones-Farmer, 2014). Thus, a collaboration between information system, supply chain, and analytical experts is key to develop an intelligent supply chain (Hazen et al., 2014).

For Big Data analytics to enable better-informed decisions it must access data from various platforms (planning systems, financial reporting, demand forecasts and suppliers' information). Big Data can only help improve the supply chain's performance after identifying the needed information, setting up the corresponding reporting, and implementing the required systems (Milliken, 2015). The adoption of intelligent supply chains using Big Data analytics to improve information accuracy, visibility, traceability, and transparency are likely to open up new perspectives (Lidong & Cheryl, 2015).

3.3. Establishing appropriate relationships with suppliers

Since supply chains range beyond firms' boundaries, it is important to consider the relationship with suppliers (Duclos, Vokurka, & Lummus, 2003). Suppliers represent a large share of companies' costs (purchased inputs) and are critical team members who contribute to the product designs, technologies, and quality (Carr & Pearson, 2002). **Supply flexibility** combines the ability to find alternative suppliers and to implement a flexible network of suppliers responding better to market fluctuations (Lao, Hong, & Subba Rao, 2010). It can be implemented to overcome **external** drivers (demand volatility and forecast accuracy) or **internal** drivers (production availability and capacity) (Tachizawa & Thomsen, 2007). Both drivers appear to affect service companies, who rely heavily on equipment from external suppliers to meet its volatile customer demand. Hence, to establish the appropriate relationship with an existing or new supplier for a specific product, it is important to evaluate the current market situation for that product and the future strategic position desired for the **individual** suppliers and **panel** of suppliers.

On the one hand, companies need to classify suppliers to come up with **individual strategies** in line with global objectives. The suppliers can be classified using the **Kraljic matrix**, based on supply risk and profit impact (Supplier Management, 2015). Supplier risk is determined based on the number of suppliers (single, dual, or multiple vendors), switching cost, and product availability (Supplier Management, 2015). The supplier can be classified as **routine** (low risk, low profit), **bottleneck** (high risk, low profit), **leverage** (low risk, high profit), or **strategic** (high risk, high profit). Other evaluation variables like supplier's dependency on the company, criticality of the item supplied or supplier's quality and reliability may also be used. Then, the supplier classification can help to set the best individual tactical approach to reach the strategic objective and better match the business needs. The supplier can be **maintained**, **developed,** (suggesting a stronger collaboration) or **phased-out** (reflecting the need to find new suppliers). It is the role of the supplier managers to evaluate the best approach. Sometimes a **strategic alliance** with a supplier can create more value through a closer and longer-term relationship (Lao et al., 2010).

On the other hand, it is important to understand the business environment to evaluate the entire and highlight existing and missing sourcing capabilities. The oil and gas industry is composed of a large number of small and medium-sized enterprises that provide equipment and technology to support operations. In a downturn, the reduced level of activity can force some suppliers into financial distress or make them loss interest in the industry and decide to supply other industries with more stable demand (PricewaterhouseCoopers [PWC], 2015). Suppliers may provide critical parts, making it acute when activity picks-up and the items are necessary to satisfy demand. Hence, because of the high risk of losing suppliers, it can be advantageous for companies to collaborate with suppliers to maintain the necessary capacity and know how to adapt to the market volatility. The market environment can help to identify and retain existing or new suppliers that are capable of adapting to changes and willing to share responsibility to increase agility (Lao et al., 2010). The implementation of a dynamic supply chain, adjusting its sourcing strategy to the market environment, is also likely to favour innovation (Storer & Hyland, 2011).

Examples from other industries highlight existing practices. During the global financial crisis in 2008, numerous suppliers in the **electronic industry** scaled back capacity or closed altogether. As a result, companies faced shortages of critical components when the market picked up. Hence, to enhance the visibility throughout the extended supply chain, a company and one of its suppliers jointly implemented an information system for both parties to access the latest information. This enabled a greater collaboration with a joint decision-making process to better align supply and demand (Geissbauer & Householder, 2011). Thus, sharing information can increase suppliers' response capabilities through greater visibility and transparency (Gosling, Purvis, & Naim, 2010). In the **health industry**, greater agility was implemented by separating the supply chain into networks based on demand characteristics. One network is dedicated to stable demand, high-volume, and highly reliable suppliers. Another network is assigned to low-volume, highly customized, and volatile demand (Geissbauer & Householder, 2011). For oil and gas service companies the separation of the supply chain could be implemented with one network for standard product manufacturing (standard tools and accessories) and one network for prototypes and customized products.

However, the adoption of specific relationships with multiple suppliers can generate complexity, which can become a source of competitive advantage if well managed. Companies need to find a balance between reducing the size of the supplier base to optimize the supply chain network and maintaining sufficient suppliers to adapt supply chain partners to the changing business environment (**partnering flexibility**) (Stevenson & Spring, 2007). Besides, for companies considered as major players in their industry, like SLB, decisions to innovate in supply chain technologies, functionalities, or processes can have a significant impact on the vendors. Since SLB represents a large share of its suppliers' revenue, when SLB implements new supply chain objectives or incentives, suppliers can be forced to synchronize their efforts to stay aligned with one of their main customer. Hence, large actors in the industry can have the power to impose new objectives beyond the firm's borders (Duclos et al., 2003).

To conclude, a better understanding of the interaction between companies and their suppliers (needs, environment, and strategy) can help to adopt greater agility and cope with the emerging complexity of the interconnected business environment (Yusuf et al., 2014). Coordination with key suppliers can improve reliability and manoeuvrability of the supply chain. It can also create joint-development opportunities for better delivery schedules, greater security on critical materials, and future innovations (Geissbauer & Householder, 2011).

3.4. Different contractual alternatives

Contracts constitute the legal framework of a relationship between a supplier and a buyer. **Supply contracts** formalize the negotiations around all the variables specific to the sourcing environment including the cost of components, quantity purchased, time of delivery, and quality of goods (Li & Kouvelis, 1999). As it can benefit both suppliers and buyers, contracts are a relatively easy mean to reach greater supply chain agility. They can help suppliers with greater stability and buyers with greater flexibility to respond to demand fluctuations (Stevenson & Spring, 2007). According to Li and Kouvelis (1999), the flexible and risk-sharing contracts under

price uncertainty can be related to **time-flexible contacts** and **quantity-flexible contracts**. Both include risk-sharing features providing the supply chain with agility capabilities.

Time-flexible contracts allow a firm to specify how many units it will purchase without specifying the exact purchase time (Li & Kouvelis, 1999). For oil and gas service companies, because of the wide range of services offered and a worldwide presence, orders are usually emitted when there is an actual need. Hence, a majority of the contracts with suppliers does not impose a specific purchase time. While the time-flexible contract allows a firm to gain visibility on the future purchase price (no change over a finite period) (Li & Kouvelis, 1999), the demand uncertainty oil and gas service companies face makes it difficult to commit to a specific quantity in advance.

Quantity-flexible contracts allow a firm to purchase quantities within a pre-specified window (Li & Kouvelis, 1999). These contracts improve the coordination with suppliers through superior materials and information flows, enabling suppliers to plan ahead (Lao et al., 2010). **Total minimum quantity commitment contracts** are often used in the electronic industry. These require the buyer to sustain a minimum cumulative quantity on a specific time line, also derived into "periodical commitments" or "period-by-period replenishment schedules" (Li & Kouvelis, 1999). This gives the supplier greater visibility and can help set a minimum activity level reducing the risk of supply disruption (Stevenson & Spring, 2007). The minimum quantity allows the supplier to cover its fixed costs and maintain the necessary capacity not to go into financial distress. Since oil and gas service companies usually manufacture highly tailored products in-house or rely on manufacturing companies to supply a majority of the equipment quantity-flexible contracts can reduce the risk of supply disruption and contribute to improve the supply chain agility.

Other examples of **risk-sharing features** in contracts include the possibility to share the cost of holding inventory or sharing the costs of investments. A firm can decide to store additional quantities to prepare for higher demand forecasts. The additional inventory can ease a suppliers' financial burden (Chung, Talluri, & Narasimhan, 2010) and avoid supply disruptions. A firm may

also enter a joint-development program to share the required investment to innovate or increase capacity. In the oil and gas industry, this can help to maintain suppliers' commitment and motivation.

However, there is a possible trade-off between **uncertainty** and flexibility (Prater, Biehl, & Smith, 2001). On the one hand, long-term procurement contracts can help reduce uncertainty, develop trust, and accommodate changes easier. On the other hand, spot purchasing contracts can favour short-term flexibility by offering the possibility to adjust orders in response to market changes and to quit an alliance if desired (Stevenson & Spring, 2007). Supply chain managers should consider this trade-off when setting the strategy with their suppliers.

To conclude, contractual features can provide greater agility by helping supply chain managers to reinforce their supplier panel. By avoiding the risk of losing suppliers, contractual alternatives can help maintain relationships with key suppliers and reduce the risk of supply disruption (Chung et al, 2010). In addition, contracts can also be an efficient tool to coordinate investment and capacity planning by increasing information sharing activities, and favour innovation to reduce costs (Wakolbinger & Cruz, 2011).

3.5. Complementary domains of supply chain agility

In addition to information systems, collaboration with suppliers and contractual features additional domains can contribute likewise to the implementation of greater supply chain agility. These domains include talent retention, geographical diversity, and financial hedging.

According to Lau and Hurley (2001), the development of the **organizational flexibility** is key to acquire a sustainable competitive advantage and long-term commitment throughout the organization. Here, the organization covers the company culture, knowledge, workforce, and business practices. As people account for a large share of the organizational, support from the entire workforce intervening across the supply chain is required to achieve a sustainable level of agility. As such, the relevance of training, education and employee empowerment enable to keep

and attract competent employees for the adoption and implementation of a more efficient supply chain. Conversely, deep organizational hierarchies may impede cooperation and communication, preventing the cross-functional integration required for employee's participation. Major head-count reduction during downturns can also have negative effects on the working environment of the company. Following a series of layoffs, companies often suffer from disenfranchised employees and low productivity of those who remain at the company, damaging the company's brand internally and externally (PWC, 2015). Job rotation and multitasking can be effective tools to build a mobile and well-trained workforce, as the shift from one function to another allows employees to acquire new skills through a combination of tasks and develop human capabilities in the long-run favouring interaction across functions (Lau & Hurley, 2001). In addition, multitasking can ensure innovation by rapidly deploying best practices across functions (McKinsey & Company, 2011).

For companies operating worldwide, diversifying tasks geographically can enable great savings. As an example, moving manufacturing and developing suppliers East and South (E&S) has become increasingly popular. By moving E&S, firms can benefit from lower labour rates and take advantage of lower costs, especially for products with high volume and stable demand. In addition, with demand expected to rise in Asia, namely India and China, developing suppliers close to manufacturing workshops and future clients in the region may also reduce logistics costs and lead-time (McKinsey & Company, 2011). By moving E&S, companies can also create price competition and reduce dependency on single sources or competitors by developing alternative suppliers. Moreover, the spreading of sourcing and manufacturing across countries creates a natural hedging against external risks (geopolitical or natural disasters) that may hurt some regions locally. Hence, firms can conduct business cases on specific products to identify sourcing opportunities in areas like Asia to reduce costs and increase flexibility.

Companies that depend on volatile commodity prices or operate in multiple currencies may also use **financial instruments** to hedge impending risks and improve financial performance. The hedging can be completed through backward integration (purchase of suppliers) or by financial

products, like future or forward contracts (Buhl, Strauβ, & Wiesent, 2011). Futures can address the input price risk on corresponding raw materials as well as neutralize the output price risk (products sold) (Fu, Zhang, Yao, & Zhang, 2012). The hedging contributes to less fluctuation, helping companies to plan and organize current and future expenses and reduce speculation (Buhl et al., 2011). Unlike operators, oil and gas service companies are not selling or buying crude oil to end-customers, hence they are not using financial instruments to hedge the oil price. However, because oil and gas service companies are operating at a global scale, they can use financial instruments to protect themselves against currency and exchange rate fluctuations.

To conclude, for companies to survive in today's highly uncertain business environment agility has been adopted by multiple industries and within various domains of supply chain. According to Chiang, Kocabasogly-Hillmer, and Suresh (2012), cultivating supply chain agility can be an effective strategy to overcome demand volatility and risks of disruption. Agility constitute an effectively strategy to coordinate and redeploy organizational competencies to seize opportunities, minimize threats and develop the needed dynamic capabilities to provide timely responses and product innovation. The means and methods to reach greater supply chain agility are numerous and can be challenging to implement because of the trade-offs between complexity, efficiency, uncertainty, and flexibility. The aim is to configure the supply chain and build the required capacity and efficiency to be in line with demand requirements (Gligor, Esmark, & Holcomb, 2015). The reviewing of the agility concepts and the emphasis on selected complementary elements can help managers to identify where to invest efforts to adapt better.

4. Schlumberger: Upstream player

4.1. Schlumberger at a glance

Major players including Schlumberger (SLB), Halliburton (HAL), and Baker Hughes (BHI) dominate the oil and gas service industry (table 5). In 2014, SLB employed around 120,000 people and registered a record revenue of $48 billion, making it the largest player (Marketline, 2015).

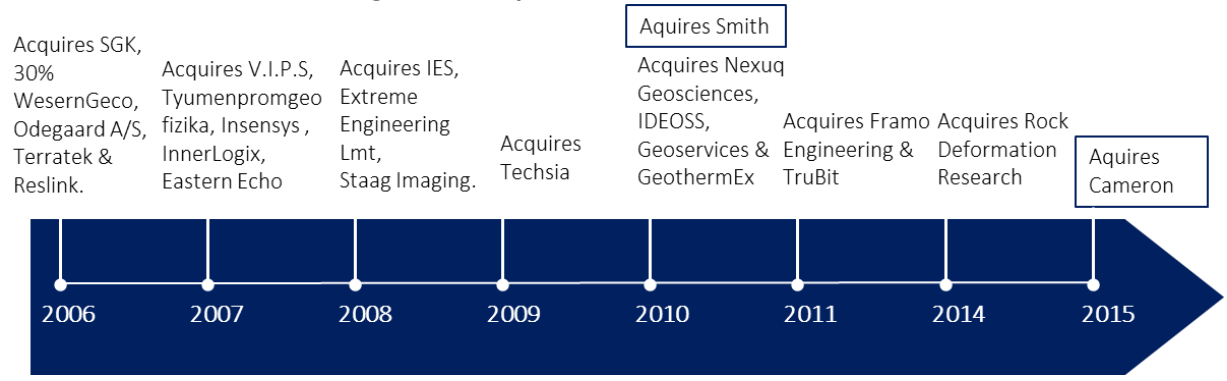
Table 5: Competitor breakdown

SYMBOL	MKT CAP	EBITDA	EPS	YIELD	PRICE
SLB	105.87 B	12.46 B	3.36	2.40	83.53
HAL	36.68 B	6.19 B	1.77	1.70	42.80
BHI	25.78 B	3.43 B	0.60	1.20	59.16

Source: Yahoo Finance, (2015, July)

In 2014, SLB is headquartered in Houston (US). However, two French brothers founded the company in 1926 for mainly Wireline activities (logging jobs). Yet, it quickly expanded internationally with operations in the Soviet Union in 1929 and in the US in 1932. SLB has grown organically and through acquisitions to diversify its business and reduce its dependency on exploration activities (figure 11). In 2015, the megamergers of Baker Hughes (BHI) and Halliburton (HAL) and SLB's acquisition of Cameron are creating a more **combative environment** within the oil and gas service industry (Groves & Melville, 2015).

Figure 11: Acquisition timeframe since 2005

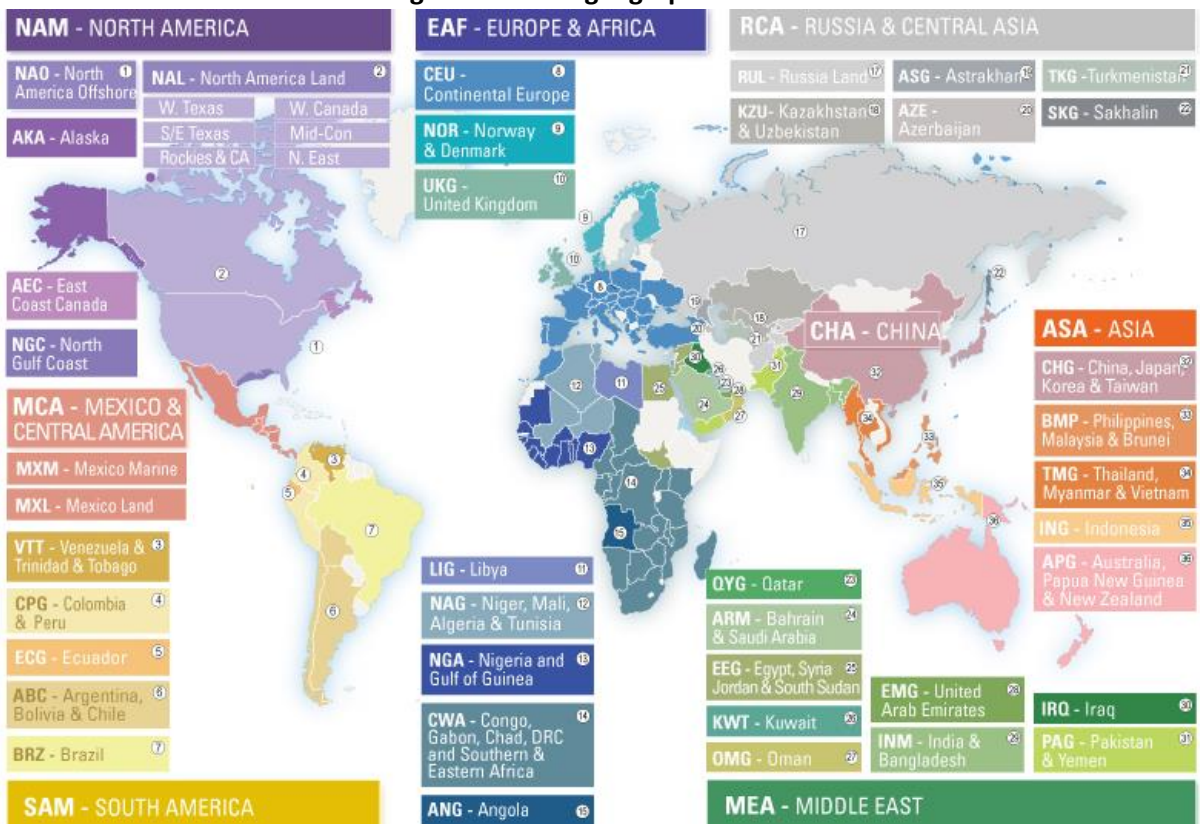


Source: Schlumberger (2015)

Schlumberger (SLB) is a diversified oil and gas service company providing national and multinational oil companies (referred to as **operators**) with **upstream** technologies and services.

SLB operations are organized geographically in areas and Geomarkets (consisting of one or more countries) (figure 12).

Figure 12: SLB's geographical structure



Source: Schlumberger Internal Documentation

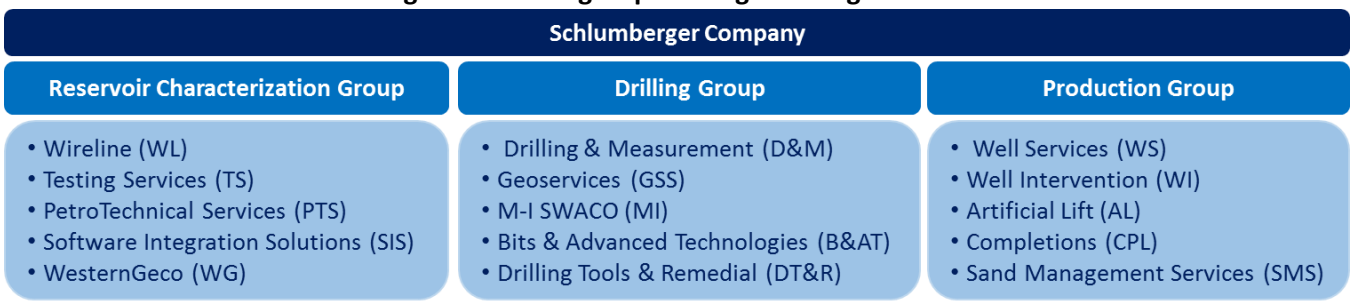
SLB's products and services cover the three phases of an oilfield life cycle matching the three SLB groups (1) reservoir characterization, (2) drilling, and (3) production (table 6). Each group is composed of different **segments**, equivalent to activities, covering the wide range of products and services SLB offers its clients (figure 13).

Table 6: Oilfield life cycle

Phase	Definition	*SLB Group*
Exploration	Various geophysical and geological surveys to build a model of the subsurface to identify reservoirs	*Reservoir Characterization*
Development	Strategy and design to drill and place the wells in the reservoir as effectively and efficiently as possible	*Drilling*
Production	Services and products to ensure that the well continues to produce throughout its life cycle to maximize reservoir recovery	*Production*

Source: Cohen and Roussel (2013)

Figure 13: SLB's group and segment organization



Source: Schlumberger Internal Documentation

Moreover, SLB focuses on technological development through **Engineering, Manufacturing, and Sustaining** (EMS), a cross-functional internal organization dedicated to technology and innovation. These shared manufacturing workshops, study centres, and production centres enable all segments to benefit from innovation and assistance to stay ahead of competition.

4.2. Procurement and Sourcing (P&S) function

At SLB, the P&S function is part of the Shared Service Organization (SSO) also grouping various support functions, like contract management, finance transactions, and human resources. SSO operates across segments and areas to leverage on size and global footprint and improve the quality and efficiency of the internal support to the field operations (Cohen & Roussel, 2013).

The main objective of the function is to rise the competiveness of SLB. (1) **Procurement** refers to the transactional activities required for the purchase of products or services. It involves the complete process from the field request to the reception at the location and invoice payment. For the EMS activities, procurement covers the purchase of raw material and tools for the manufacturing of products. (2) **Sourcing** refers to the management and strategical decisions related to the panel of suppliers. It includes identifying, selecting, and tendering new suppliers as well as assessing and monitoring suppliers' performance and risks.

Since its creation in 2002, the P&S function is continuously evolving to meet the challenges lying ahead. At all levels, projects are undertaken to improve the efficiency of P&S, including (a) geographical organization, (b) categorization of expenditure, (c) information technology (IT) infrastructure and (d) acquisition opportunities.

(a) P&S geographical organization

The P&S function is implemented cross-functionally at the global and local level of the organization. Local P&S managers, in areas and Geomarkets, are in charge of field requests to respond to local specificities (procurement) and may manage critical local suppliers (sourcing). Meanwhile, Global P&S managers are required to leverage on the size of SLB by aggregating expenditure across locations. Managers are coordinating the selection of supplier and conducting market analysis in alignment with field requirements. This enables to gain bargaining power when negotiating contracts with main suppliers and to identify global strategies and possible partnership opportunities to reduce costs and create value.

(b) P&S expense categorization

SLB has an extended and diversified supplier base. The company relies on more than 100,000 suppliers, including small, medium, and large enterprises, of which 3,000 are critical (providing a critical item, facing operational or financial difficulties, or on which SLB is highly depending). To facilitate the monitoring of suppliers four **categories** of expenses have been created. Each category is composed of **sub-categories**, also called families, permitting a more detailed classification of expenditure (table 7). The categorization across activities and areas enable negotiate volume discounts with suppliers leading to greater savings.

Table 7: Category organization for expenditures

Sub-Category (Family)	Chemicals & Logistics (C&L)	Drilling & Evaluation (D&E)	Surface Equipment & Services (SE&S)	Indirect
	• *Base Fluids & Brines* • *Bulk Chemicals* • *Ocean & Air Freight* • *Proppants & Minerals* • *Specialty Chemicals*	• *Tools and Accessorizes* • *Electronics* • *Machined Parts* • *Raw Materials* • *Oilfield Services Companies, & Alliance* • *Rig Management*	• *Field Support Equipment* • *Integration, Pressure Containment Equipment, Air & Steam, & Inspection Services* • *Maintenance & Repair* • *Vehicles*	• *Engineering & Construction* • *IT Hardware and Telecom* • *IT Services* • *IT Software* • *Staffing* • *Travel Agencies* • *Cards & Reallocation*

Source: Schlumberger Internal Documentation

With increased pressure from segments to maintain margins, managers are looking for synergy opportunities internally across segments and reducing costs externally with suppliers. The aim is

to favour internal sourcing through a greater integration between segments and reduce the outsourcing of products and services offered internally. Supplier managers are also challenging operations on their orders, looking for process and equipment standardization potentials, developing suppliers for price competition, and identifying acquisitions opportunities.

(c) P&S Information Technology (IT) infrastructure

Various IT systems tailored to SLB needs were initially used to complete the P&S activities. As part of the **Transformation project** between 2013 and 2020, large investments are undertaken to integrate all IT systems within one business software. This will permit a stronger integration and coordination within the internal supply chain organization with inter-organizational synergies and a superior capability to identify agility opportunities and make better strategic decisions (Swafford et al., 2008). In the meantime, the existing IT systems are constantly subject to new projects to improve the efficiency of the P&S function (table 8).

Table 8: Existing IT systems and corresponding projects

IT System	Functionality	Project
Schlumberger Web Interface for Supplier (SWPS)	e-Procurement system regrouping supplier's products, services & conditions	Objective: improve the procurement of goods and services at the optimal price while driving consistent and predictable delivery to operations Method: review the procurement process and increase the usage of negotiated catalogs to benefit from lower prices from suppliers
Ariba	Contract management & saving	Objective: provide visibility and easy access to contract and savings projects
Global Oilfield Logistics & Distribution (GOLD)	System managing the logistic network of SLB hubs	Objective: provide distribution efficiency and quality
Approved Supplier List (ASL)	List of all approved SLB suppliers and related documentation & information	Objective: improve the supplier panel Method: provide complete supplier profiles (criticality of product supplied, dependency on SLB…)
Oracle Reporting	Reporting tool for cost analysis and performance monitoring	Objective: easy access analytics from all IT systems
Others (iDistrict & RITE)	Asset management and planning tools	Objective: provide better visibility on asset utilization forecast and status

Source: Schlumberger Internal Documentation

4.3. Downturn, an opportunity for acquisition

During a downturn, there is a rising pressure to reduce the spending across the entire business without compromising future production or quality. In the short-term, expenses are reduced by freezing specific category expenditure, like imposing a travel ban or avoiding excessive equipment purchases for a better utilization of existing assets. However, in the long-term these

instructions may hamper created savings. Thus, short-term savings should be used for targeted investments. As an example, the downturn can fragile players in the oil and gas industry and create opportunities for companies with solid cash reserves, like SLB, to gain control over devalued suppliers. This permits to reduce supply chain dependency on critical suppliers or acquire capabilities in missing domains to complete the company's portfolio (McKinsey & Company, 2015).

To conclude, SLB is facing a more combative oil and gas service industry, where the P&S function needs to continuously improve efficiency and cost reduction. The organization is working on supporting local operations, while leveraging at a global level, improving the monitoring of expenses, and encouraging IT integration (Transformation project). However, there is room for improvement and as a major player in the industry, SLB has the bargaining power to influence the negotiation outcomes and has the potential to set trends and play a key role in creating incentives to innovate and encourage the development of supply chain excellence within the industry.

5. Methodology

This chapter describes the methodology used for the empirical study. It contains the outline of the study, the strategy used for an accurate data collection, the sources used, and the credibility and limitation of the methodology applied.

5.1. Outline

The empirical analysis can be folded into two phases.

The first phase presents different approaches to evaluate the impact of an oil price fluctuation: (1) **Global level** presents the general reaction of the entire company, (2) **Segment level** presents the impact on a selected activity, and compares the impact on different locations. The objective is to highlight SLB's reaction to the oil price volatility.

The second phase focuses on the P&S approach and includes an expenditure analysis. The study highlights two major challenges SLB encounters with suppliers during a downturn, generating risks on P&S's capability to adopt to the volatile oil and gas market. This phase presents real examples and corresponding recommendations to provide supplier managers tools to contribute to the improvement of the P&S agility.

5.2. Data collection

The data was collected through both **quantitative** and **qualitative** methods.

The **quantitative data** collection strategy was selected to review the financial data and validate or reject assumptions on the impact of oil price fluctuations on revenue, activity, and cost. The data originates mainly from internal SLB information systems available for analytical purposes, including dashboards, historical revenue and job count data, and suppliers' expenditure between 1997 and 2015 (depending on the selected supplier). In addition, the financial controllers provided data on the selected segment from January 2007 to September 2015. The 2007 to 2015 period enables to consider the impact of oil price fluctuations prior to a downturn (2007 and

2013), during a downturn (2008 and 2014) and after a downturn when the market picks up (2009).

The **qualitative data** collection strategy was adopted both to set the assumptions to be validated or rejected by the quantitative data and to collect illustrations on challenges encountered with suppliers. A document review on supply chain agility and on the oil and gas industry gathered the information used to derive the assumptions. These documents include journal articles and external reports from open sources or consulting firms on the oil and gas market outlook and on supply chain practices adopted in other industries. The information gathered for the real examples originates from internal information from supplier's profile and **in-depth interviews** with the supplier managers. The presented cases were chosen based on a **nonprobability sample** selection, by approaching supplier managers from various activities, functions, and geographical areas. This enabled to collect examples from various countries, namely China, Canada, the US, France, and the UK. The interviews were carried face-to-face or over the phone. The objective was to collect evidence on the evolution of the relationship between SLB and its suppliers and comprehend the risks it engenders on SLB's business performance.

The mix of quantitative and qualitative data collection strategies provides a more complete empirical study, looking at the breadth of the research question, analysing the broad trends, and identifying targeted elements where a complementary quantitative research can provide greater insight (National Science Foundation [NSF], 2015). In addition, the in-depth interviews permit to capture specific situations involving complex, subjective, and detailed information (NSF, 2015).

5.3. Limitations

For confidentiality reasons, some of the information used for the analysis is not communicated, namely values and suppliers names. Nevertheless, the provided information on suppliers and presented trends are sufficient to demonstrate the impact of the market volatility on SLB's business performance and highlight the challenges and risks generated by falling oil prices.

Although the combination of qualitative and quantitative research enables to reach a robust study with a better understanding and stronger findings, it is accompanied by other challenges, namely reliability, validity and scope limitation (NSF, 2015). For the quantitative data, the information was crosschecked with various sources including annual financial reports justifying the validity and reliability of the data. Concerning the qualitative information, reports, and articles converged on the information used to set up the assumptions proving the robustness of the statements. Furthermore, while the studied suppliers cannot be scaled up to the entire population of SLB suppliers, it proves the existence of real cases of challenges and risks looming SLB's performance.

6. Schlumberger: Empirical Study

Despite the fact that a downturn generates less activity and revenue, it is an opportunity to reassess the current situation and transform the company's supply chain function to minimize the impact of future dips. The empirical study aims at understanding SLB's reaction to the oil price fluctuations and dig into challenges faced with supplies generated by the oil-crisis. The objective is to identify ways to improve P&S's capabilities to take advantage of the uncertain environment and enhance the company's competitive advantage.

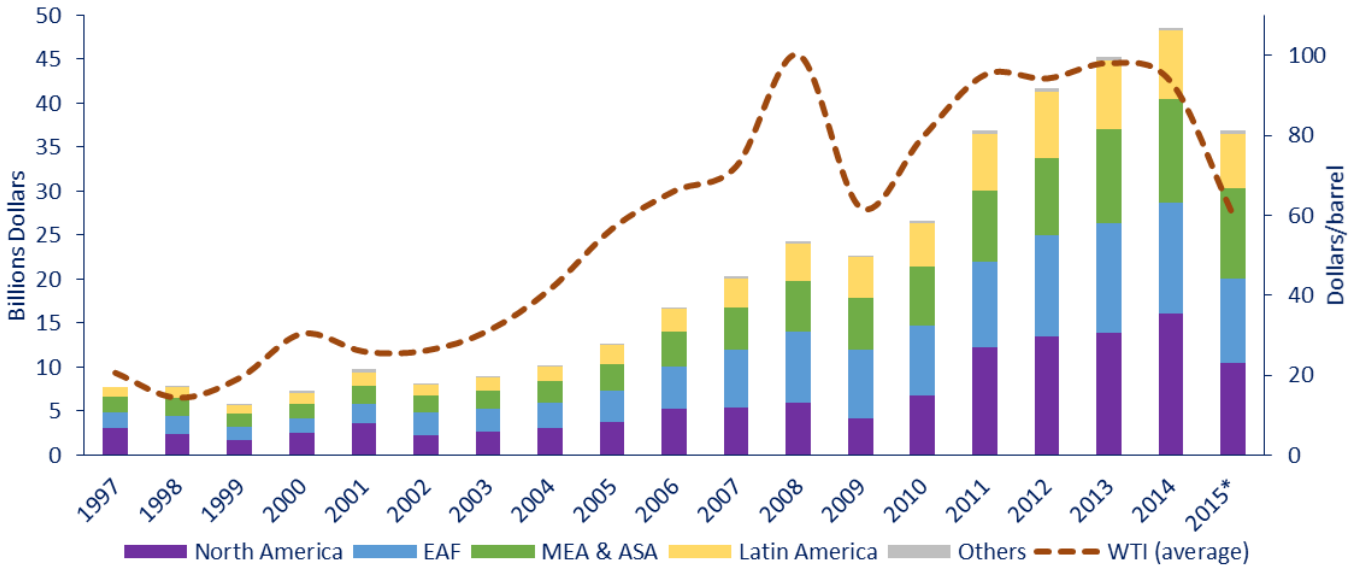
6.1. Global impact of oil price fluctuations

The analysis at the **global level** aims at understanding the impact of volatile oil prices on SLB in general. This view is considering the impact on (a) the revenue and activity level of the entire company, and (b) the revenue per activity group.

(a) Correlation between SLB's revenue and activity and the oil price

The relationship between SLB's revenue and the oil price between 1996 and 2014 indicate a strong positive correlation of 0.97, also observable at a regional level where the correlation is between 0.93 and 0.96 for each area on the same period (figure 14).

Figure 14: SLB revenue per area and oil price (WTI)

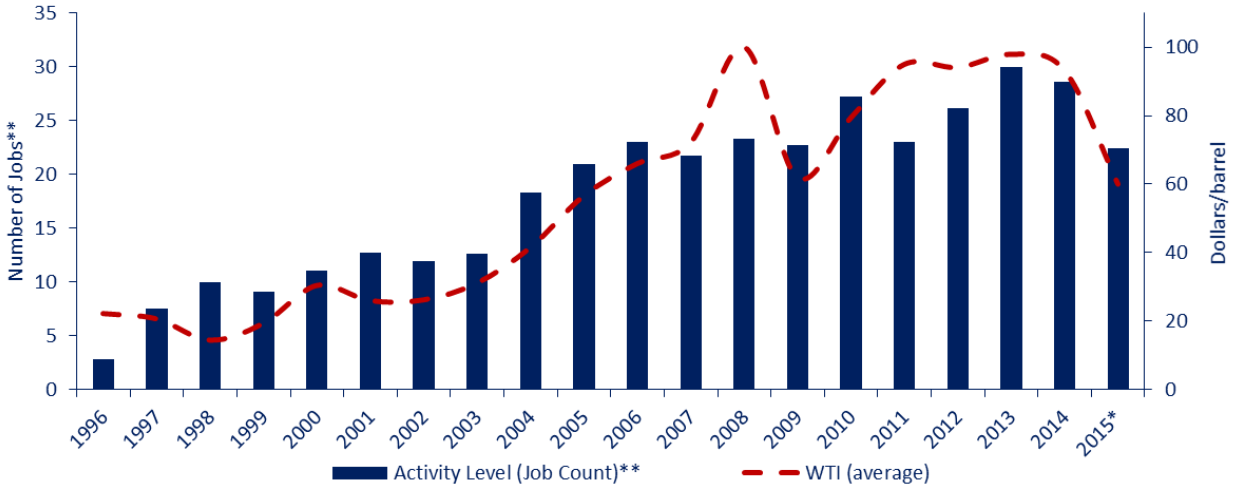


** Annualized Value (estimated)*

Source: Schlumberger Internal Data

The same positive relationship is noticeable when looking at SLB's activity level and the oil price, with a correlation of 0.92 between 1996 and 2014 (figure 15). The number of jobs reflects the activity level. A job is equivalent to the work required to complete a service for the customer. The definition of a job varies from one SLB activity to another. For drilling activities, a job corresponds to a run (the action of going down in the well and back up again). For logging activities, a job corresponds to a data collection operation, where a complete set of data may require multiple runs.

Figure 15: Evolution between activity level and oil price (WTI)



** Annualized Value (estimated)*
*** Proportional representation, not actual values*
Source: Schlumberger Internal Data

To conclude, there is a strong correlation between the oil price and SLB's revenue and activity level. This observation indicates that the ability to improve the response toward the oil price volatility is key to sustain growth in an increasingly competitive environment.

(b) Fluctuation impact on SLB groups

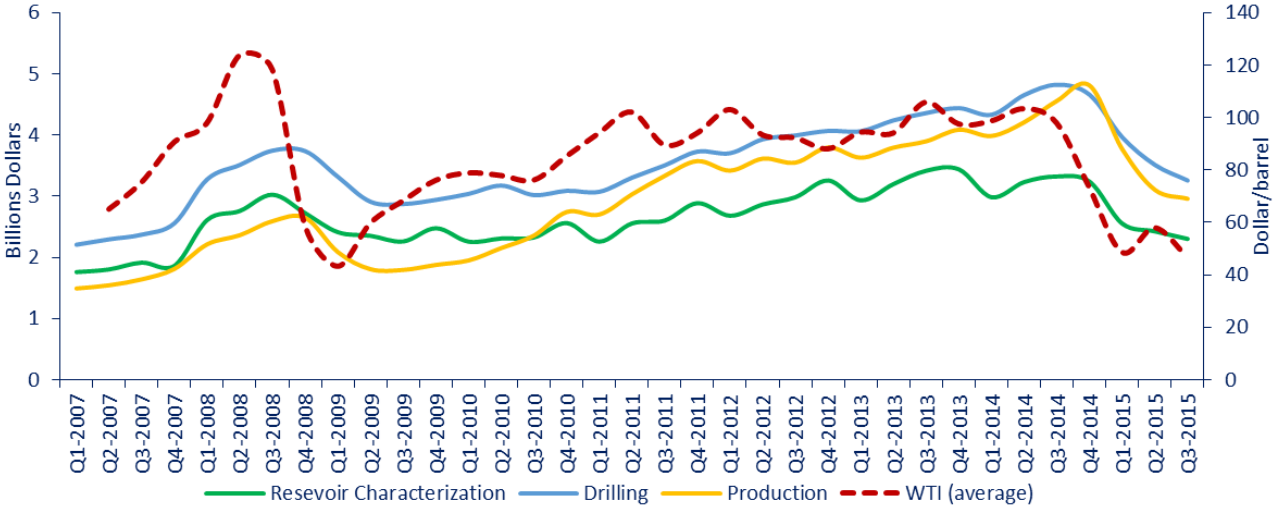
Oil and gas reports suggest that service companies should see a sequence in the impact of oil price fluctuations on their activities. When the oil price drops, operators tend to reduce their investments in seismic research and focus on production in mature fields. Hence, oil and gas service companies should first see a fall in the revenue of reservoir characterization activities (geology and seismic). Then, the completion of ongoing projects and the discovery of fewer reserves should decrease the revenue of drilling activities. The revenue of production activities

(exploitation of existing wells) should increase when operators focus on mature fields and then fall with the lack of investment in new fields and the depletion of existing reservoirs (abandoned or closed).

***Assumption 1**: SLB groups (reservoir characterization, drilling, and production) are impacted in turn as operators adjust their investments to the oil price.*

Based on assumption 1, lower oil prices should affect in turn the revenue of (1) the reservoir characterization group, (2) the drilling group, and (3) the production group. Likewise, the same sequence is expected to affect positively the groups when oil prices are rising and activity picks-up. However, the evolution of the group's revenue does not suggest a clear order in the groups affected (figure 16).

Figure 16: SLB revenue per group and oil price (WTI)



Source: Schlumberger Internal Data

The analysis indicates that while lower (higher) oil prices reduce (increase) the revenue of the three groups, the delays do not validate the expected sequence. Hence, other drivers are most likely affecting the sequence by compensating or accentuating the trends. These drivers may include regional specificities, contractual specificities, or incentives from the top management.

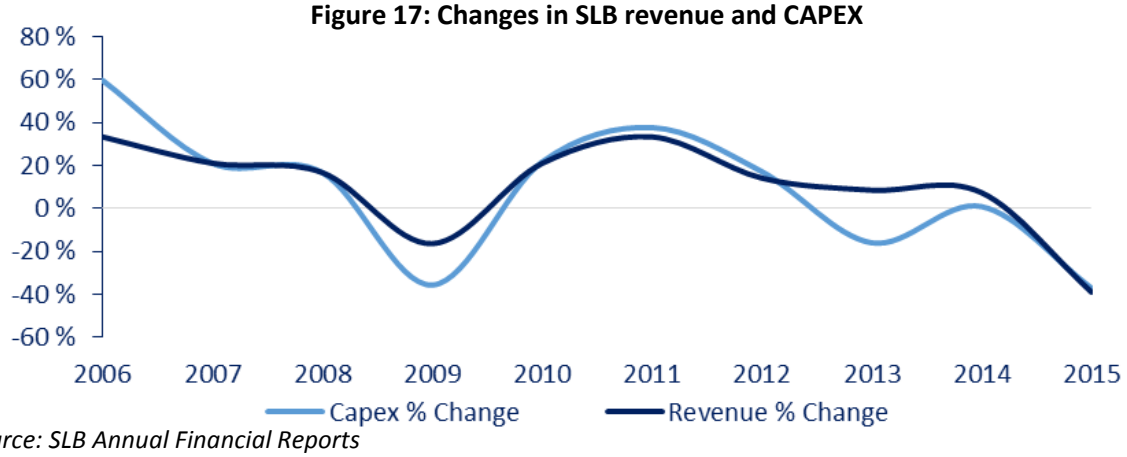
***Finding 1**: The sequence at which SLB groups react to the oil price fluctuation is likely impacted by additional factors, including contractual, regional specificities or top management incentives.*

To explain how these divers can influence the trends this part looks into the possible contractual differences from one activity to another and includes an example from a top management incentive.

SLB's revenue is generated by three main sources: (1) **long-term contracts** for field development (from exploration to production), usually around 3 years, (2) **monthly fees** (regardless of the number of jobs completed), and (3) **spot activity** (punctual jobs). Long-term contracts generally dominate but the share of each revenue source varies from one segment (activity) to another. For example, Wireline's revenue may come from 50% long-term contracts, 30% spot activity, and 20% monthly fees, while Well Service's revenue may come from 50% long-term contracts, 40% monthly fees, and 10% spot activity. Since operators typically cut investment when the oil price drops, they try to limit or cancel spot activities and renegotiate long-term contracts and monthly fees. Hence, the contractual differences from one activity to another may pollute the impact of oil price fluctuations on SLB groups.

The directives from top management can also differ from one segment to another depending on the competitive environment of the activity. As an example, the segment headquarter may set a budget restraint on capital expenditure (CAPEX). The oil and gas industry involves capital-intensive activities, which rely on high level of investments before becoming profitable. SLB's CAPEX and SLB's revenue tend to move in the same direction (figure 17). Hence, a CAPEX restriction at a segment level is also likely to affect the segment's revenue and lead to a misrepresentation of the group's reaction to the oil price fluctuations.

Figure 17: Changes in SLB revenue and CAPEX



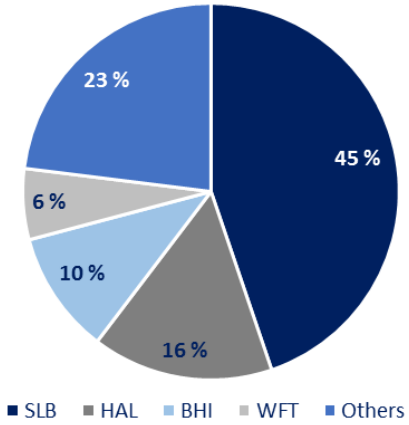
Source: SLB Annual Financial Reports

6.2. Segment impact of oil price fluctuations

The analysis at the segment level looks at (a) the revenue impact of oil price fluctuations on the delays and magnitudes of different areas and (b) the dominating effect (price or volume) on falling revenues.

The segment selected, **Wireline** (WL), is SLB's **historical flagship business**. The segment is part of the reservoir characterization group intervening at the exploration stage of the oilfield life cycle. WL provides logging information to evaluate the subsurface formation of rocks and fluids to plan and monitor well construction and evaluate well production (Schlumberger, 2014). In 2014, SLB covered 45% of the global market share (figure 18).

Figure 18: Market share WL in 2014



Source: Spears & Associates (2015)

(a) Fluctuation impact on geographical areas

Areas can differ in terms of jurisdiction, geopolitical environment, and type of oil reserves (conventional or unconventional). Hence, the delay and magnitude of the impact of oil price fluctuations is expected to be dissimilar from one region to another. The analysis compares the revenue evolution of the WL segment for three areas:

- North America (NAM), as it produces a lot of shale oil (short-lived projects) in a market mainly composed of small and medium players.
- Middle East (MEA), as it benefits from easily accessible reserves in a market mainly composed of large nationally owned companies.

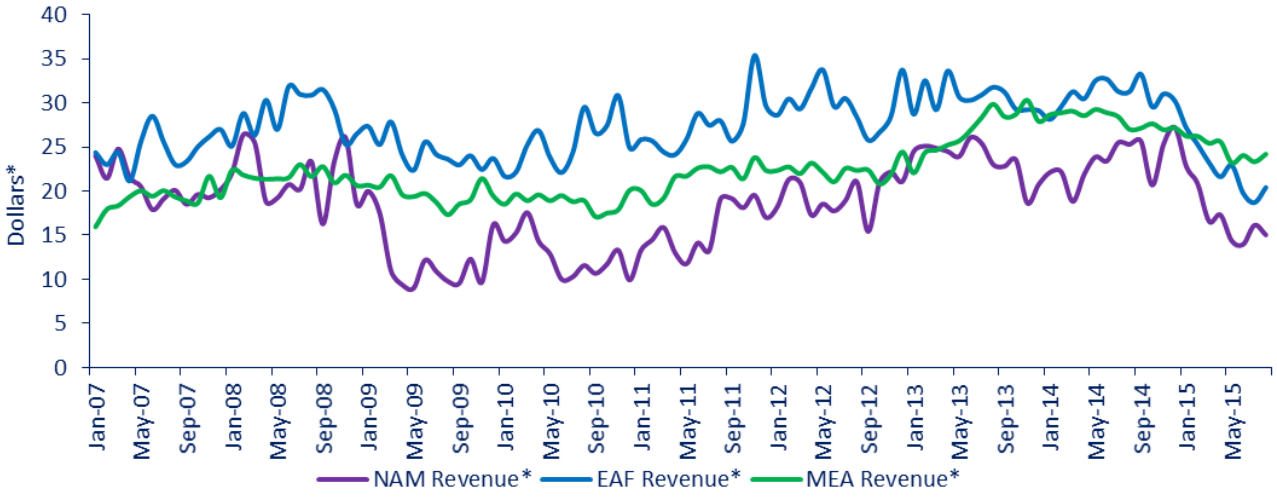
- Europe and Africa (EAF), as it is a combination of both types of reserves in a market composed of mainly international oil companies.

In NAM, a lack of investment may have a more direct effect on revenue as no new projects are undertaken and small players present a high risk of financial distress. In MEA, the revenue should remain relatively stable as projects are longer lasting. Hence, the oil price fluctuation is expected to affect NAM's revenue first and more abruptly, while MEA's revenue is expected to remain relatively stable. As a reference, EAF is expected to lie between the other two areas.

***Assumption 2**: Regional environments affect the reaction delay and magnitude of oil price fluctuations on revenue.*

According to assumption 2, areas should react differently to the oil price fluctuations. Although there seems to be **no specific sequence** in the reaction delay, the magnitude appears to differ from one region to another (figure 19). In MEA, the revenue dropped by 15% between September 2008 and May 2009 (9 months) and 11% between December 2014 and August 2015 (9 months). In NAM, the revenue dropped by 43% and 44%, respectively over the same periods. In EAF, the revenue dropped by 29% and 32%.

Figure 19: WL revenue fluctuation per area (MEA, NAM and EAF)



** Proportional representation, not actual values*
Source: Schlumberger Internal Data

The analysis indicates that MEA appears more stable relative to a change in the oil price, while NAM and EAF (especially NAM) react more abruptly to the oil price fluctuation. Hence, the regional specificities (local environment) seem to have an influence on the revenue evolution.

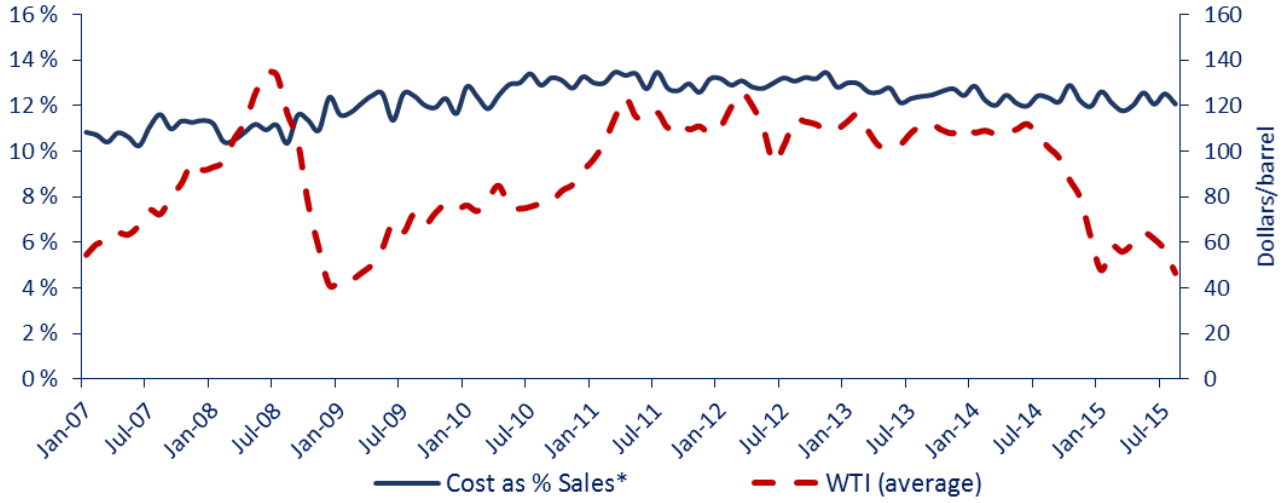
Finding 2: The regional environment affects the magnitude of the impact of oil price fluctuations on the areas' revenue, however regional differences do not seem to affect the reaction delay.

(b) Revenue reduction: volume or price effect?

When oil prices fall, the revenue of all SLB groups and segments is negatively impacted. The falling revenue is triggered by a **price effect**, meaning a modification in the price charged to the customers, or a **volume effect**, meaning lower level of activities (reduced quantities sold). An analysis of the WL segment for EAF allows identifying the dominating effect.

The evolution of the total costs as a percentage of sale indicate that the margins are maintained relatively constant (figure 20). The fall in revenue seems mainly linked to a reduction in the **volumes sold** to customers or if the price charged to customer falls, SLB is able to reduce costs equally, maintaining stable margins. Hence, SLB seems efficient at maintaining margins while operating at a lower level of activity or turning toward suppliers to reduce costs.

Figure 20: WL revenues and costs as a percentage of sales fluctuation



** Proportional representation, not actual values*
Source: Schlumberger Internal Data

To conclude, this part enables to understand the influence of the oil price volatility on SLB's portfolio. The analysis shows a strong correlation between SLB's revenue and activity level and the oil price. However, the expected sequence at which the different groups should be impacted is not clear. The reason could be linked to drivers like diverging contracts, top management incentives, or regional specificities. Finally, the analysis on the prevailing effects on falling revenue indicates that SLB is efficient in preserving margins by reducing costs with suppliers.

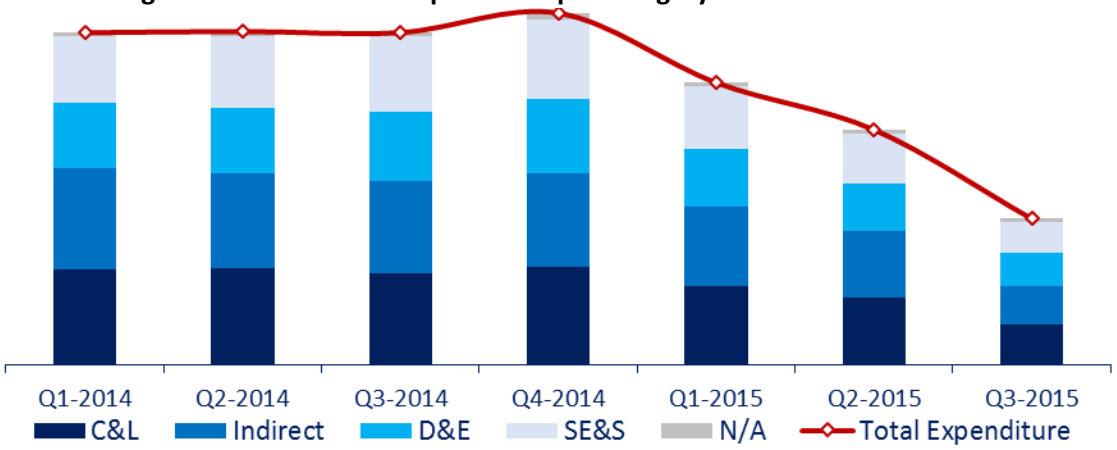
6.3. Expenditure analysis: challenges and risks

The increased complexity and integration of the world economy has increase the importance of the P&S function to improve efficiency and cost reduction to stay ahead of competition. First, the analysis of SLB's expenditure will enable to identify the main challenges SLB suppliers encounter in a downturn. Then, the illustration of these challenges with real example will highlight the key risks harming P&S's ability to operate successfully in a more volatility environment.

(a) Downturn impact on SLB categories

During a downturn, service companies face severe cost pressure from operators with contract renegotiation and the postponement of orders (Martén et al., 2015). Hence, SLB purchases **lower quantities** from suppliers and supplier managers renegotiate **price reductions** with suppliers to maintain financial performance. Between Q4-2014 and Q3-2015, SLB suppliers saw their revenue with SLB fall by more than 50% because of lower volumes and lower prices (figure 21).

Figure 21: Evolution of expenditure per category between 2014 and 2015



Source: Schlumberger Internal Data

In addition, the shares of each category expenditure on total expenditure are relatively constant, indicating that quantities and prices are reduced for all the suppliers regardless of the category (table 9). In the 3rd quarter of 2015, the reduced share of the indirect category expenditure by 2 points is likely due to the fact that it is the easiest category to control internally (ex: implementation of a travel ban on all SLB employees). The increased share of the D&E category expenditure by 3 points can be explained by the high reliability on external suppliers (ex: unfeasibility to cancel orders).

Table 9: Share of category expenditure on total expenditure

	Q1-14	*Q2-14*	*Q3-14*	*Q4-14*	*Q1-15*	*Q2-15*	*Q3-15*
C&L	29 %	29 %	27 %	28 %	28 %	28 %	28 %
Ind	30 %	29 %	28 %	27 %	28 %	28 %	26 %
D&E	20 %	20 %	21 %	21 %	21 %	20 %	23 %
SE&S	20 %	22 %	23 %	23 %	22 %	22 %	21 %

Source: Schlumberger Internal Data

To conclude, all categories are impacted by expenditure reductions in a downturn. The lower level of activity of SLB customers requires fewer equipment and products (**lower quantities**) for operations. The P&S incentives to reduce costs encourage further **price reductions** negotiations with suppliers.

(b) Downturn generated challenges with suppliers

The reduced revenue and level of activity in the downturn are generating great challenges for suppliers: (1) suppliers go **bankrupt** because of the reduced level of activity and (2) suppliers lose interest and **lack confidence** in the oil and gas industry, shifting customer base to industries with a more stable demand.

The challenges of bankruptcy and lack of confidence can be illustrated through real examples SLB has encountered with a number of its suppliers. The selected cases present oil and gas centric suppliers (directly impacted by oil prices or depending entirely on the oil and gas industry) and non-oil and gas centric suppliers (indirectly impacted by oil prices or supplying other industries). This illustrates the various type of suppliers and industries concerned. In addition, the cases are

taken from various countries presenting the international scope of these challenges. The cases are gathered in a table including:

- Presentation of the supplier (size, country of origin, type, and relevant information),
- Description of the supplier's business and reaction to the impact of the downturn,
- Corresponding risks looming SLB's business performance.

Table 10: Illustrations of SLB suppliers

Supplier	Supplier Profile	Business Description and Outlook	Potential Risks
Supplier A (Electronics)	**Medium-sized France** **High Mix/Low Volume** **Non-oil and gas centric** Long-term relationship with joint-development programs for particular products.	**2008**: SLB cancelled a large order putting Supplier A into financial distress. Supplier A diversified its customer base toward industries with a more stable demand (Aeronautic & Biomedical). **2014**: SLB reduced its dependency on Supplier A, leading to an abrupt fall in expenditure. Supplier A reduced capacity and sat a strategy to diversify its customer base further away from oil and gas. **General**: Supplier A regrets SLB's lack of communication regarding future development generating unexpected cancellations & reduced expenditure without notice.	▪ **LEGAL RISK**: According to the French Rule for commercial relationship termination legal pursuits could have been followed after the order cancellation. ▪ **OPERATION RISK**: The transition will force SLB to develop alternative suppliers, requiring time and efforts to reach same quality. ▪ **REPUTATION RISK**: Lack of communication can damage the relationship (affecting supplier's effort in upturns) and SLB's reputation with other suppliers.
Supplier B (Electronics)	**Small-Sized France** **High Mix/Low Volume** **Non-oil and gas centric** Single source for critical product.	Supplier B reduced capacity because of large expenditure reduction in 2015 and low 2016-forecast. Hence, when the market will pick up the recovery period will be longer because supplier needs to train people & buy new equipment.	▪ **CAPACITY RISK**: Supplier B doesn't maintain resources and skills. ▪ **OPERATION RISK**: Supplier B reduced investments and innovation efforts for SLB products.
Supplier C & D (Electronics)	**Small-Sized France** **High Mix/Low Volume** **Non-oil and gas centric**	**Supplier C** was close to bankruptcy because of a fall in activity. SLB encouraged another supplier to acquire Supplier C. **Supplier D** went bankrupt within a few months after a sharp fall in SLB expenditure.	**OPERATION RISK**: Supply disruptions and empowerment of suppliers or competitors in the event of acquisitions.

Table 10: Illustrations of SLB supplier (continued)

Supplier	Supplier Profile	Business Description and Outlook	Potential Risks
Supplier E (Machined Parts)	**Small-sized** **France** **High Mix/Low Volume** **Oil and gas centric** Customer base is 80% Cameron and 20% SLB.	Although Supplier E has a low risk of bankruptcy, SLB will become single customer after the **SLB-Cameron merger** (2015). To overcome the downturn Supplier E implemented a flexible workforce with a large share of contractors and insourced low value added processes (previously outsourced) to keep talent in-house.	▪ **LEGAL RISK**: single client obligations. ▪ **CAPACITY RISK**: long-lasting downturn might require more headcount reduction leading to a lack of skilled personal when the market picks up.
Supplier F (Machined Parts)	**Medium-Sized** **France** **High Mix/Low Volume** **Non-oil and gas centric** Mother company of a drilling specialist supplying SLB.	The reduced expenditures and low forecast forced the child company (drilling specialist) to be acquired by two sister companies. During the re-organization equipment used for producing SLB products was sold.	**CAPACITY RISK**: SLB does not weight heavily in the re-organization.
Supplier G (Machined Parts)	**Large-Sized** **China** **High Mix/High Volume** **Non-oil and gas centric** State owned aviation supplier regrouping many companies. Supplier was selected by P&S and developed by SLB.	SLB provided Supplier G with know-how (quality and technology), while Supplier G invested heavily in dedicated workshops responding to SLB high requirements. To maintain the collaboration, all planned investments projects are on hold and SLB has postponed instead of cancelled most of its orders. Supplier G transferred personal to sister companies. Although SLB tries to maintain activity by shifting production from fragile suppliers to Supplier G, SLB is not on the priority list in the case of capacity conflicts.	**MOTIVATION RISK**: A long-lasting downturn will compromise the postponed orders and the planned investments.
Supplier H & I (Machined Parts)	**Medium-sized** **China** **High Mix/High Volume** **Non-oil and gas centric** Private owned suppliers with high capacity. Supplier was selected by P&S and developed by SLB.	The reduced expenditure and low forecast generate a more than 25% free capacity. Suppliers H & I have assured to not lay off employees to keep efficient workforce, however 2014-downturn led to a >80% drop in SLB expenditure.	**MOTIVATION RISK:** A long-lasting downturn may negatively affect suppliers' efforts to maintain capacity.

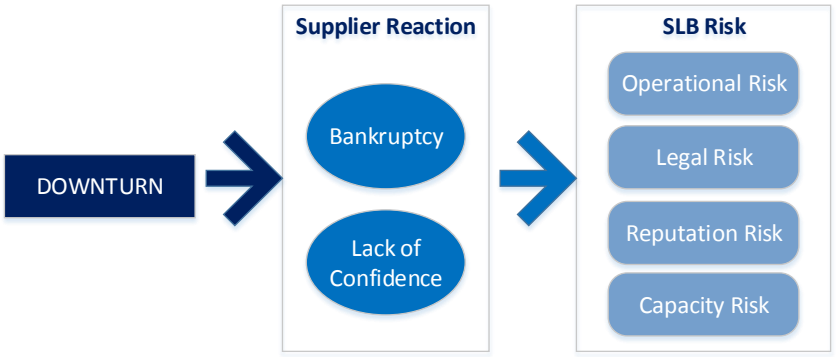
Table 10: Illustrations of SLB supplier (continued)

Supplier	Supplier Profile	Business Description and Outlook	Potential Risks
Supplier J & K	**Small/Medium-sized** **Canada** **Non-oil and gas centric** Low dependency on SLB <10%.	No planned demand in 2016. For **Supplier J**, the supplier manager requested a special order to sustain the supplier ahead of new demand. However, with the long-lasting downturn the request was adjourned.	**<u>OPERATION</u> RISK:** • **Supply disruption** because of possible bankruptcies. • **Quality** impact of headcount reduction. **<u>CAPACITY</u> RISK:** • Loss of expertise gained from qualification. • Loss of capacity due to potential diversification. **<u>MOTIVATION</u> RISK:** • Loss of supplier's willingness to maintain and develop the relationship further.
Suppliers L & M	**Small-Sized** **UK** **Oil and gas centric** **Supplier L:** High dependency on SLB >70%. **Supplier M:** High dependency on SLB >60%.	**Supplier L** faced a 50% SLB expenditure reduction in 2015 and further reductions are expected in 2016. The supplier was acquired by another supplier. SLB cancelled a very large order in 2015 and deferred all the orders after August 2015 leading to a high risk of bankruptcy for **Supplier M**.	
Supplier N	**Small-Sized** **Norway** **Oil and gas centric** Low dependency on SLB <10%.	SLB has built up enough inventory for 2015, leading to no planned demand in 2016.	
Supplier O	**Small-Sized** **United Arab Emirates** **Non-oil and gas centric**	Supplier O expects demand to fall by 25% in 2016 across all customers, with not planned demand from SLB.	
Supplier P	**Small-Sized** **US** **Oil and gas centric** Family-owned with a high dependency on SLB >60%.	Supplier P supports many SLB segments with a very large portfolio of parts, which would be difficult to re-source in the case of failure. A large cancel of orders in 2015 and a limited number of forecasted orders leads to a high risk of bankruptcy.	
Suppliers Q & R	**Small-Sized** **France** **Oil and gas centric** **Supplier R** is single-source for burners & pumps.	**Supplier Q** faced a low probability of new orders in 2016 and the postponement of the payment of a delivered project. Hence, there is uncertainty on the supplier's ability to manage loss in 2015-2016. The low visibility puts doubts on **Supplier R** business continuity. Supplier R is trying to develop new clients to balance the oil downturn.	
Supplier S	**Small-Sized** **Singapore** **Oil and gas centric**	Supplier S faced a drastic drop in revenue (up to 80%). Although it has the financial capacity to sustain the business with a low level of activity, Supplier R may not be able to continue with a long-lasting downturn and the inability to develop new clients.	

(c) Supplier challenges and SLB risks

The downturn causes supplier challenges, namely bankruptcy and lack of confidence, generating significant risks on P&S ability to cope with the volatile environment (figure 22).

Figure 22: Downturn impact on suppliers generating risks looming over SLB's business



- **Operation** risks refer to supply disruptions or the transition period while developing alternative suppliers. Both require efforts and time to develop an alternative supplier and reach the same level of quality and after sales service. Operation risks may also result from a large supplier or competitor acquiring a small or medium supplier close to bankruptcy. In this case, the competition may become fiercer with large players gaining market share and bargaining power over SLB.
- **Capacity** risks can be linked to both equipment and skills. The reduced interest in the oil and gas industry can encourage suppliers to set up a strategy where it diversifies its customer base away from SLB. In addition, in a re-organization or acquisition, suppliers may decide to reduce machinery, workshop space, or talent required for the production of SLB tailored-equipment. These decisions should improve the financial performance of the company to sustain profitability in a downturn. However, they impedes the supplier's recovery time because of headcount reductions and sales of equipment. Hence, the supplier will need more time to develop new skills and acquire machinery.
- **Reputation** and **motivation** risks may be a result of the lack of visibility in terms of planning and of SLB's communication on the strategy adopted with the supplier. These deficiencies can have a negative impact on SLB's reputation toward other suppliers or hurt supplier's motivation to provide greater efforts in upswings, regardless of the financial incentives.

- **Legal** risks are very location specific, as the national jurisdiction governs the rules on the relationship between a company and its suppliers. In France, the obligation linked to the termination of a commercial relationship or abrupt reduction of expenditure (putting the supplier in financial difficulties) is severe. Thus, a downturn can significantly increase the risk of legal pursuits.

To conclude, the existence of numerous worldwide examples justify the importance of addressing and anticipating these situations (bankruptcy and lack of confidence) to avoid threats on SLB's business performance. For SLB, these challenges are important in the **downturn**, hurting current operations and reducing bargaining power, and in the **upturn**, affecting capacity to react.

6.4. Discussion and recommendations

The understanding of the complex oil and gas industry enable to comprehend the environment in which SLB is operating. The illustrations recognize the current risks hurting the P&S's capability to cope with the volatile market. The literature review on supply chain agility provides the required knowledge to understand the P&S function and possible ways to improve its ability to overcome the looming risks and cope with the uncertain market environment.

The supply chains are under tremendous pressure to compete in the rapidly changing environment (global competition, shorter product life cycles, and dynamic changes of demand pattern) (Tiwari, Tiwari, Samuel, & Bhardwaj, 2013). This environment requires company to adopt more flexible supply chain to more easily respond to uncertainties, unpredictable situations, and risks, minimizing **cost**, **quality** (labour and performance), and **time** (delivery) (Tiwari et al., 2013). While SLB categorizes its suppliers to evaluate and monitor better the extended panel of SLB suppliers, the risks illustrated by the cases are not necessarily accounted for. Each of the risks (operational, legal, reputation and capacity) can be translated into a value or financial cost based on the impact on SLB' business performance. Thereafter, the financial cost associated to the looming risks should help in determine the best strategy to adopt with supplier

to reach the best possible outcome. This financial cost can be determined through time, cost, and quality.

- **Time** means the period required to complete the audits or the administrative procedure for a new supplier to be validated. It also includes the time required to conduct a market study to identify new players or evaluate the performance of existing suppliers.
- **Cost** relates to the travel expenses for the audits, the costs linked to testing the equipment, and the opportunity cost of lost sales during supply disruptions.
- **Quality** relates to the fact that the oil and gas industry has high requirements and low level of acceptable risks. For the supplier to fulfil these requirements SLB provides technology and knowhow, including trainings (to develop skills) and product designs. Hence, the development of a new supplier requires time and cost to reach a satisfactory level of quality and after sale service.

Monitoring supplier's health and risk of failure can help determine the potential impact of supplier distress on a company's ongoing project and future demand (McKinsey & Company, 2011). Hence, on a case-by-case basis, SLB can use the financial cost to identify the best strategy to adopt with suppliers. Some suppliers can generate a higher value through a stronger collaboration, while other suppliers bring more value without a collaboration. This consideration can help to concentrate efforts on key suppliers and assure the sustainability of SLB's business performance. Once the strategic position to adopt with a supplier is identified, recommendations can be implemented to improve SLB's agility capability. These solutions can be folded into (a) **internal** and (b) **external** recommendations.

(a) Internal recommendations

The internal recommendations can be implemented within the SLB organization. From the literature on supply chain agility, a company must focus on providing greater **visibility** to be able to react better to the market environment. Hence, the internal recommendations are mainly linked to the development of the IT infrastructure and the opportunities to leverage across the entire SLB organization.

Since SLB is currently integrating its business infrastructure under a global platform, there are growing possibilities to benefit from **Big Data**. The interconnected IT systems will permit the implementation of analytical tools, like asset optimization algorithms or scenario analyses, to provide greater internal visibility. Hence, SLB will be able to improve its alertness and optimize its asset utilization. This recommendation is in accordance with SLB's target to improve the asset utilization by redeploying existing fleets more efficiently (Schlumberger, 2014). In addition, with forecasting models, SLB will be able to better plan and adjust expenditure to reduce costs and increase operational efficiency.

Moreover, SLB relies on small strategic suppliers for certain equipment. Since during the downturn the valuation of oil and gas companies is likely to fall, it is an opportunity to opt for **vertical integration** by acquiring strategic suppliers and internalize the production of critical items. In addition to reducing SLB's dependency on external suppliers, the internalization of products can enable to maintain a certain activity level in the SLB manufacturing centres (EMS). The manufacturing of previously outsourced products could limit the headcount reduction and enhance the capability to **retain talent** in house.

Furthermore, a majority of SLB's suppliers are providing highly specialized equipment and technology often customized to SLB's needs and requirements. Opportunities to **standardize or rationalize** certain items across segments and locations could decrease the range of products and the number of suppliers needed. A standardization of products and equipment could also lead to higher volumes, and hence lower costs. Avoiding specifications can also favour less complex processes and reduce the time to reach the market (higher inventory) (McKinsey & Company, 2011). This approach has already been adopted by integrating two segments (slickline and wireline) into one segment to benefit from synergies and develop cheaper and common items. Supplier managers should look into opportunities to rationalize needs across segments and avoid the highly customized products.

(b) External recommendations

The external recommendations can be implemented for a stronger collaboration with key suppliers. These recommendations include IT system improvements and risk sharing features widely discussed in the literature on supply chain agility.

Like internally, the collaboration with suppliers can be enhanced by integrating IT systems. Suppliers are criticizing the lack of visibility and communication SLB provides in terms of planning and strategy. With greater visibility within SLB, supplier managers will have the possibility to communicate further on the expenditure outlook without being obliged to cancel and postpone numerous orders without notice. The objective is to shift from a demand driven to a forecast driven supply chain (Christopher, 2000). According to Singh and Acharya (2013), a rapid information sharing across all supply chain members can dilute the impact of uncertainty and increase collaboration among partners. Hence, the implementation of an integrated IT system will enable supplier managers to make better strategic decisions and improve the collaboration with suppliers by providing greater visibility in terms of both planning and strategy.

Categorizing the panel of suppliers and evaluating their performance is key to set the best strategy to adopt with suppliers. Both supply chain managers and academics can ensure that greater value can be created through stronger collaboration with suppliers. In addition, because of the time, quality and cost associated to a supplier going bankrupt or losing confidence in the oil and gas industry, the opportunities to build stronger collaboration with suppliers can improve P&S's ability to address the volatile market environment. This collaboration can be achieved through the implementation of **contractual features**. For example, sharing-risk by building up inventory or implementing a total minimum quantity commitment contract, obliging SLB to maintain a minimum purchase order during downturns to avoid a supplier going bankrupt.

The oil crisis can also be viewed as an opportunity to redesign the P&S function by challenging the current status quo and focus on **innovation**. The rethinking of the current technologies, organizational practices, and infrastructure can also generate greater collaboration with

suppliers with the adoption of **joint-development programs** with key partners. With the constantly changing oil and gas environment, putting efforts in innovation is likely to provide long-term savings.

The knowledge of supplier challenges generated by an oil crisis and the associated risks likely to affect SLB's business performance must be accounted for when setting the strategy with the suppliers. First, as expressed in the literature on supply chain agility and confirmed by the case study on SLB suppliers, an access to more and better information can enable better decision-making and improve communication with suppliers. Then, stronger communication and collaboration within the organization (across segments) or with suppliers are essential to build a flexible and agile P&S function to gain competitive edge over competitors. The cost management, valuable information on supply trends, and close relationships with appropriate suppliers can help to strive for consistency between capabilities and competitive advantage (Carr & Pearson, 2002).

7. Conclusion

The complex and volatile oil and gas industry is creating a challenging environment for oil and gas service companies. Volatile because the industry has been through multiple oil crisis. Complex because the drivers behind the oil crisis are generated by a wide array of domains (including economical, geopolitical, and technical). In addition, the market outlooks are predicting a persisting volatile and complex environment, with the oil price expected to face further fluctuations and the increased integration and globalization of the world economy. Large players are facing fiercer competition and encouraged to leverage on size and global footprint to reduce cost and gain operational efficiency to sustain growth in the changing business environment.

SLB is highly impacted by oil crisis. This study provides evidence that the oil price fluctuations has a significant effect on SLB's revenue, activity, and cost. While the sequence at which SLB's activity react to the oil price fluctuation is not clear, the analysis provides evidence that SLB is efficient in preserving margins by turning toward suppliers to reduce costs. The strong reduction in expenditure is generating great challenges for suppliers, namely bankruptcy because of reduced levels of activity and lack of confidence in the oil and gas because of the reduced revenue received from SLB. These challenges are imposing significant risks on SLB's operations, capacity, reputation, generating possible legal risks.

Identifying the challenges, understanding the risks, and selecting the right strategy are major steps to define where to improve P&S's ability to cope with uncertainty. SLB has already implemented ways to enhance the P&S function, by categorizing suppliers and improving internal procedures. However, the literature on supply chain agility provides some additional means to overcome these looming risks and increase the agility of the P&S function. Some of these means are aimed at improving the visibility gained from the IT systems to provide better communication internally and externally with suppliers (analytics and Big Data). Others enable to see opportunities within the downturn to come out from the crisis stronger (vertical integration and

innovation). Yet, the recommendations should be implemented on a case-by-case basis, considering the evaluation of the existing panel of suppliers, the market environment, the global strategy, and the financial impact of the possible risks.

Additional cases and segments analysis may be conducted to improve the coverage of the study and increase the applicable scope. As the findings are resulted from specific cases, there is room for additional analysis to complete the provided findings. This may include supplementary analysis on the impact of oil price fluctuations on individual SLB activities (segments), additional case studies on suppliers, empirical studies on other oil and gas service companies or the impact of other relevant oil and gas indicators, for example metal pricing, like steel, widely used as a raw material for oil and gas equipment.

8. References

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