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1. Introduction

Without any doubt, the energy industry is one of the most critical assets for our today's society and even more compelling for our daily lives (Urciuoli et al, 2014; Mast, 2005). Any disruption can cause tremendous impacts on companies dealing with energy products, as well as on our economy. It is especially true when it comes to the oil and gas industry, which faces an array of risks and uncertainties. No matter the industry, every sector consumes energy. To list some of them: households, healthcare facilities, telecoms and other services need electricity to run correctly. Moreover, the globalization tends to make the oil supply chain longer, therefore longer lead times are observed, increasing the odds of supply disruptions. As a matter of fact, long and complex supply chains increase uncertainties that companies face (Manuj & Mentzer, 2008). The involvement of multiple means of transport such as sea vessels, pipelines, trucks and railroad has increased the burden. (Chima, 2007).

In this context, the supply chain risk management (hereafter SCRM), the crisis management and resilience became relevant topics and have been discussed by previous researches. Christopher (2011) argues that the company with better logistics and supply chain management can improve and sustain their competitive advantage over the rival companies (Cited by Szusek and Hassen, 2012). Chima (2007) stated that oil and gas companies' main challenge is not the scarcity of the resource but rather the production and delivery of petroleum products to the final consumers at a competitive cost. Hence, a robust supply chain management is paramount, as it will enhance this objective. Thus, oil companies strive for a vertical integration as it enhances the control over the chain. Moreover, previous researches have highlighted the relevance of governmental implications to ensure the resilience of energy supply chain (Urciuoli et al, 2014).

Estimating the costs of the supply chain disruption is somehow trivial, but some studies have showed the importance of it. According to Achebe (2011), a risk model based on supply chain was developed in order to analyse strategic and long-term scenarios. The study showed that *"for a generalized oil and gas supply chain like the Gulf coast area of the US, a very critical (in terms of risk rating), and very severe (in terms of duration) event at the crude source - like crisis in Nigeria or Iraq, occurring during the fall season could likely cause an approximately 35% drop/loss in production of the supply chain. The study*

also showed that other events like a refinery explosion/fire, tank leak/crack, or pipeline fire/attack that is also very critical and severe, occurring during the fall season, could also lead to an approximately 40% loss/drop in production of the supply chain”.

However, given the literature, very few researches have focused on the link of SCRM and the emerging countries. In addition, the study of how the oil companies have managed the sourcing of crude oil in the context of European Union regulations is an underexplored topic.

The purpose of this investigation is to determine how oil industry in Belgium deals with risks when sourcing crude oil from emerging markets, and in relation to those, what are the mitigation strategies to manage disruption to enhance a low-risk supply chain. We can assume, given the high dependency of Western countries and especially Belgium from the oil producing countries, that the governments and the oil corporations have established strong plans to not interrupt the flow of oil supply.

As an exploratory-based study, I have decided to broaden the scope to the Middle East. The principal reasons that encouraged me to focus on the oil industry for this paper are twofold. On the one hand, oil is well known to be the most traded commodity on earth and probably the most critical resource for our society. To support this statement, Hartshorn (1993) asserts by some physical measures, *“oil is still the world’s biggest business”*. On the other hand, from a more subjective point of view, the oil sector has since always given rise to a lot of unanswered questions. Moreover, the oil industry is principally a supply chain management industry (Achebe, 2011). It involves all the steps to deliver the product to the final consumer, i.e. exploration, drilling, operations of pipelines, operations of refinery and final delivery to the consumer. In brief it was a bargain for me to write about this exciting subject and involve a supply chain management perspective. The reason to broaden the scope to Middle East was clear to me: it is by far the first world producer region and at the same time exporter of crude oil.

This paperwork is divided into five sections: after the introduction, the “History and background” part aims at presenting the oil sector in the Middle East under the axes of economy, geopolitics and geostrategic context. Next, a quick snapshot of Belgian relations with the most influent Middle East countries. The rational behind this latter part is to help the reader situate himself into this industry. Next to that, I expound the

“Literature review” on SCRM by going through important topics to highlight the best practices into this area. Thereafter, the “Methodology and case-study” section explains the approach chosen to sample my interviews, and the framework used to collect and analyse the data. The following section “Research findings” develop the results of the four single cases reflecting the oil supply chain followed by a cross-case analysis to identify new propositions to enrich or complete the literature findings. Finally, I will wrap up with conclusions and limitations for future researches.

2. History and background

Without the shadow of a doubt, oil has always been the principal global concern and yet, today, there are still a lot of mysteries around its scope. Hence, this section aims at providing great insights over probably the most critical commodity on earth: the black gold. Through the economic context but also geopolitics and geostrategic contexts, I will develop the ins and outs of crude oil trade in a context of globalization. The goal here is not to develop an in-depth analysis but rather to help the reader situate himself in this context.

2.1. Premises

First and foremost, I believed interesting to understand the oil's origin and its particularities. A plenty of explanations are available but all agree on the oil formation. In his book, Hartshorn (1993) explains *“Oil and gas were formed prehistorically from organic marine sediments under calm seas protecting them from decomposition by oxygen. Over millions of years, some of these sediments were converted by anaerobic bacterial action, heat and pressure into source rocks for hydrocarbons. (...) Most of the hydrocarbons formed in source rocks gradually escaped into more porous and permeable ‘reservoir rock’ strata nearby, where oil drilling may reach them. Any form of trap within these rocks strata in which oil and gas migrating upwards are sealed by some impermeable layer of ‘caprock’ (...) is known as reservoirs. One or more reservoirs formed in the same trapping circumstances constitute an oil and gas field. Within a sedimentary basin, there may be one or more petroleum provinces containing oil and gas fields.”* (Cited by Hartshorn, 1993)

In the oil industry, distinction of oils by names such as Brent Light crude oil and Bonny Light, but also different types of crude oil (e.g. light, heavy, sweet and sour) are observable. Light oil differentiates itself by a low density of viscosity while heavy oil is the opposite. Concerning sweet oil, it contains less sulphur than sour oil. The preferred types of oils in the market are the light and sweet ones principally because they are less complex and time consuming for refining. Although the common term to define oil is “black oil”, it depends on its viscosity composition and its variation of colours from black to yellow depending on its hydrocarbon composition. More precisely, oil has a measure that is called “oil gravity”. The oil gravity is a measure developed by the American

Petroleum Institute (hereafter API) and is defined by a formula $(145,5/\text{gravity at } 60^{\circ}\text{Fahrenheit minus } 135,5)$. In a nutshell, the lighter the crude oil is, the weaker its gravity, and the higher its API gravity is. Generally, crudes densities are between 20°F (very light) and 60°F (very heavy) (Hartshorn, 1993). For more simplicity and comprehensiveness for the reader, I decided to focus this paperwork on the crude oil in a much broader way.

2.2. Oil in the Middle East

The Middle East borders, also known as Western Asia according to the United Nation designation, are defined and recognised by the United Nations itself as eighteen countries¹. Those countries are listed and are part of the Middle East region (see Appendix 2) including countries such as Azerbaijan, Armenia, Georgia or Cyprus.

It is no surprise that the Middle Eastern region is known as the biggest producer and exporter of crude oil, with Saudi Arabia as the first world's producer (CIA, 2015). In March 1938, oil was first discovered in Saudi Arabia in its Dammam oilfield (OPEC, 2015, CIA, 2015). For the Middle Eastern Kingdom, oil reserves are about 18% of the world's proven oil reserves. The energy sector counts approximately 50% of the GDP and about 85% of exports earnings (OPEC, 2015). Moreover, crude oil export is estimated to reach 7,153,000 barrels per day (hereafter b/d) while crude oil production reaches 9,713,000 b/d. It is interesting to see the predominance of the petroleum industry on the Saudi Arabia's revenues. Similarly to other OPEC's members, the largest oil exporter is a monoculture economy, heavily depending on oil (Hartshorn, 1993). To reinforce this statement, the CIA World Fact Book acknowledges the Saudi Arabia oil-based economy. Nevertheless, the Kingdom do not only possesses oil as a natural resource as it includes natural gas, iron ore, gold and copper (OPEC, 2015). But those ones only represent a non-significant fraction on revenues compared to the oil trade. From a comparative standpoint, other Middle Eastern countries such as Iraq, Iran, Qatar or even Kuwait are also influential players in crude oil trade. For instance, in late 2007,

¹ Retrieved from <http://unstats.un.org/unsd/methods/m49/m49regin.htm>, online, consulted on April, 7th 2016

the Qatar oil and gas revenues pushed the country with the highest per capital income in the world² (CIA, 2014).

Although other sources of energy are available such as renewable wind, water and solar energy, they will never be as much profitable as the crude oil trade, even if its reserves are limited in the time (cited by Szucs & Hassen, 2012). In fact, nobody exactly knows the world's crude oil reserves. Laurent (2006), a famous French journalist well-known for his controversy subjects, claims that – *“les chiffres concernant les réserves mondiales de pétrole sont totalement faux, volontairement grossis par les pays producteurs. En Arabie Saoudite et en Russie, les montants exacts relèvent même du secret d’Etat³”* – *“the data concerning world’s oil reserve are totally false and are voluntary grown by the producer’s countries.”* He goes even further by asserting that the exact amount of crude oil reserve, in Saudi Arabia and Russia, are State’s secrets. Conspiracy or not, the oil industry or rather the government oil-producing countries are often criticized for their opacity. However, BP Statistic Review 2015 provides us a clear illustration of oil reserves by region, showing the Middle East predominance (Appendix 1). Still today, some oilfields are being discovered with the most recent oil reserve discovered in 2015 and located in Bolivia within the Santa Cruz region⁴. On top of that, we must know among reserves discovered so far by the industry that they are named “proved” reserves. Moreover, scientists make the distinction between these so-called “proved” and “probable” reserves (Hartshorn, 1993). The latter only provides chances to find oil from the field whereas the other is a field where oil is being extracted. For the world’s largest exporter of crude oil, Saudi Arabia proven reserves are estimated to exactly 268,3 billion of barrels⁵ (estimation on 1st January 2015 - CIA, 2015). Somehow, oil production from Saudi Arabia is secured for a well foreseeable future.

2.3. Economic, geopolitics and geostrategic context

Since the Industrial Revolution in the 19th century, the oil industry has never been more significant in today’s world economy and in our daily lives. With the tendency towards

² Retrieved from: <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/qa.html>, consulted on April 7th, 2016

³ Translation from: LAURENT E. “La face cachée du pétrole”, 2006, Plon, pp411.

⁴ Retrieved from <http://www.rfi.fr/ameriques/20150618-bolivie-decouverte-gisement-petrolier-triple-reserves> online, consulted on April 7th, 2016

⁵ Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html>, consulted on April, 7th, 2016

globalization, world trade and transportation are encouraged. Oil stays the number one energy source for many industries due to its easiness of transport; storage and handling while other energy sources do not (Mast, 2005). The biggest oil consumer is acknowledged and reckoned by the United States, followed by the European Union and completed by China for the top three (Appendix – 3, CIA, 2010)⁶. According to the latest Statistical Review of World Energy from BP⁷, the global oil consumption has increased by 840,000 of barrels per day. This growth is mainly due to emerging economies. Despite the decrease average oil consumption of China, the sovereign state of East Asia still takes the first place (with 390,000 b/d), followed by Saudi Arabia (190,000 b/d), Brazil (180,000 b/d) and finally India (120,000 b/d).

2.3.1. OPEC and its member countries

From early development of oil industry in 19th century, major oil corporations abroad have dominated the oil production and marketing: Standard Oil Trust, Royal Dutch Shell and Anglo Oil Company (Wyant, 1977). Thus, this context gave a lack of power control to government producing countries of their own resources (Alnasrawi, 1985). In 1960, major multinational companies decided to reduce oil prices of crude oil exported from the Middle East and triggered the action by government producing countries to create the Organization of Petroleum Exporting Countries (hereafter OPEC). This new organization, which counts as founding members: Iraq, Iran, Kuwait, Saudi Arabia and Venezuela, was born during a deep reflexion of Third World countries about the sovereignty of their resources. Now, these countries can count on the support of eight more nations that joined the organization later on: Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), and Angola (2007). However, the collaboration between those countries was challenging, especially between the Middle Eastern countries. Alnasrawi (1985) argues, *“due to divergent economic and political conditions among member countries, conflicts within OPEC were inevitable”*. Indeed, according to the same author *“prior to 1971-73 conflicts emanated from the concession system itself, in that each government attempted to have its oil company maximize output in order to maximize*

⁶ Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2246rank.html> , online, consulted on April 7th, 2016

⁷ Retrieved from <http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/oil-review-by-energy-type/oil-and-product-consumption.html>, online, consulted on April 7th, 2016

revenue. (...) An increase in output in one country had to be at the expense of output in other countries." This main issue is considered having triggered the 'quota system'. As a matter of fact, the OPEC's members have agreed that the total output should be limited, therefore ceiling the production (Wyant 1977, Hartshorn, 1993, Alnasrawi, 1985). Nevertheless, as one can argue, the OPEC's quotas were rarely respected. Sheikh Ali Khalifah al-Sabah, the Kuwaiti oil minister, said in February 1990; *"Everybody who could (exceed the quota), did. Everybody who couldn't complained about it"* (cited by Hartshorn, 1993). Some are going even further by admitting the irrelevancy of the quotas system, and their willingness to see them scrapped out as soon as possible, as it was the case for Sheikh Ali (Finance Minister of Kuwait). One important fact of OPEC cartel remains in its significant influence of crude oil prices, production and export. According to the U.S Energy Information Administration, the organization (OPEC) is responsible for 40% of the world's crude oil and 60% of the world's traded petroleum product. Hence, *"Because of this market share, OPEC's actions can, and do, influence international oil prices. In particular, indications of changes in crude oil production from Saudi Arabia, OPEC's largest producer, frequently affect oil prices."* (U.S.EIA, 2016)⁸. Appendix 4 provides us with a clear illustration of the OPEC's predominance in terms of crude oil reserves share compared to non-OPEC countries.

2.3.2. Oil crisis

Due to its significant influence, the OPEC organization may now use this newly acquired leverage to change aspects of the international economic system (Alnasrawi, 1985). Thus, in February 1971, a new agreement with companies emanated from the producing countries in order to regulate the price of oil: The Teheran Agreement. According to one OPEC official, after The Teheran Agreement, *"It was a real turning point for OPEC (...) OPEC got muscles"* (cited by Yergin, 1991). Under this settlement, the producer nations concluded on additional taxes per barrel, which had as a consequence to increase their revenues. Furthermore, in March 1971, The Tripoli Agreement was signed and gave to Libya better conditions compared to the agreements signed by the Gulf producers (i.e. The Teheran Agreement). Here again the apparent lack of unified, long-term policy objectives were fatal because it injected instability into the previous settlements (Alnasrawi, 1985, Wyant, 1977).

⁸ Retrieved from <https://www.eia.gov/finance/markets/supply-pec.cfm>, consulted on March 16th, 2016

In 1973 the Arab-Israeli War, also known as the Yom Kippur War that opposed Egypt and Syria against Israel over a territory conflict, had a relevant role in the OPEC's decision about the oil production. Indeed, the Arab Petroleum Exporting Countries⁹ (hereafter OAPEC), a regional inter-governmental organization of only Arab oil exporting countries, imposed an oil embargo on the Western countries supporting Israel in this conflict. But as one can argue the OAPEC's decision aims at increasing prices and controls through restricting supplies (Wyant, 1977). Indeed, *"Historically, crude oil prices have seen increases in times when OPEC production targets are reduced."* (U.S.EIA, 2016). For the first time in history, OPEC decided to raise prices without waiting to reconvene negotiations with the companies (Wyant, 1977). The seriousness of the embargo led consuming countries to be more concerned about the oil supplies. Even the 37th U.S. President Richard Nixon took several measures in order to minimize disruption in the US economy and said in his speech *"(...) the sudden cutoff of oil from the Middle East had turned the serious energy shortages we expected this winter into a major energy crisis. That crisis is now being felt around the world, as other industrialized nations have also suffered from cutbacks in oil from the Middle East"*¹⁰. This context is known to be the first oil shock price, followed by the second shock during the Iranian Revolution in 1979 when Khomeini defeated the Shah of Iran Muhammad Reza Pahlavi.

2.3.3. Actuality

Today, the crude oil is playing a major role especially in the economical and geopolitical contexts. With the recent shale gas exploration into the American lands, the war in Syria opposing rebels against the Bashar forces, and the embargo against Iran due to their nuclear program, oil has been facing a particular attention by all stakeholders.

2.3.3.1. Shale gas in America

After the discovery of shale gas on the U.S territory (but also in Canada), Saudi Arabia's concerns were predominant. Being afraid to see its influence counterbalanced by this new discovery, Saudi Arabia wanted to punish the US and in the same time asphyxiate the American producers. In order to discourage the American exploration, Saudi Arabia has decided to drastically increase its own oil production, which had as consequence to

⁹ Retrieved from <http://www.oapecorg.org/Home/About-Us/History> consulted on March 16th, 2016

¹⁰ Cited by Richard Nixon: "Address to the Nation About National Energy Policy.," November 25, 1973. Online by Gerhard Peters and John T. Woolley, *The American Presidency Project*. <http://www.presidency.ucsb.edu/ws/?pid=4051>

dramatically decrease the world oil prices. In fact, the shale gas exploration implies expensive techniques such as drilling that must be realized deeper into the shale formation (Appendix 5). The Kingdom of Saudi Arabia has reached its objective since the American shale explorations have registered a production decrease in 2016. According to the last report of the Internal Energy Agency (IEA), the American drilling has decreased around roughly 500,000 barrel per day and therefore manifests a production decline of petroleum. With a price of 30-40 dollars per barrel for crude oil, the shale gas could not compete anymore and several exploration fields were forced to shut down, making huge investment losses.

2.3.3.2. Iranian embargo

As one can argue, the case of Iran is isolated. As a matter of fact, since 2003, the European politics regarding Iran is highly influenced by the Iranian nuclear program concerns. Since then, many dialogues implying Great Britain, France, Germany, China, Russia and the United States, have been taken in parallel with sanctions applied by the United Nation¹¹. However, the International Atomic Energy Agency (IAEA) assessment of the Iranian nuclear program is alarming and in late 2011, the European Union decided to strengthen its sanction against the Iranian Republic. Therefore, many sectors have been affected by this drastic measure (i.e. weapons, finance, transport, oil & gas, petrochemicals, precious metals and every sector that may be linked to the nuclear program). In January 2016, the United Nations have decided to lift every single economical sanction against Iran. The European and Iranian diplomatic representatives assert, *“Iran having fulfilled its commitments, today, financial and economical sanctions (multilateral and national) tied with the Iranian nuclear program have been lifted”*¹². The economical effects of this decision are numerous; on the one hand, as the Iranian oil embargo has been removed, oil prices will progressively decline. *“Teheran was exporting only 50% of its oil capacity”*, asserts Thierry Coville, researcher for Iris and Iran specialist. On the other hand, the second major effect is related to the banking sector. So far, every financial transaction to Iran has been prohibited and huge assets have been blocked abroad due to the embargo. Removing the embargo will unlock huge flows of

¹¹ Retrieved from http://diplomatie.belgium.be/fr/politique/themes_politiques/paix_et_securite/sanctions/sanctions_iran consulted on April 16th, 2016

¹² Retrieved from <http://www.france24.com/fr/20160115-levee-sanctions-iran-changements-accord-nucleaire-economie-petrole-aiea-etats-unis> consulted on April 16th, 2016

capital, so far frozen in foreign bank accounts. Coville (2016) asserts that the Iranian government will dispose about \$30 billion from the aforementioned accounts, and will boost the Iranian economy.

2.3.3.3. *The Islamic State in Syria and Iraq*

Since the 9/11 attacks, the international community has led a terrorist hunting with the US blessings. Since then, wars and political tensions have been numerous; the war in Afghanistan (2001-2014), the Iraq invasion from the US troops (2003), the Arab Spring and protests, riots and civil wars (began in 2010 with Tunisia) and more recently the on-going civil war in Syria that began in 2011.

In Syria but also in Iraq, the rebel group called the “Islamic State” (IS) took several oilfields and refineries and trade crude oil over in order to finance their activities. According to the US treasury, the IS could have earned several millions of dollars from the sale of crude oil and refined products “*who in turn smuggled them in Turkey and Iran, or sold them to the Syrian government*”¹³. US and its coalition claimed having hurdle several IS oil facilities by engaging air strike attacks, cutting one of the major revenue sources for the IS. Indeed, “*Where production throughout its territory in Syria and Iraq was once as high as 70,000-80,000 b/d, US intelligence officials now estimate it is down to 20,000-40,000 b/d*”¹⁴. Through the black market, the IS were selling crude oil at a competitive price of around \$50, sometimes even \$20-30. The US have announced serious sanctions against anybody who trades with the IS oil.

2.3.3.4. *Belgium and its trade relations with Middle East*

In the context of this thesis, I will mainly focus on the bilateral relations between the Middle Eastern regions and Belgium. Next to that, a quick snapshot of trade relations between the most important Middle Eastern countries with Belgium. Again, the goal here is to situate the reader into this context rather than to make an in-depth analysis.

When analysing the Belgian Trade Agency data, we rapidly observe the predominance of the United Arab Emirates (UAE) and Saudi Arabia in their trade relations with Belgium. Indeed, in 2014 the net exportation from Belgium to UAE was estimated to €3,601

¹³ Retrieved from <http://www.bbc.com/news/world-middle-east-29052144> consulted on April 16th, 2016

¹⁴ Retrieved from <http://www.platts.com/podcasts-detail/crude/2016/march/capitol-crude-031416> consulted on April 16th, 2016

million (+11,0% compared to 2013), placing this country as the 17th most important client of Belgium and the 22nd supplier of Belgium. Moreover, Saudi Arabia can be seen as the second most important Middle Eastern country for its trade relations with Belgium. With a net exportation estimated to more than €1,497 million (+21,3%), the Kingdom is (in 2015) the 24th client and 31st supplier of our Monarchy. From a comparative point of view, the other countries (also members of the OPEC) such as Iran, Iraq, Qatar or Kuwait are far away in the list of the clients and suppliers of Belgium. Despite this fact, numbers in terms of bilateral relations are significant for the Belgian economy. For instance, the Islamic Republic of Iran is the 57th client and only the 101st supplier of Belgium with as major import section: plastics (60,1%), followed by vegetable products (14,2%) and finally chemicals (12,6%). The total exportation has reached an amount of 297,9 million during the first 9 months of 2015.

Surprisingly, no mineral products (where crude oil or bitumen are under-sectioned) were imported from the UAE. Instead, the main sections are composed of precious metals and stones (89,1%), chemicals (2,1%) and base metals (2,0%). For Saudi Arabia, mineral products are not the main sections of importation to Belgium. Indeed, the latter section represents only 13,3% against 50,6% for plastics (principally ethylene polymer and polypropylene). The last section of the top three is composed by chemicals and represents 39,9% of the total importation. As shown in the Belgian Petroleum Federation Table 1 below (Fédération Petrolière Belge), the overall Belgian crude oil imported from Middle East in 2014 reached an amount of 8,222,000 tones. Therefore, it represents 26% of the total crude oil importation in 2014, with an increase of 4% compared to the previous year.

Table 1 - Belgian crude oil import by region origin

	K Ton			%	
	1973	2013	2014	2013	2014
Middle East	29,830	6,051	8,222	22	26
<i>including</i>					
<i>Saudi Arabia</i>	15,927	5,451	7,608	20	24
<i>Iran</i>	7,221	0	0	0	0
<i>Iraq</i>	818	302	370	1	1
Russia	517	12,443	11,653	45	36
North Sea	106	4,270	4,524	15	14
<i>including</i>					
<i>UK</i>	-	1,452	1,776	5	6
<i>Norway</i>	106	2,626	2,726	10	8
Africa	5,696	4,023	5,842	15	18
<i>including</i>					
<i>Nigeria</i>	949	2,889	4,348	10	14
Venezuela	997	437	653	2	2
Others	249	394	1,296	1	4
TOTAL	37,395	27,618	32,190	100	100
<i>including</i>					
<i>OPEC</i>	36,344	9,850	14,235	36	44

Source: Adapted from Fédération Pétrolière Belge – Rapport Annuel 2014

According to the World Economic Forum, Saudi Arabia benefits from a strong macroeconomic environment and has pushed the country ranking at the 25th place (out of 140). Note that we may take into consideration the recent oil price drop, which may affect this ranking, and may lead to reconsider this respect. Considering a grade scaling from 1 (worst) to 7 (best), the same source attributes a score of 5,1 to Saudi Arabia “Institution pillar” (18th/140). The latter trend is principally due to a well-perceived

management of different sub-categories of public institutions such as: property rights, ethics and corruption, and security. To reinforce this trend, the crown deputy Muhammad Bin Salman has recently announced that Saudi Arabia will lead 34 Islamic nations to fight against terrorism (CIA, 2015). As security is one of the most relevant factors for oil companies when sourcing oil in emerging markets, Saudi Arabia seemed to possess all traits of a confident and trusted country.

Other data and rankings that are available to assess the Middle Eastern countries business environment and that could potentially affect supply chains include the following:

- ✚ Supplier quantity: According to the Global Competitiveness Report 2015, Saudi Arabia ranks 21st/140 worldwide and third in the Middle East behind Qatar and UAE.
- ✚ Supplier quality: From the same report, Saudi Arabia ranks 54th/140 far behind UAE (24th) and Qatar (21st).
- ✚ Infrastructure: Is considered as well developed for the UAE and among the best in the world, which gave a security feeling for sea vessels (also called 'tankers') transporting crude oil (6th/140 in GRC 2015-2016). According to the United Nations Conference on Trade and Development (UNCTAD), maritime shipping is the preferred mean of transportation for oil, and oil shipment accounts for 30% of the maritime trade¹⁵. Qatar and Saudi Arabia are placed further in the ranking respectively as 18th and 30th, principally due to less developed roads and railroad quality infrastructure.
- ✚ Goods market efficiency: Including 'competition' and 'quality of demand conditions', again the UAE is taking the first place in the Middle East, closely followed by Qatar (5th/140) and Saudi Arabia (29th), which is less well-perceived in terms of buyer-sophistication meaning that purchasing trend decisions tend to be more based on the lowest price.
- ✚ Financial market development: Saudi Arabia is placed 41st worldwide against 20th for the UAE. Only Qatar (13th) ranks ahead among the Middle East countries. In fact, investing in Saudi Arabia and Qatar is quite challenging for entrepreneurs due to the difficult access to equity funding conditions and bank loans. As one of

¹⁵ Retrieved from <http://www.planete-energies.com/en/medias/close/transporting-oil-sea>, consulted on April, 16th 2016

the most oil-based economy, the Saudi Arabia government has lately approached investors to expend their commitment in the healthcare sector, leisure and tourism industries, in order to diversify the economy (CIA, 2015). However, with the recent oil price decline, the government may be forced to make drastic changes ahead for their long-run timeline.

✚ Education and training: Having a highly educated workforce can contribute to enhance the supplier reliability and we can argue that consequently, associated risks are diminished. Therefore, the quantity and the quality of education is central. However, according to the Global Competitiveness Report 2015-2016, Saudi Arabia in particular has still efforts to make for improvement in this pillar, placing the country at the 49th worldwide. Indeed, government encourages the growth of private sector and at the same time the employment more Saudi nationals. According to the CIA World Fact Book, Saudi is particularly focused on employing its large youth population, which generally lacks the education and technical skills that the private sector needs.

Even if some Middle Eastern countries are considered among the wealthiest in the world (Saudi Arabia, Qatar, Kuwait, UEA, etc.), doing business with these countries are not risk free. As a matter of fact, most of the Gulf countries were the witnesses of the Arab Spring in 2010 and have led to many inequalities and protests against the political regime. For instance, the war in Yemen (country border of Saudi Arabia), opposing the President forces and the Shias rebels, is considered a “*serious implication for the region and the security*” (BBC, 2015). Moreover, Kuwait and Saudi Arabia continue discussions on a maritime boundary with Iran, reinforcing tensions with Iranian politics. Forced labour, prostitution, domestic-servant conditions or even migrant workers terms are examples of criticisms from the international community against the Saudi Arabian politics (CIA, 2015). As a matter of fact, Ducroire, a Belgian public credit-insurer, classifies the war risks of countries on a scale grading from 1 (best) to 7 (worst). In that category, Saudi Arabia obtained the grade of 4, which shows in a way the ‘unstable’ environment of the country. Those indicators make us think about what risks prevail when the Belgian companies are doing business with the Middle Eastern countries in order to manage supply chain risks.

3. Literature review

3.1. From risk origin to vulnerability in global sourcing

As one can argue, “*risk is a fact of life*” (Dittmann, 2014). This statement is even truer when it is applied to the supply chain context. As a matter of fact, several authors and practitioners assert that due to economic changes (e.g. globalization and outsourcing), risk exposure has increased for all sectors. This latter trend has led companies’ supply chains to become longer, more complex and therefore more vulnerable (Norrman & Jansson, 2004; Blome & Schoenherr, 2011; Manuj & Mentzer, 2008; Chen et al., 2013; Christopher & Peck, 2004; Tang & Tomlin, 2008; Chopra and Sodhi, 2004; Blackhurst et al., 2005). All those effects caused complexity in supply networks (Croom, 2000 Harland et al., 1999; Christopher, 1998). Indeed, supply chains are more easily exposed to risks than ever. In the past, the traditional business was simpler. Now, facing the aforementioned difficulties, risk is becoming more significant (Harland et al., 2002).

Figure 1 - Vulnerability is the result of a sequential from long and complex SC



However, we have to clarify that risk is conceptual. Indeed, different behaviours are observable against risk. Some individuals or companies are risk-averse (i.e. they prefer covering against risk¹⁶) while others are risk takers. Going further in this assertion, Manuj and Mentzer (2008) and Rohrmann (1998) stated that risk is principally based on the individual perception and experiences but also on belief and on societal acceptance. Therefore, we could conclude that the reaction to risk depends on each individual’s interest for risk. Nevertheless in the context of supply chain, risk can be assimilated to loss (Prakash and Mittal, 2014).

Exploring the literature, we can find a plenty of definitions for risk. Going from a more generic one; “*risk is a combination of probability or frequency of occurrence of a defined hazard and magnitude of the occurrence*” (BS 4778), to a more specific one (in a context of business); “*level of exposure to uncertainties that the enterprise must understand and*

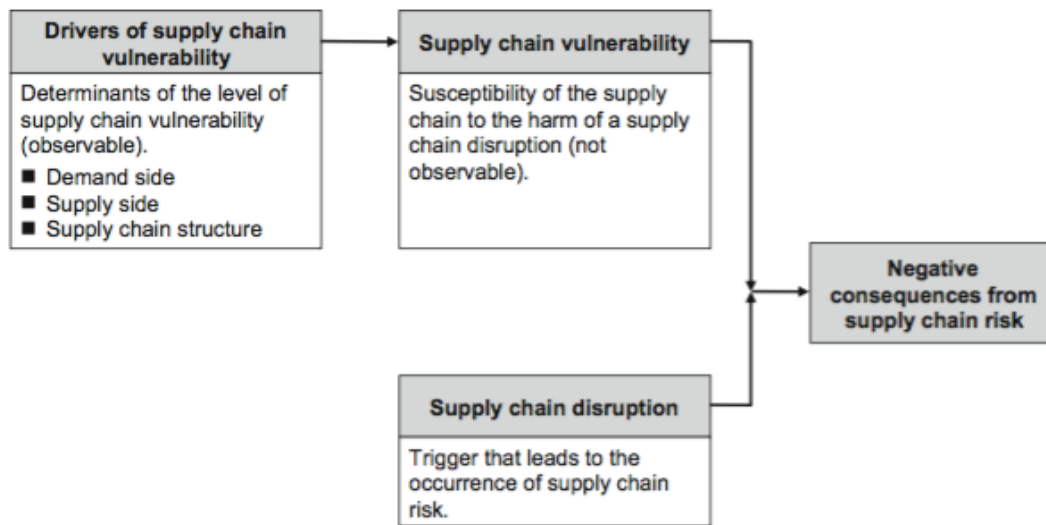
¹⁶ Retrieved from: <http://www.investopedia.com/terms/r/riskaverse.asp>, consulted on March 1st, 2016

effectively manage as it executes its strategies to achieve its business objectives and create value" (Deloach, 2002). Some other definitions are also more accurate. Indeed, Mitchell (1995) defines risk as the probability of loss and the significance of that loss to the organization or individual. While Manuj and Mentzer (2008b) encompass risk as the distribution of performance outcomes of interest expressed in terms of losses, probability, speed of event, speed of losses, times for detection of the events and frequency.

Vulnerability is the effect of the risk (Prakash and Mittal, 2014). As already said, due to business trends such as outsourcing, globalization and more integrated processes; organizations are dealing with a more complex environment, which has increased the risk. As a matter of fact, firms were used to produce in-house, source locally and sell directly to the end consumer and risk was less spread (Harland et al., 2002). Nowadays, risk is diffused throughout the entire supply network. Indeed, going global and the fact that companies strive to focus on their core activity had increased the number of players among the supply chain. Therefore, it left room for vulnerability.

The supply chain vulnerability has been defined broadly by Christopher and Peck (2003, p4) as *"an exposure to serious disturbance"* and by Jüttner et al. (2003, p.200) as *"the propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences"*. Furthermore, Svensson (2000) adds an important nuance: the increased vulnerability of supply chains appears even more substantial when the focal firms' business has become dependent to the suppliers' organization. Meaning that if outsourcing is performed through local suppliers instead of vertical integration, the supply chain will face higher vulnerability.

Figure 2 - Supply chain vulnerability and disruption



Source: From Wagner and Neshat, 2010

Figure 2 depicts the relationship between supply chain disruption and supply chain vulnerability. Wagner and Neshat (2010) have classified the supply chain vulnerability drivers into three groups: supply side (e.g. supplier-supplier relationship), demand side (e.g. customers dependence) and supply chain structure that “stem to a large degree from the disintegration of supply chains and the globalization (and off-shoring) of value-adding activities” (Srai and Gregory, 2008). By addressing those major drivers, organizations can more easily find appropriate supply chain risk management (hereafter SCRM) approaches to the given situation that led to vulnerability. In fact, organizations no longer retain their competitive advantage without implementing strong and proactive SCRM initiatives to their vulnerabilities (Wegner and Neshat, 2010).

At the same time, a longer and more complex supply chain make it harder for companies to understand the whole range of risk that can potentially affect them, increasing uncertainties. The concept of uncertainty has already been widely defined. According to Galbraith (1973), uncertainty resides in “the difference between the amount of information required to perform the task and the amount of information already possessed by the organisation”. In another understanding Milliken (1987) defines uncertainty as the “perceived inability to predict something accurately”. Figure 1 shows the sequential parts leading to vulnerability in supply chain.

Considering those harmful indicators, it is widely accepted that SCRM is a necessity in

today's business (Wegner and Neshat, 2009). Christopher and Lee (2004) or Tang (2006a) shared the same argument by asserting that due to the increasing risk in the supply chain, it is important to manage them. For Blome and Schoenherr (2011), supply chain risk management became an essential topic.

In the following chapter, we will discuss the different approaches to conduct an effective supply chain risk management.

3.2. Supply chain risk management (SCRM)

Before entering more deeply into this topic, let us give time to understand the notion of supply chain. Christopher (1992) defined it as *"a network of organisations that are involved, through upstream and downstream linkages, in different processes and activities that produce value to consumers"*. In the same way, many authors have followed this vision more recently. For instance, *"arrangement of organizations, their facilities, acts and activities that are involved in manufacturing and giving a product or a service"* is suggested as an extra definition by Prakash and Mittal (2014). Again, Handfield and Nichols (1999) define supply chain as: *"The supply chain encompasses all activities associated with the flow and transformation of the goods from the material raw stage (extraction) through to the end user, as well as the associated information flows. Material and information both flow up and down the supply chain"*.

Taking into account these premises, I would understand that supply chain risk management can be viewed as a part of these general definitions on supply chain, but focusing on *"applying risk management tools to deal with risk and uncertainties caused by or impacted on logistics related activities and resources"* (cited by Norrman and Lindroth, 2002).

Lately, several authors and practitioners have developed an array of approaches to manage supply chain risk. Blome and Schoenherr (2011) claimed that SCRM has been developed from various angles. For instance, Li and Barnes (2008) developed proactive SCRM methods when sourcing from emerging market. Blome and Schoenherr (2011) suggested that SCRM needed to be reconsidered in the context of financial crisis. Going further, supply chain should be understood and managed as a whole for an end-to-end supply chain (Rao and Goldsby, 2009). In that regard, Norrman and Jansson (2004) argue that companies should not only focus on their own risks, but rather on the risks in

the whole supply chain. Once again, Manuj and Mentzer (2008) put emphasis on the importance to look after the entire supply chain.

In line with continuously managed risk across supply chain, Chen et al (2001) stated that the supply chain collaboration is important to mitigate supply chain risks. But to them, this approach has not been thoroughly investigated. Many authors gave a definition of collaboration in SCRM (see Tang 2006, Jüttner et al., 2003, Zsidsin et al. 2000, Chopra and Sodhni, 2004, Christopher and Peck 2004, Giunipero and Eltantawy 2004, Hallikas et al. 2004). One of them can be seen as *“two or more companies adopting a long-term perspective and working together to create unique value that neither partner can achieve alone”* (Lockström et al., 2010; Nyaga et al., 2010).

Christopher and Lee (2004) emphasize on the crucial need to mitigate supply chain risk through improved confidence. In fact, the longer the supply chain is, the less visibility on the buyer's side, resulting in a lack of confidence between the supplier and the buyer. One can argue that buffering can be seen as a way to hedge against risk. However, it could have a reverse effect in the sense that holding too much inventories can lead to financial risks (Christopher and Lee, 2004).

A more recent study conducted by Wiengarten et al. (2016) aims at analysing the risk management practices through the supply chain integration on cost and innovation performance. The supply chain integration is defined as *“the extent to which a company strategically interconnects and aligns its supply chain with partners, upstream and downstream”* (Jayaram et al., 2010; Schoenherr and Swink, 2012). It is generally accepted that integrated supply chain leads to improved performance (Schoenherr and Swink, 2012). Wiengarten et al. (2016) speak about *“superior performance”* when supply chain integration is implemented. As a matter of fact, supply chain integration can be viewed as the opposite of the arm's length effect. However, it cannot be all for the best. In fact, some researches have concluded that the supply chain integration can provide negative results (Stank et al., 2001; Cousins and Menguc, 2006; Flynn et al., 2010; Narasimhan et al., 2010). For instance, Devaraj et al. (2007) recognize that the supplier integration does contribute to performance, whereas the customer integration does not.

Not only academics suggested insightful strategy to manage the supply chain risks. As a matter of fact, companies have also developed interesting SCRM approaches that

conducted them to be key players in SCRM best practices. The well-known computer manufacturer IBM developed and patented a tool (TRA - Total Risk Analysis) able to collect tremendous data on many dimensions from most of their sourcing countries. Moreover, this tool is able to divide, filter and show high-risk country-product-component combinations in order to develop mitigation plans. Far beyond this risk management tool, is effectively the management process to use this tool and react properly (Dittmann, 2014).

Now that overwhelming insights and practices for supply chain risk have been discussed, I can assume their intention to reduce risk, uncertainties and vulnerability as a consequence of today's complex supply chains.

White (1995) stated that, despite the fact that several risk management systems exist, they all tend to a generic process: risk identification, risk estimation and risk evaluation. Going further, those three main phases can be split into three main categories: qualitative (identify, describe, analyse and understand risks), quantitative (establishing a model to identify their effects) and control (aiming at responding efficiently to identified risks) (Sime et al., 1997). In the same way, Norrman and Jansson (2004) suggest a three step framework consisting in; Identification/Analysis, Assessment and Management. Some other academics tend to go forward on managing risk adding phases of "Control" and "Monitoring" arguing that environments are continuously changing (see Tummala and Schoenherr, 2011).

3.3. Risk identification and measurement

The pattern that consists in following five steps (or three for the generic one) of global supply chain risk is standard for all companies that strive to mitigate the risk and therefore the uncertainty (Manuj and Mentzer, 2008). As a matter of fact, it is widely and undoubtedly acknowledged that the first step into SCRM is the risk identification.

The risk identification phase is the most critical phase and probably the most important one (Blome and Schoenherr, 2011). Indeed, if risk is not identified, how can it be assessed and managed? In the same vein, Power (2009) stated that risk awareness is essential for risk management.

3.3.1. Risk identification

While reviewing the in-depth literature for supply chain risk management, many attempts for risk identification can be found. Indeed, different approaches have been developed to help identify potential risks; supply chain mapping, checklist or check sheets, event tree analysis, fault tree analysis, failure mode and effect analysis (FMEA) and Ishikawa cause effect analysis (CEA) (Tummala and Schoenherr, 2011). Table 2 presents a wide range of methods suggested in the literature facilitating risk identification.

Table 2 - Risk identification methods suggested

Risk identification method used	Personel brainstorming
	Literature review and expert interview
	Analytic Hierarchy Process (AHP)
	Ishikawa Diagram
	Hazard and Operability
	Expert views (survey)

Source: Adapted from Prakash and Mittal, SD

Before entering more deeply into the numerous techniques, let us have a look at the different categorizations and classifications of risks suggested by academics.

Christopher and Peck (2004) and Christopher (2005) classify supply chain risk into five categories: process risk, control risk, demand risk, supply risk and environmental risk (cited by Christopher, Khan and Yurt). Similar categorisations were suggested by Manuj and Mentzer (2008a) with more specific criteria's. According to Jüttner et al. (2002), the important risk sources that have to be considered when you analyse supply chains can be classified into three categories; (1) External to the supply chain (e.g. social, environmental risk), (2) Internal to the supply chain (e.g. labor, equipment, IT systems), and (3) Network related (i.e. insufficient cooperation) (cited by Norrman and Jansson, 2004). As a typical example for External source of risk to the supply chain, many forms of attacks in the context of oil and gas supply chain can be perpetrated. Indeed, while transport of oil and gas, in pipelines or while it is being extracted from platforms or stored in facilities (Urciuoli et al., 2014). Tang (2006) is less precise in his classification

and classified supply chain issues into two major groups: supply and demand. Indeed, risk comes from the supply's side but also from the customer's side (Chen et al., 2013).

Dittman (2014) suggested to conduct brainstorming sessions with some experts to identify the potential risks that may hit supply chain. Moreover, he put emphasis on the free-flowing meeting and the fact that members should not be criticized or intimidated. As a typical risk firm's global supply chain may face, he listed a starter list of major risks: routine supply chain risk, natural disaster, quality problem, forecast errors, damage, political/civil unrest, culture clash, terrorism, strikes, third-party risk, law, piracy attacks, safety problem, etc. In line with this idea, Harlan et al. (2003) goes further by suggesting to perform those brainstorming sessions in collaboration with other supply chain partners. Another method suggested by Dittman (2014) is to engage teams in what he calls "war games" simulations so the firms are put in real disaster scenarios to apprehend and anticipate possible disruption in supply chains.

An important tool acknowledged by Norrman and Jansson (2004) in their Ericsson's case is the risk mapping. It consists in drawing the upstream channel representing the supplier and supplier-supplier. Harland et al. (2003) suggested the similar idea as a first thing to do for companies that strive to identify risk. The aim is to benefit from a clear view of the business flow and catching critical parts and risk source in the process.

Broaden the scope of petroleum supply chain in the literature, Fernandes et al. (2009) suggest a framework that helps identify and rank the potential risks. Figure 3 presents a new risk management hierarchical framework. Practically, the risk identification process uses the aforementioned framework in order to identify the risk elements that are: *risk agent* (i.e. drivers of organisational risks such as finance area or transport activity), *risk source* (i.e. causes of the risk, e.g. increased VAT), *risk object* (i.e. resources of an organization like the country tax structure) and finally the *risk events* representing the factual occurrence and resulting in a loss (e.g. reduced profit) (Fernandes et al. 2009).

Figure 3 - Risk management hierarchical framework



Source: Retrieved from Fernandes et al. 2009

The aforementioned combination of elements leads to *consequences*, followed by *risk mitigation* plans related to each of the risk agent and could reduce risk sources. Finally the *planning level* stage aims at providing a timeline for the mitigating strategies. *Payoffs* can therefore be expected and provide quantitative data.

3.3.2. Risk measurement

“You manage what you measure”. Following the process of Tummala et al. (2011), the second step is the risk measurement, which involves the determination of all consequences of potential supply chain risk and their magnitude of impact. Crockford (1986) defines consequences as “*the manner in which or the extent to which the threat manifests its effects upon the resources*”. Hence, the severity levels can be assessed. Moreover, according to Crockford (1986), there are four types of undesirable consequences: trivial, small, medium and large. Each of them has different characteristics such as: frequency, severity and predictability. Table 3 summarizes a framework developed by Crockford (1986) in line with losses that may occur. Manifestations may include a loss of (or a damage to) assets, a loss of income, an interruption of service levels, cost overruns, schedule delays, a poor process performance, liabilities incurred, damage repair costs or injuries (Tummala and Schoenherr, 2011). In the same regard, Norrman and Jansson (2004) established a matrix in order to measure the risk according to their severity and predictability.

Table 3 - Framework developed by Crockford (1986) in line with losses

Undesirable consequence	Implications
<i>Trivial losses</i>	Losses that are expected to occur in any organization and can be met by normal operating budgets
<i>Small losses</i>	May present small issues, unless their frequency become so high (otherwise, it becomes a “medium loss”)
<i>Medium losses</i>	Would not cause serious concerns if it happens at regular intervals, so that provision could be made annually
<i>Large losses</i>	Present a serious issue. If it happens, it could be catastrophic for the firm (this happens very rarely)

Source: Adapted from Tummala and Schoenherr, 2011, p.476

However, loss can be less tangible than the aforementioned. Indeed, given today’s context, the speed of information is steadily growing, and coupled with the power of media, growing importance of pressure groups, social activism and NGOs will not hesitate to criticise immoral actions (Harlan et al., 2002). As a matter of fact, media can easily damage companies’ reputation. Illustrations are tremendous; the Brant Spar oil platform suffers from Greenpeace and the media pressure which can lead to situation where Shell’s reputation is poor. Another example in the oil industry is Texaco. Indeed, the African-American community has pursued the company for discrimination and has accused the firm not being diversified. Again, the media played an important role in the reputational deterioration (Schwartz, 2000). As a last example, let us talk about the Union Oil Company of California (known as Unocal corporation) that has suffered from pressure coming from shareholders and customers about their pipeline project connecting Burma and Thailand, in collaboration with the French Oil Company. Transparency and respect of human rights in a country seen as one of the worst on the planet were at the heart of the scandal (Schwartz, 2000).

3.4. Risk assessment and evaluation

Harland et al. (2003) argue that assessing the risk is a critical step in a firm’s overall supply network. Typically, the assessment phase is performing by answering two generic questions (Mitchell, 1995):

- What is the probability of an event occurring?
- What are the consequences and potential losses?

In other words, the assessment phase aims at obtaining information about risk. Yates and Stones (1992) define the risk assessment phase as *“identifying potential losses, establishing their extents, understanding their potential likelihood, classifying their significance and evaluate the overall risk”*.

Looking at the definition, I realize how the evaluation of the risk is important. Following the rational of Tummala and Schoenherr (2011), risk ranking and risk acceptance are particularly sub-steps of the evaluation phase. Let us take an in-depth look at the risks prioritization and the relevant tools used to assess the risks.

3.4.1. Risk assessment paradigms

In the literature, many authors attempt to develop propositions on supply chain risk assessment. Among them, Steel and Court (1996) approach the risk assessment by a three steps assessment; the company should first determine the probability of a risk event occurring (according to high, medium or low), and then establish the duration of the problem and finally investigate the business impact of the risk event. Going further, several authors strive to calculate the risk for quantitative purpose (Wu et al., 2006; Harland et al., 2003; Manuj & Mentzer, 2008; Tummala & Schoenherr, 2011; Steele & Court 1996, cited by Zsidisin et al., 2004; Adams, 1995). Thus, risk can be computed as; *probability of occurrence (X) business impact*. After that, a common method suggested by Norrman and Jansson (2004) consists in comparing events (by assessing their probabilities and consequences) and puts them in a risk map/matrix showed in figure 4.

Figure 4 - Risk map/matrix



Source: Retrieved from Norrman and Jansson (2004)

According to Tummala and Schoenherr (2011) rationale, two methods can be used: (1) objective information and (2) probability distribution. However, if the objective information is not available, the subjective one can replace it where beliefs and judgments can be used to approximate distributions. It is crucial to understand the probability distribution of risk (Manuj and Mentzer, 2008). However, in contrast to the normal distribution view, this “hypothesis” can usually be rejected. Indeed, extreme events happen much more frequently, which leads to a switching view to a more “leptokurtic” distribution where fatter tails can be observed (Manuj and Mentzer, 2008).

The same authors suggest dividing the risk assessment tools into three broad categories: decision analysis, case study and perception based. Table 4 summarizes different approaches to assess the risk.

Table 4 - Approaches to assess the risk

Methodology	Authors	Summary
Decision analysis	Berger, Gerstenfeld and Zang (2004)	Decision tool was made to determine the choice between a single or multiple supplier(s). Moreover, they suggested the use of Critical Ratio that evaluates the cost of operating with multiple suppliers minus cost of a single supplier, the whole divided by the disaster loss.
	Treleven and Schweikhart (1988)	Furthermore, these authors suggested a conceptual risk/benefit assessment model for sourcing decision by decreasing the probability of risk component or decreasing the impact for each of the risk components.
Case study	Harland et al. (2003)	Tool developed for mapping the supply network (identifying and assessing risks, forming and implementing a collaborative SC network strategy).
	Hauser (2003)	Analyse, prioritize and measure the economic impact of risk on various business activities “where every company prepares an inventory of risks” (called risk portfolio). The risk portfolio is of use by providing a methodology “to prioritize cost and risk elements in order to achieve best-cost outcome”.
Perception based	Hallikas et al. (2002)	They divide the risk on supply chain in two dimensions; severity and probability (risk matrix), which can be useful for companies not having sufficient data to build a probabilistic model.
	Norrman and Lindroth (2004)	They developed a cube (3 axis – unit of analysis, business continuity management process, type of risk from operational to strategic)
	Bookstabler (1997)	He based his method on expert and knowledgeable managers interviews.

Source: Adapted from Manuj and Mentzer (2008): summary of assessment tools (non-exhaustive list)

Sometimes legal requirements can represent motivations for companies to develop formal risk assessment techniques (Zsidisin et al. 2004). As an example, through regulation, EU imposes the State Members to hold minimum levels of crude oil's stocks at least 90 days of average daily net imports oil or 61 days of average daily domestic consumption oil (Urciuoli et al., 2014).

As already stated in point 3.2. *Risk measurement*, intangible losses such as credibility, reputation, status, authority and trust are highly relevant. Therefore, it must be assessed as well (Harland et al. 2002).

In accordance with what has been described in the research frameworks (see Harland et al., 2003; Hallikas et al., 2002; Yates & Stone, 1992), all the methods consist in evaluating the likelihood of occurrences of a negative event and its potential impact(s).

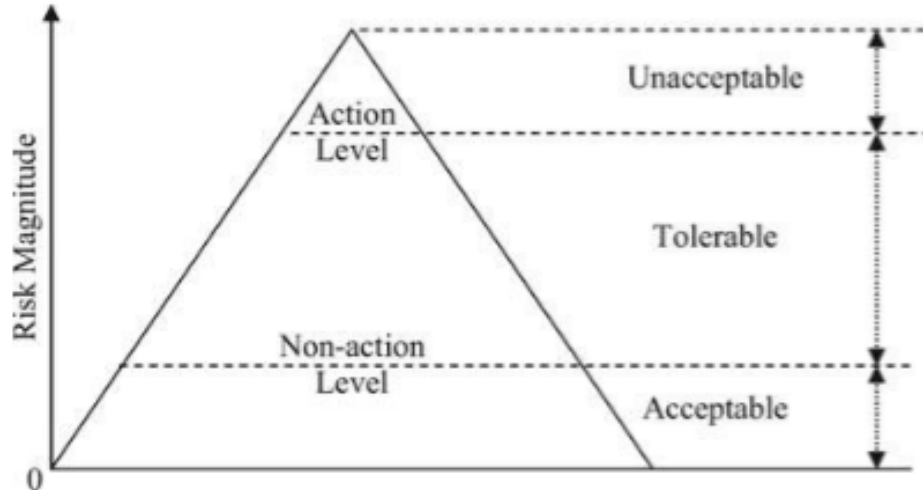
3.4.2. Risk evaluation

After having assessed the risk by determining potential likelihood of occurrences and consequences, we should evaluate the risk and, one step further, develop strategies to mitigate those risks.

- Risk ranking: As already stated in this paper, Tummala and Schoenherr (2011) divided the risk evaluation into two sub-steps putting risk ranking on the top. Every identified and assessed risk will be assigned to a numeric value. This numeric value called "Risk Exposure Index" is the result of a multiplication between the "Risk Consequence Index" and "Risk Probability Index". As a matter of simplicity, authors suggest to group indexes representing the same trend of risk exposure. The severity level (representing the Risk Consequence Index) is then categorized into four quantitative forms: Catastrophic (4), Critical (3), Marginal (2) and Negligible (1). Probabilities is classified into: Often (4), Infrequent (3), Rare (2) and Extremely rare (1). Therefore, several computations can be performed. As an example, a huge risk with an event occurring frequently will be graded 16 (as $4 \times 4 = 16$).
- Risk acceptance: This phase aims at plotting risk against tolerance of the company performing the assessment. As stated earlier, Manuj and Mentzer (2008) assert that the reaction to risk is also seen as an individual perception based on beliefs and social acceptance. Hence, every individual and companies

will have a different approach of risk perception and their acceptability levels (Norrman and Jansson, 2004; Tummala and Schoenherr, 2011). According to these authors, not all the risks can affect the end-to-end supply chain. Therefore, a prioritization phase must be done to conduct usage of resources to manage the risk properly (Harland et al. 2003). Indeed, engaging too many efforts on mitigating the risk is not recommended. Norrman and Jansson support this statement and assert that *“too high investment in safeguards is not good business practices”*. A model called ALARP (As Low As Reasonably Practicable) allows classifying risk as unacceptable, tolerable and acceptable (Engineering Council, 1994). The model takes the form of a triangular shape (see figure 5) and expresses that most of the risks will be acceptable while few others will be considered as unacceptable. Indeed, some risks has minor implications over the supply chain operations while others (seen as unacceptable) can be seen as big concerns for the company, leading to adverse effects and therefore shut down of the assembly line (Tummala and Schoenherr, 2011).

Figure 5 - Triangular shape of risk tolerance



Source: Retrieved from Tummala and Schoenherr, 2011

Sometimes, it is hard for companies to lower the likelihood of occurrences of some types of events, such as macroeconomics or political risks. As a typical example in the energy supply chain: wars, illicit and violent strikes, sea piracy, sabotage, vandalism or riots can happen at any moment and disrupt the supply chain (Luft and Korin, 2003). Crude oil prices mostly depend on the OPEC countries members (Rose, 2004), as they are responsible for more than 60% of the world’s traded petroleum product (U.S.EIA,

2016). Therefore, any form of political disruption in the OPEC's countries could badly affect prices on a global scale.

Finding correct mitigation strategies are one step further and it needs to be put in place in order to avoid or to reduce the probability of occurrences. The next chapter details this aspect.

3.5. Risk management and mitigation strategies

We have almost reached the end of the SCRM process journey. By having identified/measured and assessed/evaluated the different risks that may face an organization, mitigation plans can take place. "*Focus on reducing the consequences if an adverse event is realized*" is given as a definition for risk mitigation by Norrman and Jansson (2004). Paradoxically, a research conducted by Repenning and Sherman (2001) over several industries showed that many firms do not invest in improvement programmes to reduce risks, especially because "*nobody gets credits for fixing problems that never happened*" (cited by Tang, 2007).

Yet, numerous ways to mitigate the risks have been developed by practitioners. However, it is far from easy to make. In fact, Rice and Caniato (2003) and Zsidisin et al. (2000, 2003) stated that still a lot of companies acknowledge investing in resources for managing supply chain risks, but a lot of them are not familiar with how to manage them. According to Christopher (2006), having inaccurate data makes it difficult for the firms to perform cost/benefit or return on investment analysis. These are the main reasons why most companies do not take action.

There are two possible ways for mitigation strategies to take place: a proactive way and a reactive way. On the one hand, a proactive way should develop solutions to risk that may occur on beforehand: efficient IT systems allowing visibility, effective relationships by improving trust and confidence, using multiple sourcing, etc. are typical ways used by companies to avoid supply chain risks. On the other hand, trying to reactively respond to supply chain risks is generally seen as "*suffering from negative consequence of supply chain risk*" (Blome and Schoenherr, 2011). In either way, the purpose is to reduce negative consequences in case an inconvenient event occurs.

3.5.1. Mitigation strategies paradigms

We are sometimes afraid to recall it, but a well-known proactive manner suggested by many authors to mitigate the risk is the diversification of suppliers (Chen et al., 2013; Tang, 2006; Manuj and Mentzer, 2008). Particularly in oil and gas industry, strategies such as network re-engineering (i.e. supply base network design) and the creation of a global sourcing risk management culture are proposed by Christopher et al. (2011).

Findings from AMR Research's recent supply chain survey indicate that closer collaborations with trading partners, the passing of cost increase to customers, the use of dual/multi-sourcing strategies and redundant suppliers, and performance-based contracts with supplier and services partners, are the most successful methods most often used to mitigate risks (Tohamy, 2009).

Some other relevant approaches of managing disruption of supply chain can be found in the literature. As an anchor point, strategies need a flexible approach of contract agreement and may be even combined with make-and-buy strategies to split production across different factories (Finch, 2004; Sheffi, 2006; Zsidisin et al., 2000). Another approach suggests centralising outsourcing contract to improve delivery lead times and reliability of services. As already said in this paper, holding inventories to avoid uninterrupted replenishment is also a strategy. But obviously, several authors warn us that having stocks leads to an increase of costs (Sheffi, 2006; Tang, 2006; Tomlin, 2006; Torhaug, 2008). To ensure quick recovery in case of disruption, it is fundamental to set up access to transportation as multiple transportation mode, and consequently multiple routes and distribution channels (Tang, 2006; Tomlin, 2006).

3.5.2. Supply chain resiliency

Researchers confirm that some risks cannot always be avoided and suggest to focus on the enhancement of resilience instead of trying to avoid them (Christopher and Peck, 2004; Rice et al., 2003; Sheffi, 2001, 2005). After all, the goal of every supply chain management techniques is to make the supply chain more resilient (Tang, 2006). The resilient term refers to the *"ability to return to the initial state or to move to a more favourable one than before the disruption"* (Christopher & Lee, 2004). Therefore, supply chain resilience can be defined as *"the capability of companies to anticipate, identify, react and learn from incidents"* (Craighead et al., 2007; Rice et al., 2003; Sheffi, 2005).

Energy supply chains are critical assets for our societies (Urciuoli et al., 2014). As a matter of fact, disruptions in energy can cause tremendous impacts on societies. We know that households and industries consume energy. A lack of access to it could cause negative consequences on other economic sectors and decrease our quality of life (Halldorsson and Svanberg, 2013). It is asserted that risk management is an important tool to deal with security threats (Williams et al., 2008). To our knowledge, security threats are the most relevant concerns for the energy industry. As a matter of fact, many forms of attacks in the context of oil and gas supply chain can be perpetrated: while transport of oil and gas, in pipelines or while it is being extracted from platforms or stored in facilities. Illustrations are not scarce. For example, in 2002, the terrorists attacked the Limburg, a French oil tanker carrying 400,000 barrels of crude oil (Hurst, 2008). In 2004, the Sudanese rebels attacked an oil field, killing 15 people. Again, in Southeast Turkey, guerrillas belonging to PKK party have staged a bomb attack on an oil pipeline (cited by Achebe K. O., 2011). According to a study conducted by Urciuoli et al. (2011) in the energy sector, it is interesting to see that all the energy companies perceived as exogenous security threat: political conflicts/instability. Fernandes et al. (2009) stated that the countries where natural resources commonly originated from unstable political government are subject to more risks or terror attacks and wars (e.g. Qatar, Nigeria, Algeria and Egypt) (cited by Urciuoli et al., 2014). It seems that a poor political context is the catalyst for instability and terrorist attacks.

To conclude, authors acknowledge that the supply chain strategies are generally well implemented in order to mitigate the risks. However, due to critical resources such as oil and gas, government and organisation are necessarily forced to interfere in order to build a resilient supply chain (Urciuoli et al., 2014):

- “ *Critical infrastructure protection*. The EU has implemented several codes of conduct in order to enhance transport and port facilities through preventive measures (ISPS – International Ship and Port Facility Security; EPCIP – European Programme for Critical Infrastructure Protection; TNCEIP – Thematic Network on Critical Energy Infrastructure Protection).
- *Foreign politics*. The EU members strive to develop several partnerships to foster economic integration, democratic reform and energy security through many other countries located in Southern Mediterranean, Central Asia, African and Middle East

countries.

- *Dependence reduction. One of the main risks of European supply chain is to become dependant on their suppliers, which directly implies a loss of power, less advantageous contracts and putting at stake continuous replenishment (Lonsdale, 1999). Therefore, EU is trying to open communication channels with diverse countries to support the portfolio diversification of energy companies. In addition, EU is trying to focus more on alternative renewable source of energy such as wind, solar, hydro-electric (European Commission, 2012c). Furthermore, new negotiations with countries located in Central Asia (mainly Azerbaijan and Turkmenistan) are taking place to built new pipelines system.”*

Figure 6 - Resilient supply chain framework



Source: Adapted from Deloitte¹⁷

Christopher and Lee (2004) stated that uncertainty could be decreased by sharing information with visibility along the supply chain. In fact, visibility is seen as an antecedent of supply chain resiliency (Brandon-Jones et al., 2014). However, visibility and flexibility are not enough to strive for resiliency. As a matter of fact, supply chain resilience is a network-related concept; therefore, it must embrace all members of a supply chain to align forces in case of disruption (Sholten & Schilder, 2015). Hence, the concept of collaboration is important. To support this statement, Chen et al. (2001)

¹⁷ Retrieved from <http://www2.deloitte.com/ie/en/pages/deloitte-private/articles/improving-supply-chain-resilience.html> Consulted on March 9th, 2016

acknowledge that supply chain collaboration is important to mitigate supply chain risks but this approach has not been investigated thoroughly according to them. Daugherty et al. (2006) founded that “ *organizations engaged in collaborative relationships achieve improved visibility, higher service levels, increased flexibility, greater end-customer satisfaction and reduced cycle times* “. Going further, the need to gather control to the aforementioned features is predominant (Christopher and Lee, 2004). Otherwise, a lack of control numb the process and therefore market opportunities. If well implemented, organizations will benefit from confidence. Figure 6 draws comprehensive resilient supply chain framework that includes all features already discussed earlier.

To support these aforementioned strategies, the 9 “robust” supply chain strategies proposed by Tang (2006) (which are somehow a summary of all possible strategies already discussed) are seen as a good stream to provide resilience to a firm SC. However, we must pay attention and check that it incurs some challenges. As a matter of fact, costs are difficult to estimate in a competitive view. Although it is seen as an “insurance premium”, it is trivial to estimate returns. On the other hand, strategies to mitigate the risk are called to be in line with the business strategy. It is what the author calls “strategy fit” and prevents divergence from business strategy.

3.6. Risk contingency plans

Although it is asserted that nowadays supply chain becomes more responsive, flexible, agile and consistent, it is at the same time fragile and mostly still reactive to risks (Kleasius, 2014)¹⁸, especially in energy sectors. Indeed, it has already been explained earlier, the oil and gas industry is often targeted to an array of attacks or even natural disaster and made-man causes such as lack of maintenance. In the same sense, Achebe (2011) recognizes in his paper that “*Current approaches to managing risks and uncertainties in the oil and gas critical infrastructure supply chains are mostly reactive, employing re-routing of supply and rationing (...) The existing models to our knowledge only deal with stream flow rates and not the demand and supply aspects, and do not take into consideration the inherent risks and vulnerabilities from events, different routes, various sources and individual supply chain units”.*

¹⁸ Kleasius K. “Supplier contingency plans at nuclear power plant”, 2014, APICS presentation Dubai consulted on March 14th, 2016

3.6.1. Business continuity management

Practitioners argued that it is almost impossible to avoid every risk that may face an organization's supply chain. Therefore, the need to build plans to mitigate the supply chain risks is highly encouraged.

As anchor, a familiar term known as "Business Continuity Management" (hereafter BCM) is given by the literature. BCM refers to recovery plans in respond to critical external events. However, it goes beyond the simple fact of recovery by addressing a number of measures and action plans to ensure continuity of service supply provided by the company (Norrman and Jansson, 2004). Paradoxically, even if the majority of companies qualify BCM as very important (see Chartered Management Institute survey, 2013), studies have showed a lack of implemented BCM practices but also a lack of incentive to put in place such practices along the supply chain (Norrman and Jansson, 2004). The case of Glasgow airport terrorist attack in 2007 is meaningful and demonstrates that BCM is essential (BCI, 2010). By having identified disruption that may affect the service continuity, plans were put in place and tested with well-trained staffs. On top of that, a crisis team and a business recovery team were formed to operate on such incident. By these means, over 3,500 passengers were evacuated and terminals were reopened within a staggeringly short period of time.

3.6.2. Crisis management

Lately, the term "Crisis Management" has widely spread out because of numerous cases of corporation crisis. As a matter of fact, it is acknowledged that "*Crisis Management has become the subject of more papers in journals, trade magazines and documents...*" (BCI, 2012). Furthermore, it is important to know that Crisis Management does not overcome or replace BCM, but is rather seen as an integrated part or business continuity program or often as an associated discipline.

Numerous ways of defining the term "crisis" has already been developed. Actually, it generally depends on the context against which it is set. However, similarities can be found and terms such as instability and threats are common to these definitions. Nonetheless, Business Continuity Institute (hereafter BCI) (2012) suggests the following definition: "*A time of instability for an organisation in which the impacts of event(s) threaten its operations, survival, or reputation*". Therefore, Crisis Management can somehow be defined as a way to handle crisis.

Going further, BCI views Crisis Management as a three steps concept, involving (1) pre-crisis preparation, (2) crisis response and (3) post-crisis recovery. In the first step, the objective is twofold: the planning and creation of a structure to deliver a respond. But also arguing that planning is not a sufficient task, training and exercising is highly recommended to allow organizations to be capable to respond to crisis. The crisis response implies three actions to respect: recognize the crisis, activate the Crisis Management Team (CMT) and contain the incident by CTM (BCI, 2014). Having performed these steps, post-crisis recovery aims at dealing with negative consequences that harms organizations for a while following the event, and strives to return to “business as usual”.

In order to develop proactive measures and hedge against unforeseeable events, Supply Chain Risk Leadership Council (SCRLC, 2011) has established a crisis management process to recover from crisis event (figure 7).

Figure 7 - Crisis management process



Source: Adapted from SCRLC (2011), p 21

This process will allow organizations to build crisis-management structure and therefore provide integrated and coordinated planning and response activities through all levels of an organization.

4. Methodology and case-study selection

“Social sciences research follows a similar approach to that of oil researcher. It is not by drilling anywhere that we will find what we seek. On the contrary, a successful oil research program depends on the approach: study first, then drilling” (Quivy and Van Campenhoudt, 2011). In that sense, having broadened an array of articles to perform my literature over SCRM process, this section will encompass the methodology used and its sub-components in order to realize a relevant thesis. Case studies are core for the methodology followed in this paper. Koulikoff-Souviron and Harrison (2005) point out that the case method is particularly relevant for supply chain researches because it helps to “gather better information about the realities of supply chains and develop better, more complete theories about them.” Going further, a qualitative approach seemed to be the best convenient way in this context to corroborate theory and findings (Yin, 1994). Moreover, Yin (1984) puts an emphasis on case studies by asserting their relevancy when “how and why questions” are being posed. Hence, the research question (RQ) for this thesis, while particularly focusing on the Middle East, is the following:

RQ. How to deal with risk when sourcing crude oil from emerging markets?

Indeed, it would be appropriate to understand how oil companies and governments make decisions when sourcing crude oil and what are their mitigation strategies to hedge against possible risks.

In order to be pragmatic, I have decided to lead a multiple case study design, by interacting with various actors among the petroleum supply chain (see figure 8). Cited by Yin (2003), multiple case studies are seen as more compelling and therefore more robust (Herriott & Firestone, 1983).

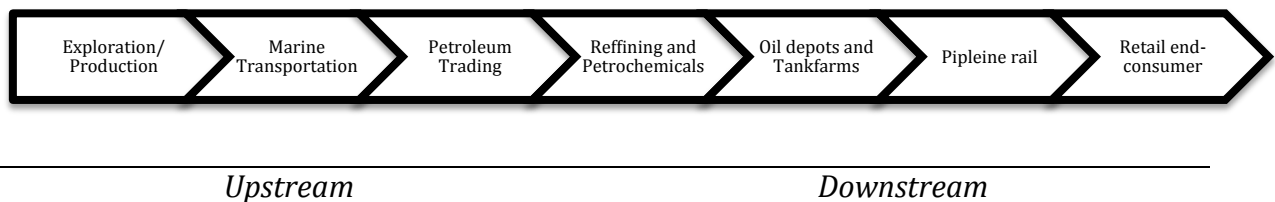
Oil has been chosen as it represents the most traded commodity¹⁹. Hence, it represents a critical asset for our societies (Urciuoli et al., 2014), and is one of the two major supplies - with gas - to/for Europe to produce energy (European Commission, 2010).

¹⁹ Retrieved from: <http://www.tradecommodities.co.uk/energy/crude-oil/> Consulted on March 17th, 2016

4.1. Sample establishment

The sample used in this thesis is composed of four cases, each representing one (or several) step of the generally accepted petroleum supply chain framework (figure 8 Fernandes, 2009). In that sense, a relevant sample can reflect better reality (Manuj and Mentzer, 2008). The four cases have each a direct or indirect relation with importation of crude oil coming from Middle East and are intermediate to household and industries consumption. Before entering in-depth into the next sections of the methodology, I found it interesting to understand critical elements of the oil's supply chain.

Figure 8 - Petroleum supply chain framework



Source: Adapted from: Fernandes (2009)

- Phase 1: Having identified potential areas, explored and start design and construct platforms, *“the first phase step in the oil supply chain is production. During production, crude oil is produced on both land and at sea. Oil production includes drilling, extraction, and recovery of oil from underground.”* (American Petroleum Institute, n.g.)
- Phase 2: After having drilled and extracting crude oil, shipment of substance can take place. Multiple forms of shipment can be possible (e.g. trucks, railcars, pipelines and marine vessels). However, according to the American Petroleum Institute (API), *“Ports of call represent the major entrance and exit points of crude oil prior to short term storage and, later, refining”*. Which means maritime vessels transportation is considered to be the most used form of shipment.
- Phase 3: Although one can argue that the next phase consists in short-term oil storage, pricing the crude oil globally is a crucial and critical step. It takes place on derivatives market taking the form of future contracts. Future contracts on crude oil are traded at the New York Mercantill Exchange (NYME),

Intercontinental Exchange (ICE), Dubai Mercantile Exchange (DME), Multi Commodity Exchange (MCX), India's National Commodity and Derivatives Exchange (NCDEX) and the Tokyo Commodity Exchange (TOCOM)²⁰.

- Phase 4: The following phase is the substance of crude oil transformation known as “refining”. The American Petroleum Institute defines it as *“Refineries act as the main transformation point for all crude oil into its various consumable products and are mainly located domestically. After receiving oil from storage facilities, refineries use various chemical separation and reaction processes to transform crude oil into usable products such as: fuel oil, diesel oil, jet fuel, and multiple essential manufacturing feedstock.”*
- Phase 5: After having transformed the crude oil into finished products, the latter can be stored into depots and tank farms before being transported to the final point of sale. In between, local pricing of refined oil is performed²¹.
- Phase 6: Once the refined fuel leaves the terminal, it is transported to its final point of sale, which includes fuel stations and airports. *“The trucking, shipping and delivery lines provide the final finished product which can be delivered across the country.”* (American Petroleum Institute, n.g.)
- Phase 7: The final stage consists of retail distribution and consumption of final customers; us. It is important to notice that the end price varies according to the product and the customer region²².

These abovementioned petroleum supply chain activities are performed sequentially (Fernandes, 2009). As such, each stage is critical hence any failure compromises the whole supply chain structure.

As stated earlier, I believed necessary to conduct my interviews reflecting the petroleum

²⁰ Retrieved from <http://www.investopedia.com/university/commodities/commodities6.asp> consulted on March 18th, 2016

²¹ Retrieved from <http://www.planete-energies.com/en/medias/infographics/oil-value-chain-well-pump> consulted on March, 18th, 2016

²² Retrieved from <http://www.planete-energies.com/en/medias/infographics/oil-value-chain-well-pump> consulted on March 18th, 2016

supply chain. As such, I followed the rationale choice behind Manuj and Mentzer (2008) suggestions, namely: credibility and transferability. Indeed, the actors must be credible and it must be possible to generalize the findings. Therefore, the interviews have the following characteristics:

- Case-study A: Marc F. – ExxonMobil Petroleum & Chemicals. As Sourcing Manager, Marc F. (he preferred to speak anonymously) works for the American company Exxon Mobil for 16 years. He performed several assessments through the world (e.g. Europe, Asia, US) and has experienced various areas (e.g. logistics, Transportation & Procurement: Maritime, Road Transport, Distribution network design and optimization). Like most of oil and gas companies, Exxon Mobil perform through several steps of the petroleum supply chain and has integrated all steps from exploration/production to retail end-consumer. Thanks to its experience, he provides me great insights over the upstream activities, focused more on the first phase, i.e. the exploration/production.
- Case-study B: Lionel Carpentier – Total Refining & Petrochemicals. Middle Officer at Total for 5 years, his work consists principally in buying petroleum products (including crude oil) available on the market and is responsible of the shipment via sea vessels. His functions consist in managing diverse area of the price risk management, i.e. hedging of daily trading positions, measurement of risk exposures (physical and paper derivatives), modelling pricing calendar & developing hedging tools (IT), price risk management projects and trainings and reporting of monthly trading P&L. He is responsible for the second and third step of the oil supply chain.
- Case-study C: Alain De Mot – APETRA. After a long career for Total Belgium, he became General Manager of APETRA in 2007. APETRA is the Belgian agency that handles strategic stocks of petroleum products in case of crisis for the Belgian market, in line with the European directive 2009/119/CE. The public company APETRA is a member of the International Energy Agency (IEA). The APETRA

support a public duty in case of oil crisis, and support IEA and European Commission initiatives. In that regard, I thought interesting to manage an interview with this company. Therefore, the company can be seen as a critical actor for the fifth step of the petroleum supply chain.

- Case-study D: Anne-Sophie Scarselli – Total Refining & Chemicals. Anne-Sophie Scarselli is working for 11 years within Total, and has 18 years of experience in the oil industry. She works for the Pilotage department of Total, within what they call the Refining & Base Chemicals (RBE) business unit, which depend on the Refining & Chemicals (RC) branch. She is responsible for the products supply (principally petrol and diesel) performed under contracts. In the downstream of Total, there are two principal branches: the Refining & Chemicals (RC) and the Marketing and Supply (MS).

4.2. Data collection

The principal data collection method is in-depth semi-structured interviews, which provided a flexible instrument to obtain information from the field (Yin, 2003). The rationale behind a semi-structured interview is to let the interviewee speak about his experience and guide me where he (or she) wants to put the emphasis on. As such, no additional notes were taken during the interview, as I wanted to not disturb the interviewee and focus on interaction between both parties. The interview guide (Appendix 5) had to be adapted to the respondents, as not all questions were relevant in terms of the company's position in the oil supply chain. For reliability concerns, the interview guide was not provided on beforehand to the selected interviewees (Yin, 2003). The respondents selected for the interviews include senior level managers or employees if access to upper levels was too restrictive to reach. Each interview lasted between 45 and 60 minutes and answers were recorded, except for one company (i.e. ExxonMobil) due to privacy matter. The latter expressed its uncomfortable behaviour and refused to be taped. Therefore, his name was not disclosed. Then, transcription and validation with interviewees took place and further analysed. In most cases, face-to-face interviews were conducted although one had to be conducted through phone call due to geographical availability of the interviewee. Group interviews can be seen as a *“risk that some people are developing a stronger social control and others are reluctant to express their views to a group”* (Albarelo, 2010). Interviews were led in French except for one in English, as it was more convenient for the respondents.

I must admit entering into the oil industry was quite challenging. However, keeping in mind the critical objective of being graduated and supporting by a certain determination enhanced positive answers from contacted persons. Thanks to this initiative, I could get other interviews with the support of contact previously interviewed. Therefore, the networking played an important role in the data collections. The interviews were performed within a period of two months, alarming internal validity (Yin, 2003). Having contacted 29 persons among more or less 10 companies by the month on February and March 2016, I could gather four strong participants working in the oil industry. Secondary data collections from organization's annual reports and websites were gathered in order to strengthen findings (known as triangulation). Indeed, using several types of data sources increase data consistency (Voss et al., 2002). To ensure the rigour

of the research by enhancing reliability, a chain of evidence has been maintained through the creation of a case-study database, containing personal notes, interview reports and documentation (Yin, 2003).

4.3. Data analysis

My first anchor consists in interviews report that will be used to create single-cases description and will further be analysed. Furthermore, collected information from internal and external documentation (data triangulation) will serve as a stream to develop findings and enhance internal validity (Yin, 2003). It is important to notice that this study implies some limitations, particularly in terms of external validity/generalizability (Yin, 2003) with regard to other countries, industries and smaller companies (Christopher et al., 2011). Therefore, further research is needed to improve the generalizability of the findings. It is elementary to recall that the propositions/hypothesis have as a purpose to provide insights on the research questions rather than a final answer. The single-case analysis will be divided into four 4 parts as follows:

- Overall presentation
- Supplier selection
- SCRM practices
- Observations

Having performed single-case analysis, a cross-case analysis will be conducted to detect similarities and differences across the studied cases (Yin, 2009), enhancing construct internal validity. Through the latter, propositions will be made and aim at giving further development in future research.

5. Research findings

5.1. Case-study A: Marc F. - ExxonMobil Petroleum & Chemicals

5.1.1. Overall presentation

Marc F. is a Sourcing Manager at ExxonMobil. ExxonMobil is an international American company (historically named Standard Oil Company) involved in the upstream and downstream of the oil supply chain. Within the Benelux, they possess two refineries, one located in Antwerp and another located in the Botlek area of Rotterdam. Still for the Benelux market, the company possess 50% of shares, as their competitors Shell, in the Nederlandse Aardolie Maatschappij (NAM: Dutch Petroleum Company). ExxonMobil produces different oil fluid products such as butane and propane (LPG), naphtha or petrol, kerosene, gas oil, heating oil, diesel and heavier oil fractions such as fuel oil for sea vessels and bitumen (asphalt). Around 1,400 people work for the Belgian plants, 1,300 for the Netherlands part and 75,300 worldwide. ExxonMobil operates via their brands ExxonMobil, Esso, Mobil, and Mobil1.

Into the Middle East lands, ExxonMobil has engaged into joint ventures and has developed its refining and petrochemicals activities with Saudi Arabia (Aramco and Sabic), Qatar (RasGas and QatarGas), Kuwait (Kuwait Oil Company), UAE, Iraq and Egypt.

5.1.2. Supplier selection

No matter the country of origin, ExxonMobil puts emphasis on high criteria when selecting its suppliers. Considering the significant relevancy of crude oil for our society, oil companies cannot afford to deal with non-reliable supplier. According to the interviewee, three principal criterions are relevant before signing a contract with the future suppliers, which are respectively: security, availability and price. The security is of primary importance for ExxonMobil, and can be generalizable to the oil industry. Marc F. asserts:

“To ensure a certain level of service, we have strong demanding security criteria...”

Indeed, the process of supplier selection is a long journey and the interviewee highlights the formal and methodological way. After having established a list of potential suppliers, they ask a series of questions through a bill of specifications. After having gathered a first set of information through self-assessment, they perform to their own due

diligence. A particularity of the company is that they rely most on their internal system than on their external system such as the ISO norms or external audit. Then, a precise selection among the potential list of suppliers is performed and the supplier audit process can be executed. In order to ensure the reliability of the suppliers, they apply a series of rules. The company sends a committed team on a regular basis to the supplier's plants, while for example they will examine their security systems. The evaluations are done very often and are followed by contingency plans. According to the interviewee:

“It is only when we are sure then we can start working with suppliers. The processes are globally the same. There can be some local variations, but in general it is the same. It is similar across the world, whether it is in Asia or Europe, it is standardized.”

According to his experience, Marc F. asserts that those measures are enough in order to work with high quality standards and keep its strong market position in the Middle East as well as abroad.

When it comes to the emerging markets, Marc F. recognized no differences regarding the above-mentioned criteria. He recalled that the ExxonMobil activities are to explore, produce and transform the crude oil, which is available in the developing countries but especially in the under developing countries. Since the company drills onshore and offshore, the plants are located across the world (North America, South America, Europe, Middle East/North Africa, Sub-Saharan Africa and Asian Pacific), they import crude oil from where they produce it.

5.1.3. SCRM practices

As one can argue, the oil and gas industry is involved in a global supply chain that includes domestic and international transportation, ordering and inventory visibility and control, materials handling, import/export facilitation and information technology (Chima, 2007). Hence, particularly in this industry, it offers a classical model for implementing supply chain risk management techniques. In the oil supply chain, as the supply chains of every industry, a company is linked to its upstream suppliers and downstream distributors.

Risk identification

First of all, before drilling into the lands onshore or offshore, oil companies must be certain to find potential sources of crude oil to extract to ensure the viability of their activity. As such, ExxonMobil works in close relationship with geologists to explore the

seabed and study the earth's crust with the highest technology. However, the interviewee underlines the importance of profitability. Indeed, sometimes the costs incurred to settle a production can exceed or be equal to the profits generated by selling the extracted crude oil. Therefore, he suggests to not going further into the researches, as it will incur financial losses for the company. The interviewee added *"to be profitable, it has been estimated that the barrel must worth (on the market) \$60"*. Moreover, he highlighted one important piece of information: *"before, the extracted crude oil was cheap (as it was on the surface), but now we must drill deeper and deeper into the land which is more costly"*. Besides, depletion of actual oilfields are forcing ExxonMobil to explore oil reserves into new frontier offshore, usually deeper, making these operations riskier as they are performed into more challenging environments.

According to his experience, Marc F. asserts two sensitivities to risk when it comes to emerging markets. He called the first one: "the industrial risk" related to the transport of crude oil. While oil is being transported, whether by tankers or pipelines, the companies are automatically exposed to exogenous threats. By these threats, he meant pollution or oil spills that may hurdle badly the company's reputation. We have seen it through the theory; several forms of concerns easily affect the reputation of oil companies when it comes to the environment protection. Moreover, he asserts, *"even with the most advanced technologies of today, it is still an important risk"*. The second risk related to the emerging market is the corruption. Indeed, ExxonMobil has to take corruption into account, particularly in the emerging countries. However, Marc F. stated *"to face against such risk, we have several means in place in terms of education, control, and trainings"* adding further *"these two problems are the ones that have a huge impact on the reputation of the company"*.

Again, procedures when sourcing from the emerging market are the same when dealing with developed countries. As an example, he does not distinct standards when the company source its product from Saudi Arabia compared to the North Sea. However, the frequency of control can vary from a country to another depending on disruption observations. He insists again *"it is not based on the emerging market criteria, these (the procedures) are objective criteria"*. For example, if they observe variance in loading in a certain harbour, they will apply more severe controls and verifications. Otherwise, he stated, *"controls are the same for all countries"*.

To other extent, a specific risk ExxonMobil is threatened by, particularly in the emerging countries with weak rule of law, is the political risk. Political instabilities can cause major supply disruptions. For example, the Straits of Hormuz is a strategic area for the Europe's oil import. Hence, the Iranian threats of closing the Straits of Hormuz in response to the EU sanctions against its oil export can cause tremendous impacts for the European countries energy consumptions. However, he feels that it is the European Union's role to deal with foreign politics affairs and asserts that the situation is trial for oil companies to reduce these macro-economic risks. Despite this latter fact, they have to keep an eye on, even if their influence power is weak in this context.

Risk assessment

Risk assessment is of course an important topic in the ExxonMobil SCRM process. A common way to assess the risks is the use of risk map matrix. Indeed, ExxonMobil uses an internal matrix tool called Organization Import Matrix System (OIMS) to evaluate the risk. During this process, they create scores for every supplier. Then, a specialized team performed the weighted scoring system, containing probabilities and including quantitative and qualitative elements. At the end of this stage, they evaluate the probability of occurrence and its business impact thanks to a 3x3 matrix. Hence, specific measures can be taken according to the severity of the assessment. To his knowledge, the interviewee did not recognize any bad experience with a supplier that has led to stop a contract.

Risk management and mitigations plans

In general, oil supply chains have put in place extensive sets of strategies to handle disruptions. ExxonMobil, and oil companies in general, are looking for the most integrated form of process. Hence, vertical integration in a cohesive manner is a basic strategy for oil companies to lead to a more efficient system and at the same time will reduce costs. Marc F. stated:

“...From the exploration of crude oil through the production, we are handling all by ourselves. It is also true for the transport to the refinery. Rather than to have several manufactures through the world, we strive to have as least as possible. Then we can produce several products such as lubricants, semi-finished products, more refined oil products, also chemistry.”

Recently, developments such as the raised of demand for better customer service, the globalization of oil companies and the increased competition highlight the need to manage oil supply chain companies in an integrated form. However, the interviewee puts emphasis on the time consuming for building such integrated process, and asserts it is an on-going process that took several years. Moreover, he highlighted the raised exposure to financial risks, since the company's income statement is consolidated. As such, the company bears more of the burden during slow sales period for example. Nevertheless, there are many benefits to vertical integration. For example, he stated that these benefits include better control over product management, greater organization along the value chain and access to new technologies. Moreover, he pointed out, by the integration form *"it allows to ExxonMobil a maximization of energy consumption"*. By balancing the benefits and costs, the firm can chose its ideal level of vertical integration.

Another strong form of risk management and mitigation techniques for ExxonMobil finds its reason in holding security stocks to meet the demand during strategic period, the so-called seasonal storages. Moreover, given the infinite shelf life of petroleum products, it allows for ExxonMobil to keep stocks for long period of time, without being worried about the preservation. Marc F. stated:

"There is a lot of buffer capacity. We have huge tanks where we stock crude oil to meet the demand. Like for example, during the winter, we know that we will need more gasoline, so the prediction are based on the consumption of gasoline for heating houses. There is certain inertia of stock during the months of March, April and Mei, stocks increased during this period."

In fact, the European Union has also played an important role into this decision. As a matter of fact, given the societal implication of energy, the European governments implies through some directives a certain level of strategic stocks in order to hedge against a possible critical context. Hence, supply chain resiliency particularly in the oil and gas supply chain is being recognized by countries as very important.

Given the scarcity of the resource, ExxonMobil is investing into new oilfield projects across the globe. As a matter of fact, Marc F. stated, *"according to recent researches, we have enough resources to sustain the production for at least 50 years"*. Hence, ExxonMobil tries to develop its skills into alternative energies such as renewable energies like wind, solar or hydroelectric. According to his words *"a bit of everything that the market has to offers"*. However, he points out one major concern for the renewable energy supply:

“It is increasing rapidly, but their level is so low that it is marginal. So it means that in percentage (the demand) it is huge, but the quantity (the offer) is very low. Secondly, the supply doesn’t meet the demand. The demand of renewable energy is greater than the offer of the renewable energy. It is a fact that we continue to consume more and more oil energy, globally, in Europe it is quite stable, and renewable energy is increasing as I said. But in Africa or Asia for example it is not the case. The oil demands there are so high that the global demand is just high.”

Moreover, he acknowledges the fact that ExxonMobil is “struggling to meet the demand” for renewable energies at a world scale. However, for the European market he thinks, based on factual data, that they can provide the expected demand for renewable energies. Nevertheless, he argued, *“fossil fuel (coal, gas and oil) is irreplaceable”*. As a matter of fact, given the importance of fuel energies we can assume that wind or solar will never be as productive as petroleum products or gas. But the most important concerns of renewable energies are the storage capacity. Although for electricity, the lithium batteries are in constant improvement to generate more autonomy, the lack of possibilities to stock such energies make them difficult to consider as a promising alternative.

Marc F. also puts emphasis on the crucial need for oil companies to have portfolio diversification combined with flexible long and short term contracts. As a matter of fact, in case of any incidents in oil producing countries causing supply disruption, ExxonMobil has the possibility to deal with other suppliers from different countries to fulfil its petroleum products needs. As such, flexible contracts give the possibility for ExxonMobil to switch from a supplier to another in order to not interrupt the flow of crude oil supply. As the interviewee argued, the portfolio diversification of suppliers is categorized according to different criteria such as the geographical distance, the quality of the product (crude oil, gas, LNG), the transport capacity and the price. Moreover, the interviewee highlighted the significant possibility to re-route and product-switch, enhancing flexibility. As such, a particular route that would be unusable due to a certain security threat (e.g. attacks, piracy or wars) can be replaced by an alternative way of transport such as pipelines or tankers (sea vessels). The same methodology is true concerning the product-switch, which involved a change in the design of the product being supplied. As a matter of fact, the company could make a choice between different qualities of gas or crude oil coming from different sourcing countries. Marc F. also

underlines the fact that at the end of the day *“traders decide from where the product will be bought”*.

The communication and information share is vital for ExxonMobil when it comes to threats in the country of origin. As such, the company confirms the importance of good relationships with suppliers to manage disruption effectively, enhancing strategies that are put in place. Marc F. pointed out that information flows quickly and is immediately known by traders.

5.1.4. Observations

After having analysed the ExxonMobil process and paths, one can argue that it is much in line with what it has been seen through the literature. Indeed, all the steps of SCRM have been decided wisely, given the critical need of energy for our society. As such, they engage a lot of resource into safety when dealing with suppliers, and at every step among the supply chain, by strong procedures and regular check up, no matter the country of origin, emerging markets or not. However, despite their strategic mitigation plans strengthening by the vertical integration strategy, ExxonMobil, like many other oil companies, depend mostly (if not fully) on producing countries. As a matter of fact, given their lack of power over oil reserves on the national oil company's hands, they are forced to be exposed to some risks out of their control. As an example, the Saudi Arabia national oil company Aramco controls over 100% of crude oil exploration and production. To support this statement, the interviewee even asserts *“we (oil companies) produce around 15-20% of world's traded crude oil”* adding further *“we are nothing compared to national oil companies, the market is in their hands”*. Also, we can notice that European Union has a major role to play in the energy business, especially in foreign politics, dependence reduction and crisis management.

5.2. Case-study B: Lionel Carpentier - Total Refining & Petrochemicals

5.2.1. Overall presentation

As noted in the methodology section above, Lionel Carpentier is Middle Officer for the Trading Desk at Total Refining & Petrochemicals. His functions consist in managing diverse area of the price risk management, i.e. hedging of daily trading positions, measurement of risk exposures (physical and paper derivatives), modelling pricing calendar & developing hedging tools (IT), price risk management projects and trainings and reporting of monthly trading P&L.

In 1999, the historical Belgian petroleum company Petrofina, created in 1920, merged with the French group Total²³. Since then, Total Belgium continues to manifest its attachment to Belgium, therefore historical country of the group since a century. Total is considered as the strongest oil company in Belgium and a major player for the Belgian economy. With around 4,500 partners working across the country, Total possesses many sites active in the refining, petrochemicals, renewable energies and natural gases. Their refinery baptized "OPTARA" located in the Antwerp port is the 3rd at the European scale, with a producing capacity of 340,000 barrels per day²⁴. They have invested roughly 1 billion € in the OPTARA facility, showing an important interest in their refining activity for the Belgian market. Total benefits from a strong worldwide market position, being present in 130 countries and ranks as the 4th integrated Petroleum Company. In 2014, the group reached a turnover amounting 177,7 billions €.

For the Middle East, Total benefits from strong relationships especially with Qatar, where the company shares more than 80 years of collaboration. Saudi Arabia's Kingdom is also a key player where the company buys principally crude oil through the Aramco and exports to the European market. In the UAE, Total has signed a 40 years agreement for exploring and producing oil into Abu Dhabi oilfields. Moreover, the company has several agreements with Yemen, Kuwait, Iraq, Jordan, Lebanon and Oman.

²³ Retrieved from http://europa.eu/rapid/press-release_IP-99-197_fr.htm, consulted on April 28th, 2016

²⁴ Retrieved from <http://be.total.com/fr-be/pour-une-meilleure-energie/raffinage-chimie>, consulted on April 28th, 2016

5.2.2. Supplier selection

The first criterion of importance when selecting supplier is quality. As a matter of fact, Total will not gamble its reputation on the market by dealing with poor quality products. In addition, oil companies are facing more and more legal constraints related to petroleum product compositions. For instance, EU compliances concerning blend of products such as methanol and ethanol to produce variety of petroleum products (e.g. diesel, petrol, etc.) must come from a biological basis (animal and vegetal fat). The second most relevant observed criterion asserted by the interviewee is the availability of the products. Last but not least, the price is the next most relevant criterion of the top three. Indeed, Lionel Carpentier highlighted:

“We will mainly look after which supplier will provide us the product that we want, in the quantity that we want, for the price we want.”

Another criteria before going further with any potential supplier is its financial situation. As a matter of fact, the company is highly suspicious regarding suppliers having concerns. In fact, they proceed through a very methodological and formal way. No matter the country of origin of the new supplier desiring to enter into the business relationship with Total, they are passing by the legal and credit departments. On a legal point of view, the European norms are the main criteria taken into consideration where compliances, political risks, embargo allow or not Total to engage further commitments. Through the credit, the assets and debts are example of criteria's further analysed with its potential suppliers.

Last but not least, when it comes to the emerging market, the security is paramount. As a matter of fact, the interviewee makes sure that all the ISO certifications are respected before dealing with a new supplier. He explains, *“If there is a terminal in Saudi Arabia where we never went before, we will never go there it is sure!”*

In the end, Lionel Carpentier stated, *“all of our suppliers are reliable”*. To his knowledge, he never has experienced bad situations with suppliers. It would be tempting to attribute this latter fact due to the size of Total and its financial and human resources to support this phase.

5.2.3. SCRM practices

It is important to acknowledge some important characteristics in the oil industry. Indeed, there are two major players on the market. On the one hand, there are the industrial companies (incl. Total, ExxonMobil, BP, Shell, etc.) that possess real assets such as oilfields and refineries. Moreover, they possess long term agreements with State societies (e.g. Aramco, Nigerian National Oil Corporation, Qatar Petroleum), which allow them to have fields at their disposal. On the other hand, traders do not possess any assets by definition. However, due to the refining crisis in 2000, traders started to invest in refining plants, transforming them into storage area or smaller refineries, in order to diversify their activity. As a matter of fact, in the 60-70' many refining sites were forced to close due to high investments in this process during these years. Before diesel, the EU market was principally a petrol market, making these refineries obsolete for the following years until today. Therefore, traders could benefit from two types of arbitrage: temporal (e.g. speculation, law of supply and demand) and geographical (i.e. export certain quality of petroleum products abroad).

Risk identification

From his point of view, Lionel Carpentier has identified a certain number of risks related to his activity. The first one is the price risk. Indeed, he stated that oil prices on the market are principally driven by macro-economic tendencies (i.e. political context, new discoveries, OPEP's decisions, renewable energies, etc.), and it is especially true when it comes to Middle East, as this region controls almost the world's traded oil. As a matter of fact, a recent situation has led to decrease oil prices at a world scale due to a sudden decision of Saudi Arabia's oil production. The reason was the new discoveries of potential shale gases across the US lands and, Saudi Arabia feeling threatened by this exploration, decided to increase its own oil production, flooding the market. The interviewee acknowledges the Europe dependency on the Middle East oil supply, cited Saudi Arabia as the first one. However, he thinks that Russia has recently taken the first place in the Belgium oil import, highlighting the close relationship that has the ex-CEO of Total, Christophe de Margerie (deceased in an aircraft accident in 2014), with the Russian President Vladimir Poutine.

The second source of risk is related to security issues. The interviewee recalled the major incident that injured the company in December 12th 1999 caused by the oil

tanker Erika sinking along the Brittany coasts. The giant oil tanker was chartered by Total, and its broke up soiled more than 400 km of coasts, endangered 150,000 birds. Therefore, Total faced a trial and was accused of "pollution and accessory to endangering lives"²⁵. Since then, they learned a lot from their mistakes and decided to strengthen their security criteria's when it comes to marine transportation. They proceed to a rigorous vessel verification policy, the "vetting", one of the strictest in terms of charter. The interviewee asserts, *"Everyone on the market knows that we have the most rigorous norms in terms of chartering"*. He pointed out later *"we even asked about the captain's age!"*

Last but not least, Lionel Carpentier cited the "credit risk" when dealing with suppliers as the next most important risk he feels threatened by. However, this risk is well managed and it will be explained in the risk mitigation section.

Risk assessment

The interviewee could not assert any formal risk assessment tool as described in the literature review. However, he is conscious about the supplier evaluation trough self-assessment and specialized external audit firms. They preform self-assessment on a daily basis. The interviewee was able to give some details about the risk assessment. As such, market data is the main tool used by traders to assess the risk that could lead to potential threats and hurdle the supply chain process. For instance, the interviewee explains:

"For the transport, there are people who assess the boats and ask several security criteria to fulfil. Then, they create database we can consult to be sure that this boat is secured enough to charter"

In the same vein, traders use other market data in order to assess products quality. They possess exhaustive database with every type of crude oil we may find in the world. Moreover, these types of crude oil are strengthened by certificate of quality emanating from a quality check firm – SGS (Société Générale de Surveillance) - the world's leading inspection, verification and testing company.

Regarding the price risk, Lionel Carpentier stated that the he uses a price calendar to determine how much quantity of product he should buy or sell and how many financial

²⁵ Retrieved from http://www.lexpress.fr/actualite/societe/environnement/le-nauffrage-de-l-erika_1618544.html, consulted on April 29th, 2016

products (i.e. derivatives contracts) he has to buy or sell to cover the risk. As such, Lionel Carpentier asserts that he uses Platt's information as a benchmark for the price assessment. The most widely benchmark used for crude oil prices are: the Brent and Dubai. The Brent refers to the physical crude oil prices coming from the North Sea and makes its way to the refineries, where the crude oil will be transformed into several petroleum products such as gasoline, jet fuel, diesel, and many more. From a comparative point of view, the Platt's Dubai is the fundamental marketplace where crude oil pricing is referenced with regard to crude oil delivered to Asian refineries coming from Middle East.

Risk management and mitigation plans

The risk management techniques can be divided into two distinct pillars: the strategic one and the operational one.

Strategic

Firstly, the main and probably the most important strategic risk management used in the context of price, is to cover traders who buy crude oil against price fluctuation thanks to the derivatives market. As it was explained in the literature, crude oil prices are highly dependent on the producing countries decisions. Derivatives are contracts between a buyer and a seller based upon underlying assets such as commodities, stocks, interest rates, bonds or currencies. These are traded Over-The-Counter (OTC), which is an informal market in the opposite to standardised and formal network such as the New York Stock Exchange (NYSE). The OTC is the most frequently used type of exchange on the derivatives market and is usually riskier for the counterparty than standardised derivatives. We can find plenty of strategies using these kinds of derivatives. For instance, a 'future contract' is a contractual agreement between the parties agreed to a pre-determined price in the future, therefore locking the price at a specific date, and covering the buyers against future price raise. Conversely, if the market price declines below the settlement price, the buyer is in a less advantageous position. After all, the trader's aim is to speculate. To support this strategy, traders like Lionel Carpentier use a well-known platform called Platt's. Platt's is a company leader in information sharing related to the energy sector and especially in the oil prices evaluation. Hence, Platt's provides every day reliable, neutral and independent information on oil prices. As such,

Lionel Carpentier asserts, *“every day, at 5:30pm, Platt’s provide the price quotation, and we buy (petroleum products) based on averages”*.

Secondly, to cover against payment default, the interviewee uses letters of credit, which involves a bank in between to act as a guarantor in case of payment failure. In brief, payments are performed 5 days after the loading date, or 10 days after the unloading. However, he even acknowledges that sometimes payment before loading is demanded. Pre-payments are also another form to cover against such a risk.

Operational

To a lesser extent, traders tend to keep security stocks in order to sell them in favourable circumstances, but the particularity is to try to keep stocks as low as possible. Lionel Carpentier pointed out: *“stocks cost money!”* Indeed, if the stock was bought at \$100 per barrel at time t and at time $t+1$ the barrel costs \$40, the financial loss is equal to \$60. Actually, it was the case in 2008 and since then, the price risk management has become ‘fashionable’ according to the interviewee’s words. Moreover, traders are assessed and evaluated on what he called “the operational yield” which is in a way the ‘productivity’ of traders.

The interviewee highlighted the importance to build long-term relationships with the key partners. As such, they try to do not apply a formal system of penalty. As a matter of fact, he stated, *“...Tomorrow, we will probably need the person with whom we argued yesterday”*. However, penalties are intended when quality products, payment defaults or delays are observed too frequently. For example, when the quality does not match the compliance or the EU regulations, the supplier is reported “bridge of contract”. Otherwise, in most cases, they engage a conversation and try to fix the problem. But in general, the aforementioned risks are well managed and mitigated thanks to the actions taken in the previous sections.

5.2.4. Observations

After having analysed Total’s case study, the following findings can be drawn: they engage a lot of resources in their supplier selection process as they strive to protect their reputation, no matter the country of origin. However, when it comes to security, the emerging markets seem to be riskier and therefore management techniques are strengthened. The same methodology is true when it comes to the quality of the

petroleum products, as the EU regulations are very strict. In the context of this work, it appears that the main mitigation techniques against the price fluctuations are the derivatives markets.

5.3. Case-study C: Alain De Mot - APETRA

5.3.1. Overall presentation

As explained in the methodology chapter, the APETRA (Agence Pétrolière – Petroleum Agentschap) is a public company counting no more than 6 workers. The agency was created in 2006 and its public duty is to handle the strategic stocks of petroleum products for the Belgian market according to the European directive 98/93/CE. As a matter of fact, The International Energy Agency (IEA) and the European Commission imposed to member states to hold a minimum of 90 days of crude oil and petroleum products. These predictions are calculated through a complex formula and are based on the oil consumption from the previous year. However, although the legislation imposed to the EU member states to hold strategic stocks, it does not impose the manner on how these stocks are managed. The legislation suggests three types of organisation; (1) decentralize, i.e. the management of these strategic stocks are in the oil companies hands (2) centralize, i.e. the creation of a corporate and legal entity and (3) mixt, the use of both. As such, every other EU member state has the APETRA counterparts: SAGESS (France), Stichting COVA (the Netherlands), Erdölbevorratungsverband (Germany), NORA (Ireland), CARBURA (Switzerland), CORES (Spain). It is important to note that these stocks are not controlled and do not belong to oil companies in Belgium. The General Manager Alain De Mot was the interviewed person for this case.

5.3.2. Supplier selection

One important precision to state is that the APETRA does not deal with emerging countries. As a matter of fact, its only responsibility implies to buy crude oil and petroleum products from industrial oil companies or trading companies in order to build safety stocks. Indeed, Alain De Mot acknowledges the need of two types of suppliers: (1) storage companies and (2) crude oil providers. The latter is either trading companies or the oil companies.

The interviewee puts emphasis on the supplier selection criteria on which he explains *“the criteria are relatively classical... the selection is rather administrative and financial than qualitative”*. As such, the main criteria retained when selecting potential suppliers are: market experiences (e.g. petroleum trading), financial sturdiness and proving that the company does not face any going concerns. The ones having passed the selection

phase are gathered into a “shortlist” which represents the suppliers of APETRA (see Appendix 6). Afterwards, the APETRA proceeds through call for bids. The suppliers can either consider or deny them. However, from his experience, the interviewee pointed out that without disclosing any names, only some of them are reactive to invitation to tenders.

In the same vein, the APETRA can sell its products in case of products replacement. Indeed, the Product Replacement Agreement (PRA) aims at replacing finished products that does not match with the composition criteria anymore (e.g. sulphur composition).

Unlike oil companies such as Total or ExxonMobil, which proceed to negotiations through arm’s length, the APETRA does not negotiate with its suppliers. They whether impose their conditions and select among the approved supplier the one who will offer the cheapest price.

Alain De Mot ended his interview by asserting that he has never experienced a bad situation with its suppliers since the creation of APETRA in 2006.

5.3.3. SCRM practices

Overall, the interviewee argues that the APETRA is not exposed to many risks, as the company is mandated for a public mission, therefore submitted to the legislation of the Belgian State. As a matter of fact, the public companies processes emanating from governments are very different from the private companies, insuring a certain ‘negotiation’ power when dealing with private companies.

Risk identification

The interviewee affirms that the risk is totally free when it comes to the quality and the quantity of petroleum products ordered. As a matter of fact, the supplier is responsible for the delivery and the APETRA’s purchase is based on the quantity received. Moreover, they proceed to a sampling system, named ProQuality, that will be further analysed by professionals in laboratories and validate if the specifications are respected before engaging any payment from the entity. Nevertheless, he pointed out two main risks, although small: the price risk and the exchange rate risk.

Regarding the price risk, the interviewee asserts:

“There is always a risk between the moment you launch the invitation to tenders and the moment you attribute it (the invitation to tenders). Also, the moment between the delivery and the billing, because the time goes and prices are changing every single day”

For the pricing method, the APETRA used a formula based on the Platt’s quotations. In addition to this formula, there is an unknown variable (called ‘X’) representing an amount of dollar per ton. Although marginal, the smaller ‘X’ is chosen among the suppliers. It is important to recall that the Platt’s price quotations are not known on beforehand. Therefore, at the end of the month, the APETRA performs through an average price between the order and the delivery of the shipment.

The other risk that has been identified by Alain De Mot is the exchange rate between the USD and the EUR. As a matter of fact, the APETRA buys in EUR but the entire market takes place in USD.

Risk assessment

Given the almost risk-free environment on which APETRA operates, information on the risk assessment phase was very scarce, and probably impossible to have since the company tries to push as much as possible the risk management to its suppliers.

Risk management and mitigation plans

As it was seen through the previous sections, the risks that may face the APETRA are very few. However, they try to cover the price risk as much as possible.

In fact, the derivatives market is forbidden for the APETRA’s operations. Therefore, the APETRA is not allowed to use future or forward contracts, as the authority prohibited the speculation for its scope. However, Alain De Mot argues:

“When it comes to speculation or avoiding speculation, it’s another form of speculation. It means that not speculating is a form of speculation, but we can discuss it for hours”.

This leads APETRA’s operations to buy only when they need it. They do not wait for any purposes. However, the APETRA has recently had the possibility to use a system called “ticket” which allows the company to buy a certain quantity of petroleum products from oil companies. In fact, it is a contract paper agreement between two parties, covering a relative short time period where the APETRA has the right to reserve oil products in order to buy them in a foreseeable future.

Usually, for supply contracts, the delivery takes place one or two months later. During that period, oil prices have changed due to macroeconomic factors. Therefore, to prevent the risk against a dramatic price increase when buying crude oil and oil products, they use an average on prices. Indeed, the interviewee argues, *“It is a way to ‘smoothing’ the price risk”*. He added later in the interview *“it is a natural risk management”*.

Through their terms and conditions, the APETRA applies severe sanctions and penalties against the supplier who does not respect his engagements. However, Alain De Mot highlighted: *“they do not need them”* arguing later in the interview that the suppliers performed very well.

To finance their activity, the APETRA needs external investments. As such, they have recourse to banking loans in an easy way. Moreover, since 2014 they have been allowed to call for the government’s help, and have received financing from the Belgian State.

Another mitigation plan developed by the APETRA concerns their crude oil reserves in order to transform them into refined products. As such, the agency has developed a settlement with refineries called Crude Against Product Agreement (CAPA) in case of crisis.

5.3.4. Observations

The energy sector has recently been strengthened, particularly in Europe, due to its high dependence to the oil and gas import. To be relevant, let us give the example of Belgium, which totally depends on its oil importation and therefore consumption. Given this fact, the authority has build resilient supply chain when it comes to the energy industry. After having analysed the case of APETRA, it seems that the agency tends to push as much as possible the risks management to the supplier’s responsibility. Therefore, the need to put efforts in SCRM is not relevant for the company. Also, as the APETRA is a small sized company, they do not have the possibility to handle activities such as transport and physical stocking in storage sites. However, they have helped the major oil companies in their management of strategic stocks. As Alain De Mot argues, *“we have taken a weight off oil companies’ shoulders”*. According to the interviewee, before the creation of the APETRA, the oil companies themselves performed the strategic stock management but unwillingly. Indeed, it was a constraint in their daily logistical operations to handle strategic stocks.

5.4. Case-study D: Anne-Sophie Scarselli - Total Refining & Chemicals

5.4.1. Overall presentation

As the company Total has already been developed in the overall, I will now mainly focus on the function of the interviewee and the supply chain on which the company operates.

Anne-Sophie Scarselli works for the Pilotage within Total. Her function principally consists in the selling of oil products (i.e. diesel and petrol) for the Belgian market. As such, her biggest client is the Marketing and Supply (MS) of Total, on which she sells the different types of fuel produced by the refinery under contract agreements. Additionally, MS is responsible for the distribution of those fuels across gas stations. To a lesser extent, the other clients of Anne-Sophie Scarselli are the major oil companies (i.e. Shell, BP, ExxonMobil, etc.). As a matter of fact, a part of the petroleum products produced by the Total refinery is sold to the competitors, just as Total sources from these competitors. This is one of the reasons why the process performed by the entity is so optimised.

Anne-Sophie Scarselli does not directly deal with the emerging countries, and especially in my case: the Middle East. However, she has performed some projects in relation with the Middle East in her career, and she has provided me with her general thought about risks exposition in such an environment. The case represents a critical link between the oil import for the Belgian market and the Western countries in general. Moreover, she asserts that Total Belgium supplies a major part of crude or refined products from the Middle East and especially from Saudi Arabia. Those are performed thanks to their refinery SATORP, based in Jubail, which is a joint venture with the national oil company Aramco.

5.4.2. Supplier selection

The main criterion to be verified is the quality of the product. It is obvious that Total cannot deal with poor quality products. As such, the price parameter is also important as the quality influences the price.

Other criteria's are important such as the reliability of the supplier in terms of financial sturdiness or trade capacity. Total, as many other companies, is exposed to ethical constraints. As such, ethics is the next most relevant criterion when dealing with

suppliers. Indeed, Total does not want to be trapped with unethical suppliers and engage its reputation.

On the one hand, to verify the ethical criterion, the company proceeds methodically. Before engaging with suppliers, the level of due diligence is highly performed. As a matter of fact, a well-established questionnaire is sent on beforehand to the supplier, where the respondent must justify several criteria's. On the other hand, for quality matters, crudes are always certified by a quality certificate referring to a "typical". These "typical" are the principal characteristics of crudes available on the market. Therefore, it enhances the reliability of the crudes being purchased.

The interviewee stated that in the overall, suppliers are well known within the industry and therefore, they are almost risk free. She further asserts that after having engaged commitments with suppliers, they must report a feedback called "fair arex", which has as purpose to detail the experience with the lambda supplier. This process allows the future buyers or any other person within Total to benefit from previous experience.

At the end, Anne-Sophie Scarselli declared that the relations with suppliers were *"well built for a long time"*. She highlighted the fact that *"the petroleum world is small, so there is obviously people who turned from a company to another, therefore people know each other"*.

5.4.3. SCRM practices

Anne-Sophie Scarselli qualifies the risk management practices as well implemented within the refining processes at Total. In fact, she asserts that potential risky areas are clearly identified, and practices are put in place in order to reduce the probability of failure.

Risk identification

The major risk that Anne-Sophie Scarselli feels threatened by is the failure of the refining tools. Indeed, in case of any issue in the refining process, whether it is technical or blocked by any social activism, a lack of oil products is immediately noticeable.

According to the interviewee, this critical risk has two origins: on the one hand, it can come from a technical reason (e.g. breakdown, steam, water or gas network issues). On the other hand, strikes or any other form of social activism is a potential source of refining process failure. As a matter of fact, a strike makes, for example, oil depots

unattainable and therefore compromises the oil products distribution to the gas stations. In fact, a recent event highlighted by the interviewee particularly well illustrates this situation. During the month of May 2016, in France, the trade union CGT has blocked six over the eight refineries of the country to protest against the new labour right project. This situation has led to critical oil supply during three days, forcing the population living near the Belgian borders to source directly from gas station in the region of Tournai and Peruwelz. According to the Belgian newspaper Le Soir²⁶, several gas stations in those regions were short of oil due to the high frequentation of their French neighbours. The access to the stocks handled by the refineries being impossible, the government guaranteed the free access to the strategic stocks in order to serve the gas station properly.

Risk assessment

According to the interviewee, the risk assessment is a central part for the refining process at Total. In fact, they proceed methodologically by analysing throughout the process the units and by looking for the potential weak points. By doing this, they build scenarios based on the probability of occurrences of a unit failure. Depending on the level of impact, they take measures in order to support the continuous flow of production by alternatives.

Besides the aforementioned techniques, a special cross-functional team is dedicated to monitor the units composing the refinery and their reliability. Those persons are actively engaged into working groups within the company but also in associations with competitors such as Shell or BP. The purpose is to share the best practice and strive for better risk management. One of these research centres is based in Feluy (Belgium) and the other one is based into the lands of Normandy (France).

Finally, Anne-Sophie Scarselli highlighted the importance to respect the targets on the units in terms of reliability. To do so, they follow-up the KPI's every month, the overall performance, and they compare them to the targets that must be reached. She ended by asserting that it is clearly one of the priorities for the company: the security and reliability, adding, *"it is the case for all the petroleum companies"*.

²⁶ Retrieved from <http://www.lesoir.be/1220365/article/economie/2016-05-25/greve-des-raffineries-en-france-stations-service-belges-prises-d-assaut>, Consulted on June 8th 2016.

Risk management and mitigations plans

The most important concern that may face a refinery is to be unable to output finished oil products and consequently compromise the supply of these fuels to the final consumer. Therefore, the only critical situation is to ensure a continuous flow of supply; hence, a protection against units' failure is core.

A common strategy to manage and mitigate this risk is the flexibility to source from other refineries in the country or abroad. Indeed, oil companies generally have at their disposal several refineries, enhancing the reliability of supply. Hence, in case of disruption in a certain refinery, another one can serve as back-up strategy. Moreover, the interviewee explains, *"a refinery is a multitude of units and a breakdown of the entire refinery is extremely uncommon"*. Therefore, even if a unit of the refinery incurs some technical problems, the refinery is still able to run at a smaller output. However, the interviewee does not dismiss the disaster scenario, for example an important explosion in the refinery, but she clearly affirms, *"It never happened"*.

Besides this formal strategy, Anne-Sophie Scarselli explains *"we have a lot of equipment in two copies"*. Hence, when a unit suffers from an unexpected event, a similar unit can immediately take the reins. The duplication of the units is very common for the refineries and it allows the continuity of the service in case of breakdown.

Another formal way of risk management and mitigation is the importance of maintenance programs. Maintenances are performed very often by external companies but always supervised by a team, and prevention is even more recommended. Indeed, Anne-Sophie Scarselli pointed out:

"We will intervene on the equipment before having a potential technical problem. For example, if we know that one unit is secure enough for X years until the next maintenance, we can decide, if this unit is critical, to perform the maintenance one year in advance to be sure that it will not fail".

A further risk management and mitigation technique finds its relevance in the optimisation of the supply chain for the refinery. In reality, nowadays the refineries operate on a volatile market and deal with complex environments (Grogard, 2012). They face issues such as weaker margins, greater operating costs due to the price increase of commodities and energy. Consequently, a change in the culture in favour of better management efficiency seems to be essential. As a matter of fact, the refiners

moved from the classical model based on the offer towards a model based on the demand. To support this strategy, a dedicated team called Optim uses linear program tools based on algorithm but also on data regressions to build models and to use them with real parameters. It is a central part for the refining process. Hence, the accurateness of the demand forecasting has become more important than ever. Grogard (2012) explains *“refiner’s margin will remain uncertain as long as the demand for petroleum product will increase modestly in the developed countries and the refining capacity worldwide will increase in the developing countries”*. Within Total, Optim handles the optimisation process for the Belgian refineries. Their duty begins with the choice of the right crudes. As a matter of fact, depending on their “convertibility”, the refineries will be able to enhance the heavier crudes, usually coming from deeper seabed (called deep offshore), containing polluting and metals. Those refineries are called “convertible” and are more and more important as the crudes quality is changing.

To estimate the demand, the interviewee acknowledged using principally forecasting based on passed data. However, she added the importance of keeping informed through the news but also keeping an eye on the different competitors. Moreover, databases are a source of information in order to plan the projection of the future consumption. For example, she highlighted that petrol consumption is declining over the years in favour of diesel that will take the predominance. Those databases emanate from various kinds of key players, such as Wood McKenzie, Platt’s, and other big petroleum consultants. Afterwards, to strengthen the information, they cross the data to verify the credibility of the findings. However, she asserts that it is clear in most cases.

At the end of the interview, Anne-Sophie Scarselli pointed out:

“I don’t think it is possible to not satisfy the market demand. With the flexibility we have, particularly at the level of our entity Totsa being present in every continent, it seems to me impossible. We have so many sources of supply.”

In some extreme situations, she acknowledged having the production cycle completely disconnected from the demand. In other words, it means that the production of the refinery cannot handle the demand of oil products. However, to fulfil her commitments, she explains having recourse to the market where she can buy oil products to meet the demand.

5.4.4. Observations

After having analysed this case, the following findings can be drawn: first of all, we can clearly observe a similar approach of every steps of a complete SCRM process (i.e. tools, risk assessment phase, management and mitigation techniques). Indeed, one can argue that those procedures are to a certain extent in line with what is drawn as best practices in the theory. Moreover, it appears that the refining stage at Total pays much attention to technical failures. Therefore, they engage a lot of efforts and supports to maintenance programs, always supervised by a member of Total. Besides, it seems that a lot of financial resources are mobilised into the refinery improvement. Indeed, environments where crude is extracted are changing, going deeper into the lands and seabed. Hence, the refineries must be able to support and enhance these crudes carrying more polluting.

6. Cross-case analysis

After having conducted four single cases studies and expounded the findings in each one, the purpose of the cross-case analysis is to highlight propositions that will counterpart the theory. However, it is important to evoke the nature of the following propositions: they are built on empirical findings of the research, thus they can only be perceived as suppositions.

Sourcing in the Middle East

When sourcing crude oil, emerging markets can be seen as a must for oil companies due to the abundance of this commodity in those countries. It is interesting to see that in majority, the sources of crude oil are located in the developing countries.

For Lionel Carpentier (Case B), it is due to chance while for Marc F. (Case A), crude oil is especially available in the under developing countries. Although crude oil is mostly available in the developed countries such as the US, Canada or North Sea, it is especially the case for the Middle Eastern countries as they control the majority of the crude oil reserve on the planet. In fact, Marc F. (Case A), Lionel Carpentier (Case B), Alain De Mot (Case C) and Anne-Sophie Scarselli (Case D) acknowledged the importance of Saudi Arabia as the number one supplier of crude oil. However, Marc F. (Case A) thinks that the US is the most important producing country for ExxonMobil due to the origin of the company, but could not assert it. According to Lionel Carpentier (Case B), Russia may have taken the number one place for crude oil supply in Belgium.

All in all, it seems that sourcing from Middle East is an operational necessity for oil companies. Nevertheless, the four single case findings made us assert that criteria applied to supplier selection in the emerging countries do not differ from more developed countries. In fact, Marc F. (Case A) pointed out the standardisation of procedures when dealing with suppliers across the world. This statement is even strengthened by Lionel Carpentier (Case B), as he recognized no differences when sourcing from Middle East or North Sea.

***Proposition 1.** Western oil companies sourcing crude oil in the emerging countries, especially from the Middle East, do not apply specific measures compared to the developed countries. These are standardised criteria and are strong enough to hedge against possible risks associated to emerging market as well as developed countries.*

Risk management techniques towards the oil supply chain

First, all of the four companies being analysed showed the importance of vertical integration as a basic strategy to enhance the market dynamic's response but also to control costs.

For ExxonMobil (Case A), risks management is a central part of their business strategy. Marc F. explains that there might be risks before extracting crude oil, and it begins with the study of the earth's crust. Therefore, they are working with the highest technology to ensure the profitability of the extraction phase. They also count on their extensive geographical presence, portfolio diversification and flexible long and short terms contracts to ensure the continuous flow of supply.

Strategically, Lionel Carpentier (Case B) counts on the derivatives market to cover himself about price fluctuations. Besides from supplier self-assessment and external audit firms, he acknowledges to use letter of credit and pre-payment in some cases to hedge against possible payment defaults. Also, traders like Lionel Carpentier tend to maintain a certain level of security stocks, but as less as possible due to the costs that it incurs. To ensure trust and confidence, they have developed long-term relationships with suppliers and tend to not apply penalty systems.

We have seen it through the APETRA case (Case C), their exposure to risks is very low. As a public company emanating from the government rules, its public duty makes the oil companies or trading companies obedient to the rules commanded by the APETRA. In fact, they do not have implemented any informal techniques to manage their suppliers and do not apply the traditional arm's length between buyers and suppliers. However, they tend to cover against the price risk as much as possible by purchasing with average on price and developed the system of "ticket".

Total Refining & Chemicals (Case D) engages a lot of resources into risk management and mitigation plans in order to avoid breakdowns or failures of the refinery. Their main management techniques are formal: geographical extension, unit's duplication, maintenance programs, and optimization of the supply chain. They have also based their strategies on market data's, forecasting and business intelligence.

Proposition 2. *At every level of the oil supply chain, formal techniques, strategic alliances and operational measures are preferred instead of informal ones.*

Table 5 - Synthetic summary table

	Case A	Case B	Case C	Case D
Supplier selection	-Security, availability and price -High quality standards -Use of tend specifications	-Trust and confidence -High quality standards -Financial sturdiness -ISO certification	-Market experience -Financial sturdiness -Call for bids	-Quality -Ethics -Price
SCRM				
Risk identification	-Seabed and lands analysis -Industrial risk -Corruption -Political risk	-Price risk -Security issues -Credit risk	-Price risk -Exchange rate risk (USD/EUR)	-Unit failures (breakdowns or social activism)
Risk Assessment	-Risk map matrix (OIMS)	-Metrics, data analysis -Price calendar	None	-Building scenarios -Monitoring -KPI
Risk management	-Vertical integration -Security stocks -New oilfields projects -Renewable energy -Portfolio diversification -Product-switch -Multiple way of transport -Flexible contract -Self-assessment -Due diligence	-Derivatives market (future contracts) -Letter of credit -Pre-payment -Security stocks (as low as possible) -Penalty system	-Average price -Penalty systems -CAPA	-Maintenance programs -Back-up refineries -Unit's duplication -Optimization of the supply chain (linear program) -Forecasting -Business intelligence -Petroleum consultant databases -Market (to buy or sell)

Supplier relationships

The four companies admit engaging a lot of resources in the supplier selection phase, all arguing that the level of due diligence by their own is a central part. They all put emphasis on formal and methodological ways when it comes to the supplier selection.

ExxonMobil (Case A) argues looking at security first, which is more likely in the emerging countries, when selecting its suppliers. In order to strengthen their commitment, Marc F. asserts that devoted teams are regularly sent to the supplier plants to verify the security systems. In fact, the company must be sure enough and confident about the supplier and wants to be sure he respects the standards.

Total (Case B) provides more details about its supplier selection phase. Lionel Carpentier put emphasis on the financial sturdiness of its supplier. Indeed, Total is highly suspicious with supplier facing going concerns. The credit department is mandated to screen the supplier and gives its approval. For him, quality is the first criterion when dealing with potential suppliers. He added that the European norms and compliances in terms of products are one of the main drivers for the quality preference.

APETRA (Case C) argues having no qualitative criteria's when selecting its suppliers. Alain De Mot argues that he does not need strategic partnership and only points out classical criteria's. However, checking the supplier's ability to fulfil the invitation to tenders established by the APETRA is crucial. The company is mandated for a public mission coming from the Belgian State. Therefore, complying with the demanding APETRA's guidelines is more than recommended, subject to serious sanctions.

Total Refining & Chemicals (Case D) put forwards the reliability of the suppliers. Although Anne-Sophie Scarselli does not deal directly with suppliers, and especially the Middle Eastern countries, she is well informed about procedures. In fact, she pointed out the level of due diligence performed by the entity and the quality certificates make the relationship with supplier almost risk free.

All of the four analysed cases argue having established good supplier relationships, going even further by asserting they never experienced bad situation with suppliers. We can assume this fact due to the high standard during the selection phase. Besides, three of the four cases pointed out that the actors among the oil industry are well known and everybody knows each other. Consequently, it seems that trust and confidence are relevant assets within the oil industry. Hence, the following proposition can be generated:

Proposition 3a. *It appears that actors among the oil industry know each other for a long time, making them all reliable. It seems that strong relationships were built through strong supplier selection criteria's and have enhanced confidence and trust*

for a long time. Therefore, a new player wanting to enter into the oil business will be seen as highly risky.

Proposition 3b. *Enforcement of due diligence process performed by oil companies is always preferred instead of certifications from the 3rd parties.*

The macro-environment factors

Unanimously, the four firms feel threatened by the political and geopolitical risks carried by the Middle Eastern governments. Indeed, Fernandes et al. (2010) and Vakhshouri (2011) explain *“The macro-environment factors on the oil and gas supply chains is easily observable in reality; countries where natural gas or crude oil commonly originated from are politically unstable and foreign companies are at constant risk of terror attacks, and wars, e.g. in Qatar, Nigeria, Algeria and Egypt”*. In particular, respondents put major emphasis on political conflicts.

Marc F. (Case A) expresses general concerns about the transport of crude oil and related products. Threats such as pollution or oil spill may endanger the company's reputation. Corruption was also cited as a potential risk when it comes to emerging markets. However, he guaranteed the means put in place in terms of trainings, control and education. Concerns about the political instability in the Middle East were also expressed by the interviewee, as the company engaged its activities in Qatar, Kuwait, Iraq and Egypt.

For Lionel Carpentier (Case B), the price risk is mainly driven by macro-environmental factors. He highlighted the recent initiative implying the drastic oil production increase taken by Saudi Arabia against the discovery of shale gas in America. The effect of such a decision made the crude oil prices decrease due to the abundance of the commodity. However, despite the lower prices of petroleum products at the gas station, which is a short-term advantage for the household, the long-term negative effects will be a decrease in new oilfield investments due to the non-profitability of petroleum product's sales. He added further his worries about the banking investments in many shale gas' producers since the discovery of shale gas in the US. In fact, those investments are no more profitable because of the interesting oil prices coming from the Middle East. He also expresses his concerns that speculation over shale gas could lead to a similar situation of the subprime crisis. Moreover, the interviewee pointed out the Amazonian

deforestation in Brazil for its biological basis (vegetal fat) to form the blend of petroleum products that may endanger the company's reputation.

Anne-Sophie Scarselli (Case D) also expresses concerns about the geopolitical risks carried by the Middle East. Due to the high investments of Total Refining & Chemicals in the Middle East plants, the company bears most of the burdens in case of riots, wars or attacks in those countries. She highlighted the need of a long-term visibility (from 10 years up to 20 years) when the oil companies invest resources in the Middle East. However, she acknowledges the difficulty of such a visibility, especially when we observe the evolution of the Arab Spring until now. The effect of strikes could also disrupt the oil supply chain in Western countries. Indeed, she highlighted the recent event of syndicate blocking the French refineries leading to oil shortage reported in many gas stations.

***Proposition 4.** Political instability, corruption and reputational matters are contextual factors related to the business environment in the emerging countries that impact the Western firms' SCRM approaches and measures.*

The resilient oil supply chain

The four firms, although being aware of the risks that may disrupt the supply chain, expressed no scepticism of not being supplied in oil in case of an incident in the Middle Eastern countries. In fact, they all put emphasis on the risk management techniques but also mitigation and contingency plans established by the oil companies themselves (i.e. portfolio diversification, geographical extension, flexible contracts, multiple way of transport, etc.) and by governments (i.e. strategic stocks).

According to Alain De Mot (Case C), only an international severe crisis could lead to potential oil shortage for countries that highly depend on oil import, such as Belgium. However, he underlines the presence of two big refineries in Belgium owned by Total and ExxonMobil, which are themselves exporters of oil products. It means that they produce more oil products than required by the Belgian market. Moreover, he highlighted the easiness of transport for such commodity as oil. In 2014, the APETRA had stocked a security stock of crude oil amounting 3.470.300 ton. According to his words, it is enough to secure the Belgian market for at least 2 years.

Total Refining & Chemicals (Case D) expressed no concerns about possibilities to not satisfy the market demand. In fact, Anne-Sophie Scarselli strongly believes that with the flexibility that the company has, especially with the entity Totsa present across the globe, it seems to be impossible to not meet the demand, even in case of a crisis. She puts emphasis on the abundance of source of supply, even if the company goes for a degraded-mode.

Proposition 5a. *Creation of third party association reduces the burdens of oil companies handling strategic stocks and in the same time enhance resiliency of the oil supply in case of a crisis.*

Proposition 5b. *It appears that oil supply coming from the emerging countries is secured enough to ensure to the European States a continuous flow of supply.*

Proposition 5c. *The creation of laws and regulations encompassing the industry's standards requirements enhance the resiliency of oil supply chain.*

7. Limitations of the study

The limitations of this study principally consist in: the amount of sampled cases performed and the qualitative nature of the data collected among the single-cases.

Although practitioners assert that a number of four cases are acceptable to build theory (Eisenhardt, 1989), one can argue that it cannot be sufficiently used to outline conclusions based on four cases only. Hence, it would be useful for future researches to replicate this study with a higher number of cases, reflecting more the studied industry.

As an exploratory-based study, the four cases make use of qualitative data. This approach is normally preferred in exploratory studies in underexplored research contexts (Urciuoli et al., 2014). Nevertheless, the findings, even if the information gathered was rich, are usually challenging to report and analyse. Moreover, the quality of information depending on the hierarchical position of the respondents but also on the organizational structure, the knowledge of these informants was not equal across the four single cases. For example, it would have been better to have access to a more specific and higher position related to the exploration/production phase for the ExxonMobil case (Case A). Indeed, some questions of the interviewee guide were not convenient according to his position.

Another shortcoming of this exploratory-based study can be found in the fact that two of the four interviews come from one corporation, although coming from different stages of the oil supply chain: Total S.A. In fact, it would be interesting to get access to a different oil company such as BP or Shell. However, due to resource constraints and a lack of negotiating power, it has not been possible.

In the overall, I believe that the outlined propositions within the cross-case analysis are interesting for practitioners willing to gather information about practices when sourcing crude oil from the Middle East. Somehow, the stakeholders among the oil supply chain could use this exploratory-based study to find out how to optimally deal in this situation. Hence, they will be able to align their strategies accordingly.

Finally, it would be useful to deepen the research question undertaken in this study to other countries considered as emerging market, or even in other industries.

8. Conclusion

My exploratory-based study aimed at determining how the oil industry in Belgium deals with risks when sourcing crude oil from emerging markets, and in relation to those, what are the mitigation strategies used to manage disruption to enhance a low-risk supply chain. To achieve this paperwork, the case study particularly focused on the oil coming from the Middle East to Belgium.

In this master thesis, investigating through supply chain risk management practices when sourcing crude oil from emerging countries has led to an array of propositions generated from the empirical findings.

First and foremost, it has been expressed that the hypothetically accepted notion of specific standards applied when sourcing crudes from the Middle East was rejected. Indeed, the interviewees highlighted the standardisations of procedures when sourcing from emerging countries do not differ from sourcing in more developed countries. In fact, the significant value of this commodity made us asserts that oil corporations developed sufficient criteria's to hedge against potential risks linked to emerging markets.

Previous research has extensively studied and recommended the application of risk management and resilience approaches (Manuj and Mentzer, 2008; Norrman and Jansson, 2004; Finch, 2004; Blome and Schoenherr, 2011). In terms of risk management techniques, one of the principal strategies developed by oil companies is the vertical integration. Unanimously, the four interviewees pointed out the importance of vertical integration as a way to enhance the market's dynamics response but also to control costs. Besides, at every stages of the oil supply chain, formal techniques, strategic alliances and operational measures are performed by entities. Within the literature, Tohamy (2009) suggested an array of risk management techniques. As such, geographical presence, portfolio diversification and flexible long and short terms contracts to ensure the continuous flow of supply are examples of strategies carried by ExxonMobil. For traders like Lionel Carpentier, they count mostly on derivative markets to hedge against price fluctuations. Moreover, they have built long-term relationships with suppliers to ensure trust and confidence. The public company APETRA is exposed to lesser risks than oil corporations due to its public duty to handle strategic stocks in case of oil flow disruptions. However, they tend to cover as much as possible against

price variation by purchasing on price averages or the system called “ticket”. Finally, Total Refining & Chemicals tend to reduce any breakdown or failure of refineries by formal techniques. These are developed under the axes of geographical extension, unit’s duplication, maintenance programs, and optimization of the supply chain.

It also seems that the supplier selection phase is of primacy to minimize risks related to suppliers from the emerging countries (or not). The case study has revealed that the level of due diligence is highly performed when it comes to supplier selection. Security is of major importance for the interviewees. As such, ExxonMobil admitted sending devoted teams on a regular basis to the supplier plans to make sure they meet the firm’s expectation. The case also revealed that trust and confidence between suppliers and buyers were built thanks to strong relationships for a long time. This is in line with previous research stating that confidence is a crucial need to mitigate supply chain risk (Christopher and Lee, 2004). Hence, it makes difficult for a new supplier to enter into relationship with oil corporation or traders if they do not justify several criteria’s in terms of security, financial sturdiness and certifications.

Preceding research in the supply chain management doctrine has already pointed out the role of governments to ensure the continuous flow of critical supplies (Urciuoli et al., 2014). In this study, the macro-environment factor also plays an important role in the supply chain risk management’s decisions. As such, the four interviewees admitted their concerns about geopolitical risks carried by the Middle East countries. It has been demonstrated that countries where natural gas or crude oil commonly originated from, are politically unstable and foreign companies are at constant risk of terror attacks, and wars, e.g. in Qatar, Nigeria, Algeria and Egypt (Fernandes et al., 2010 and Vakhshouri, 2011). As such, firms tend to protect themselves through trainings, control and education, even though it is impossible to implement measures constituting a perfect safety net.

Finally, researchers confirm that some risks cannot always be avoided and suggest to focus on the enhancement of resilience instead of trying to avoid them (Christopher and Peck, 2004; Rice et al., 2003; Sheffi, 2001, 2005). In this study, it has been evidenced that oil supply chain are resilient enough to not interrupt the continuous flow of oil supply to Belgium, and that can generally be extended to other Western countries. Surprisingly, the surveyed expresses no general concerns about not being supplied in case of major

incident in the Middle East, and put emphasis on risk management techniques and contingency plans at the corporate level.

9. References

- Achebe, K.O. (2011). *Risk based models for the optimization of oil and gas supply chain critical infrastructure. A Dissertation Submitted to the Faculty of New Jersey Institute of Technology in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Civil Engineering. Department of Civil and Environmental Engineering, New Jersey's Science & Technological Institute.*
- Albarelo, L. (2010). *Apprendre à chercher.* Paris, De Boeck Université
- American Petroleum Institute (API). *Energy – Understanding our oil supply chain.* Online <http://www.api.org/~/media/files/policy/safety/api-oil-supply-chain.pdf>, consulted on March 14th
- Alnasrawi, A., (1985). *OPEC in a changing world economy.* Baltimore. Johns Hopkins University press
- Blome, C. & Schoenherr, T. (2011). *Supply chain risk management in financial crises – A multiple case-study approach. International Journal of Production Economics, 2011.* doi:10.1016/j.ijpe.2011.01.002
- Belgian Foreign Trade Agency. (2015). *Trade relations of Belgium with Saudi Arabia.* Online http://www.abh-ace.be/sites/default/files/Bilateral_trade_sheets/January_16/saudi_arabia.pdf consulted on April 16th, 2016.
- Belgian Foreign Trade Agency. (2015). *Trade relations of Belgium with UAE.* Online http://www.abh-ace.be/sites/default/files/downloads/UAE_en.pdf, consulted on April 16, 2016
- Belgian Foreign Trade Agency. (2015). *Trade relations of Belgium with Iran.* Online http://www.abh-ace.be/sites/default/files/Bilateral_trade_sheets/January_16/1_2/iran.pdf, consulted on April 16th, 2016
- BP Statistical Review of World Energy (2015). *Oil: Production and Consumption.* Online <https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review->

2015/bp-statistical-review-of-world-energy-2015-full-report.pdf, consulted on April 7th, 2016

Business Continuity Institute (2010). The Business Case For BCM: case studies. Online <http://www.bcifiles.com/BCIBusinessCaseforBCMMarch2010CASESTUDIES.pdf> , consulted on March 14th, 2016

Christopher, M., Mena, C., Khan, O & Yurt, O. (2011). *Approaches to managing global sourcing risk. Supply Chain Management: An International Journal, Volume 16, No. 2*, pp. 67-81. doi:10.1108/13598541111115338

Christopher, M. & Lee, H. (2004). *Mitigating supply chain risk through improved confidence. International Journal of Physical Distribution & Logistics Management, Volume 34, No. 5*, pp. 388-396. doi: 10.1108/09600030410545436

Chima, C. M., (2007). *Supply chain management issues in the oil and gas industry. Journal of Business & Economics Research, Volume 5, No. 6*, pp. 27-36.

Chen, J., Sohal, A. & Prajogo, D. (2013). *Supply chain operational risk mitigation: a collaborative approach. International Journal of Production Research, Volume 57, No. 1*, pp. 2186-2199. doi:10.1080/00207543.2012.727490

Central Intelligence Agency (CIA). *The World Factbook – Middle East: Saudi Arabia*. Online, <https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html>, consulted on April 7th, 2016

Central Intelligence Agency (CIA). *The World Factbook – Countries comparison: REFINED PETROLEUM PRODUCTS – CONSUMPTION*. Online <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2246rank.html>, consulted on April 7th, 2016

Cockram, D., Van Den Heuvel, C., (2012). *Crisis Management – What is it and how it is delivered?* Online <http://www.bcifiles.com/CrisisManagementMarch2012.pdf>, consulted on March 14th, 2016

- Central Intelligence Agency (CIA). *The World Factbook – Middle East: Qatar*.
<https://www.cia.gov/library/publications/resources/the-world-factbook/geos/qa.html>, consulted on April 7th, 2016
- Dittman, J.P. (2014). *Managing risk in the global supply chain. The Global Supply Chain Institute, No. 3*, pp. 2-30.
- Delcredere-Ducroire. (2016). *Risques pays: Arabie Saoudite*. Online
<http://www.delcrederecroire.be/fr/risques-pays/#focusCountry=SA&focusContinent=&filter=undefined&min=0&max=7&tab=undefined>, consulted on April 21st, 2016
- Eisenhardt, K.M. (1989). *Building theories from case study research. Academy of Management Review, Volume 14, No. 4*, pp.532-550. doi:10.5465/AMR.1989.4308385
- Fernandes, L., Barbosa- Póvoa, A.P., Relvas, S. (2009). *Risk Management Framework for the Petroleum Supply Chain*. Proceedings of the 14th Congress of APDIO, Vencer Novos Desafios nos Transportes e Mobilidade, pp. 59-66.
- Harland, C., Brenchley, R. & Walker, H. (2003). *Risk in supply networks. Journal of Purchasing & Supply Management, Volume 9*, pp. 51-62. doi:10.1016/S1478-4092(03)000044-9
- Handfield, R., Nichols, E. (1999). *Introduction to Supply Chain Management*, New Jersey, Prentice Hall Inc.
- Hartshorn, J.E., (1993). *Oil trade: politics and prospects*. Cambridge, Cambridge University Press
- Koulikoff-Souviron, M. Harrison, A. (2005). *HRM within intra-firm supply relationships : an institutional perspective*. Academy of Management Annual Meeting.
- Kumar, S., Himes, K.J., Kritzer, C.P., (2014). *Risk assessment and operational approaches to managing risk in global supply chains. Journal of Manufacturing Technology Management, Vol. 25 Iss 6* pp. 873 – 890. doi :10.1108/JMTM-04-2012-0044
- Laurent, E., (2006). *La face cachée du pétrole*. Paris, Plon.

- Lejeune, C. (2014). *Méthode Qualitative Partie 1* [video]. Belgium: Louvain School of Management. Online <https://www.youtube.com/watch?v=fig1rOWYrO8&feature=youtu.be>.
- Mitchell, V-W. (1995). *Organizational risk perception and reduction: a literature review*. *British Journal of Management, Volume 6*, pp. 115-133. doi:10.1111/j.1467-8851.1995.tb00089.x
- Manuj, I. & Mentzer, J. (2008). *Global supply chain risk management*. *Journal of Business Logistics, Volume 29*, No. 1, pp. 133-155. doi:10.1002/j.2158-1592.2008.tb00072.x.
- Milliken, F. (1987). *Three types of perceived uncertainty about the environment: state, effect and response uncertainty*. *Academy of Management Review, Volume 12*, No. 1, pp. 133-143. doi:10.5465/amr.1987.4306502
- Mast, T. (2005). *Oil and Its Alternatives: Why They Are So Important*. U-T San Diego. Online http://legacy.signonsandiego.com/uniontrib/20050309/news_lz1e9mast.html consulted on April 7th, 2016
- Norrman, A. & Jansson, U. (2004). *Ericsson's proactive supply chain risk management after a serious sub-supplier incident*. *International Journal of Physical Distribution & Logistics Management, Volume 5*, No. 5, pp. 434-456. doi:10.1108/09600030410545463
- Organization of Petroleum Exporting Countries (OPEC). *Saudi Arabia Facts and Figures*. Online, http://www.opec.org/opec_web/en/about_us/169.htm, consulted on April April 7th, 2016
- Prakash, S. & Mittal, S. (SD). *Handling supply chain risks for sustainability: a review of key issues*. Malaviya National Institute of Technology (MNIT), JLN Marg, Jaipur.
- Platts McGraw Hill Financial (2016). *CAPITOL CRUDE: THE US OIL POLICY PODCAST THE HAZARDS OF ISLAMIC STATE OIL*. Online <http://www.platts.com/podcasts-detail/crude/2016/march/capitol-crude-031416>, consulted on April 18th, 2016
- Quivy, R. & Van Campenhoudt, L. (2006). *Manuel de recherche en sciences sociales* (4th edition). Paris: Dunod.

- Rao, S., Goldsby, T.J. (2009). *Supply chain risks: a review and typology*. *The International Journal of Logistics Management*, Volume 20 Iss: 1, pp.97 – 123. doi:10.1108/09574090910954864
- Rohrmann, B. (1998). *The risk notion: epistemological and empirical considerations*. In: M. Stewart & R. Melchers (Eds.), *Integrated Risk Assessment* (pp.39-46). Rotterdam: Balkema.
- Rose, E.A (2004). *OPEC's dominance of the Global Oil Market: The Rise of the World's Dependency on Oil*. *Middle East Journal*, volume. 53, No. 3, pp. 424-443
- Royaume de Belgique Affaire Etrangère, Commerce Extérieur et Coopération au Développement. *Régime de sanctions à l'égard de l'Iran*. Online http://diplomatie.belgium.be/fr/politique/themes_politiques/paix_et_securite/sanctions/sanctions_iran, consulted on April 16th, 2016
- Szucs, D., Hassen, K., (2012). *Supply Chain Optimization in the Oil Industry: A Case Study of MOL Hungarian Oil and Gas PLC*. MASTER THESIS IN INTERNATIONAL LOGISTICS AND SUPPLY CHAIN MANAGEMENT, Jönköping International Business School
- Schwartz, P. (2000). When good companies do bad things. *Strategy & Leadership*, Vol. 28 Iss 3 pp. 4 – 11. doi:10.1108/10878570010348530
- Supply Chain Risk Leadership Council. (2011). *Supply chain risk management: A compilation of best practices*. Unpublished document. Online [http://www.scrcl.com/articles/Supply_Chain_Risk_Management_A_Compilation_of_Best_Practices_final\[1\].pdf](http://www.scrcl.com/articles/Supply_Chain_Risk_Management_A_Compilation_of_Best_Practices_final[1].pdf), consulted on March 14th, 2016
- Svensson, G. (2000). *A conceptual framework for the analysis of vulnerability in supply chains*. *International Journal of Physical Distribution & Logistics Management*, Volume 30, Issue 9, pp. 731 - 750
- Scholten, K., Schilder, S., (2015). *The role of collaboration in supply chain resilience*. *Supply Chain Management: An International Journal*, Vol. 20 Iss 4 pp. 471 – 484. doi :10.1108/SCM-11-2014-0386

- Tummala, R., Schoenherr, T., *Assessing and managing risks using the Supply Chain Risk Management Process (SCRMP) (2011). Supply Chain Management: An international Journal*, Volume 16, No. 6, pp. 474-483. doi:10.1108/13598541111171165
- Tang, C. (2006). *Robust strategies for mitigating supply chain disruptions. International Journal of Logistics Research and Application: A Leading Journal of Supply Chain Management*, Volume 9, No. 1, pp. 33-45. doi:10.1080/13675560500405584
- Urciuoli, L., Mohanty, S., Hintsa, J., Gerin, E., Boekesteijn, G. (2014). *The resilience of energy supply chains: a multiple case study approach on oil and gas supply chain to Europe. Supply chain management: An International Journal*, Volume 19, pp. 46-63
- U.S. Energy Information Administration (U.S. EIA). *Energy & Financial Markets - WHAT DRIVES CRUDE OIL PRICES? Supply: OPEC.* Online <https://www.eia.gov/finance/markets/supply-opeccfm>, consulted on March 16th, 2016
- United Nations Statistic Division (2013). *Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings.* Online <http://unstats.un.org/unsd/methods/m49/m49regin.htm>, consulted on April 7th, 2016
- Wiengarten, F., Humphreys, P., Gimenez, C., McIvor, R. (2016). *Risk, risk management practices, and the success of supply chain integration. International Journal Economics*, No. 171, pp. 361-370.
- Wegner, S. M., Neshat, N. (2010). *Assessing the vulnerability of supply chains using graph theory. International Journal of Production Economics*, Volume 126, pp. 121-129
- White, D. (1995). *Application of systems thinking to risk management:: a review of the literature. Management Decision*, Volume 33 Iss: 10, pp.35 - 45. doi: 10.1108/EUM0000000003918
- Wyant, F. R., (1977). *The United States, OPEC, and multinational oil.* Lexington: Lexington books.

Yin, R. (2003). *Case Study Research: Design and methods* (3rd edition). Thousand Oaks, California: Sage Publications.

Yergin, D., (1992). *The Prize: The Epic Quest for Oil, Money & Power*. Free Press

Zsidisin, A., Ellram, L., Carter & J., Cavinato, J. (2004). *An analysis of supply risk assessment techniques. International Journal of Physical Distribution & Logistics Management, Volume 5, No. 5*, pp. 397-413. doi:10.1108/09600030410545445

10. Appendices