Supply chain resilience strategies for oil industry under uncertainty:Case study on the Egyptian refining industry

Walid Abd El Ghany Gebril
Supervised by:Prof Dr.Khaled El Sakty

Abstract:

The state of the world economy is mostly determined by the supply and demand of crude oil and petroleum products. Currently, the petroleum industry is confronted with the demanding objective of maintaining competitiveness in the global market, which is influenced by the unpredictable demand for petroleum products and the volatile pricing of crude oil. These circumstances compel petroleum firms to seize every possibility that enhances their profit margin. Egyptian refineries, which are the central focus of the oil industry, face risks and uncertainties due to the national and international oil market environment, as well as various supply chain factors. These factors directly and indirectly affect the feed and products of the refineries, ultimately impacting their performance and profits. Firms can use numerous supply chain resilience methods to mitigate the growing risks posed by global economic, social, political, technical, and environmental catastrophes that have the potential to disrupt their fundamental business operations. Adverse events like as natural disasters, epidemics, pandemics, terrorist attacks, strikes, financial crises, unreliable systems, logistics, supply chain breakdowns, and unexpected shortages of vital manufacturing inputs can have a significant negative influence on growth and performance. Examining both current and previously published literature, this study seeks to better understand the supply chain resilience methods used by oil refineries worldwide. In order to evaluate supply chain resilience measures in the face of uncertainty and to examine the most effective strategies employed by oil refineries, with a particular emphasis on those in Egypt, In order to help refineries and other oil sector businesses develop a supply chain resilience strategy (SCRES), it is necessary to first determine what obstacles they face.

Key Words: Supply chain, resilience strategies, oil industry, uncertainty, Egyptian refining industry, supply chain resilience strategy, Petroleum industry supply chain.

Introduction:

Petroleum is an essential and indispensable energy resource that has been responsible for satisfying more than 30% of the global energy requirements since 1990. The other primary sources of energy are natural gas, nuclear energy, hydroelectricity, renewables, and coal (Cohen, 2020). It has significantly contributed to the global economic, industrial, and scientific advancement through its diverse applications, ranging from propelling vehicles and generating electricity to construction and the production of plastics and other synthetic materials. The functionality of the entire system relies on a supply chain (SC) composed of intricate and costly procedures. Organizations are seeking secure, cost-effective, and streamlined methods to meet consumers' demands and ensure accurate execution due to the substantial investment needed for planning and managing the chain.

The literature has proposed numerous techniques for enhancing the resilience of supply networks, including augmenting flexibility and establishing redundancy. However, there is a conspicuous dearth of study on the correlations among the several tactics that might be employed in oil refineries. Certain researchers perceive these tactics as autonomous (Sheffi & Rice, 2005; Zsidisin & Wagner, 2010); however, others contend that they are interconnected (e.g. Jüttner & Maklan, 2011; Ponis & Koronis, 2012; Johnson et al., 2013), with their results either reinforcing or conflicting with one another. An example is the argument that supply chain collaboration and redundant resources/spare capacity enhance flexibility (Jüttner & Maklan, 2011; Scholten & Schilder, 2015). However, it is also argued that close collaborative relationships can either clash with certain aspects of flexibility (Stevenson & Spring, 2007; Scholten & Schilder, 2015), or result in confidentiality risks due to the sharing of sensitive information (Jüttner & Maklan, 2011). Therefore, it is necessary to examine the connections between SCRES techniques and the results of their implementation.

Supply chains are often referred to as "complex adaptive systems" because they display characteristics such as non-linearity, co-evolution, self-organization, and emergence. Therefore, it is crucial to study resilience in a comprehensive manner by examining the interconnectedness between supply chain threats and resilience strategies, rather than analyzing them in isolation.

Objectives and Research Questions:

The preceding context demonstrates that there is a clear rationale to undertake further empirical research on SCRES in the markets of oil refineries and their subsidiaries in developing countries. This is because developing countries, which are in dire need of additional studies, also endure severe consequences from disrupted supply chains. Therefore, it is crucial to comprehend the concept of resilience in supply chains within oil refineries, particularly in developing nations. This study aims to address two related research questions by analyzing the inter-relationships between threats, strategies, and outcomes in a supply chain systemically, using statistical tools. The argument is that this approach reflects the current framing of a supply chain more accurately than analyzing these factors individually and separately.

Research questions:

RQ1: What are the threats that have impact on supply chain resilience in oil companies and refineries?

a) What do oil refineries perceive to be the threats to their supply chains?

b) What strategies do they adopt to build resilience to these threats?

c) What are the most optimum resilience strategies?

RQ2: How are threats and strategies interconnected?

a) What does this interconnectedness mean for supply chain resilience?

This thesis adopts a case study approach, conducting interviews across a supply network of 12 oil refineries, processing and logistics companies in Egypt, to address the above research questions. The case study approach has been found suited to conducting research on such an emerging complex phenomenon and in such a unique context as suggested by Stuart et al. (2002). By studying a network of firms, this thesis concurs with the notion that SCRES is a network level phenomenon, whose appropriate unit of analysis should be a network rather than individual firms, as recently advocated by Kim et al. (2015a).

Overview about the Egyptian Petroleum Supply Chain:

Egypt's oil supply chain is a vertically integrated complex network comprised of several activities, infrastructures, and the participation of multiple stakeholders. The principal route of transport for crude oil and processed goods is via pipelines. They are Egypt's most secure, cost-effective, and reliable energy carrier. In 2017, roughly 5590 metric ton of refined product pipeline connected the country, reaching the majority of Egypt's governorates .Pipelines deliver almost 70% of crude oil and petroleum products annually. Each year, interstate pipelines transport more than 56.9 million tonnes of petroleum. Around 52% of petroleum carried via pipelines is crude oil, whereas 47% is refined petroleum products. Rail and trucks transport around 22% of crude oil and petroleum products, as they are more expensive and thus less efficient. The remaining approximately 6% is transported by sea carriers wherever marine shipments are available. Approximately 78 percent of crude oil and petroleum products consumed by the Egyptian market are produced within the country. Crude oil is produced in three main areas: the eastern desert, the western desert, and the Gulf of Suez. However, the western desert is the leading crude oil producing location, accounting for 56 percent of Egyptian crude oil output. The remaining 22% is imported from other nations such as Kuwait, Saudi Arabia, and Iraq.

Disruption of Supply Chains and the Petroleum Industry:

In the current rapidly changing and delicate situation, disruptions during a pandemic have become even more crucial. Supply chain disruption refers to an unforeseen event that has a significant impact and can happen at any point in the supply chain, leading to a supplier or other component stopping their operations partially or completely for an unknown period of time. Disruption risks can be classified into two categories: random disruption risks, which can happen unpredictably at any stage of the supply chain, and premeditated disruption risks, which are deliberately orchestrated to create maximum harm by disrupting performance.Fire, leakage, explosions, pandemics, unforeseen natural calamities, and supplier failure are instances of stochastic disruptions.

The United States' oil sector refining processes were badly affected by Hurricanes Katrina and Rita in 2005, resulting in the largest financial loss in history for the core of the United States' oil sector region. The deliberate disruptions of the oil supply chain, such as pipeline attacks, labor union strikes, and the ongoing pandemic, are all instances of premeditated interruptions. Our study examines both unforeseen and anticipated disturbances that impact Egyptian refineries. Relying on prevalent corporate practices such as just-in-time logistics, streamlined production, outsourcing, globalization, and cost-cutting measures has led to the development of supply chains that are efficient under normal circumstances but vulnerable to disruptions.

Research Objectives:

• To investigate about the existing supply chain resilience strategies in oil refineries around the world and past literature published.

• To assessment resilience supply chain strategies under uncertainties.

• To review optimum supply chain resilience strategies used by Oil refineries focusing on the Egyptian oil refineries.

• To identify the challenges facing oil industry specially refining companies in formulating supply chain resilience strategy SCRES.

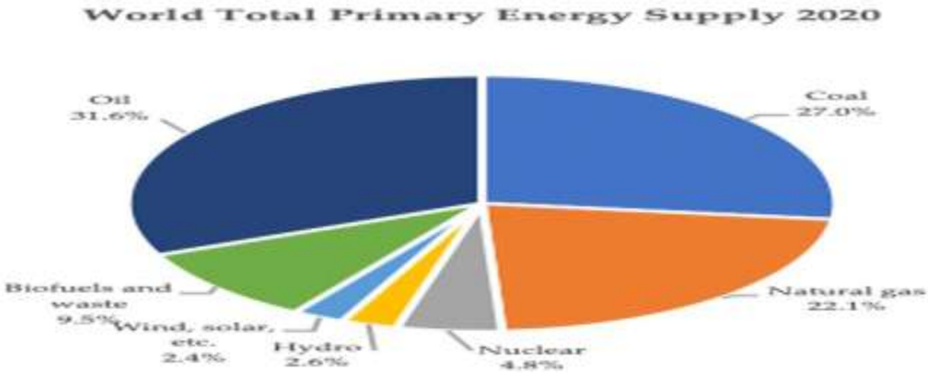
Methodology:

The research would be elaborated using the literature research and field work through conducting interviews with a supply chain manager's and expertise work in a network of 12 oil refineries and logistics companies in Egypt ,total participants in interviews are 72 participants

Petroleum industry overview:

Edwin Drake achieved the first triumphant drilling of oil wells in Pennsylvania, United States, in 1859. This marked the birth of the contemporary petroleum industry. Prior to that, oil was only present in minute quantities where it spontaneously emerged from the earth's surface in various locations around the globe. Following the discovery of "rock oil" in northwestern Pennsylvania, a sufficient amount of crude oil became accessible, enabling the construction of extensive processing systems. Initially, the early refineries employed uncomplicated distillation units to segregate the various components of crude oil. The process involved heating the crude oil mixture in a vessel and subsequently condensing the resulting vapors into liquid fractions. The primary end product was kerosene. Initially, it was employed as an alternative to whale oil for illuminating lights, but with the advent of the gasoline engine, its versatility was discovered.

Currently, the global reliance on oil is substantial, with a consistent and continuous increase in demand each year. The International Energy Agency reports that in 2021, oil accounted for 31.6% and natural gas accounted for 22.1% of global energy consumption. According to Figure 3, oil has been the primary energy source utilized since 2021, with coal and natural gas following closely behind.



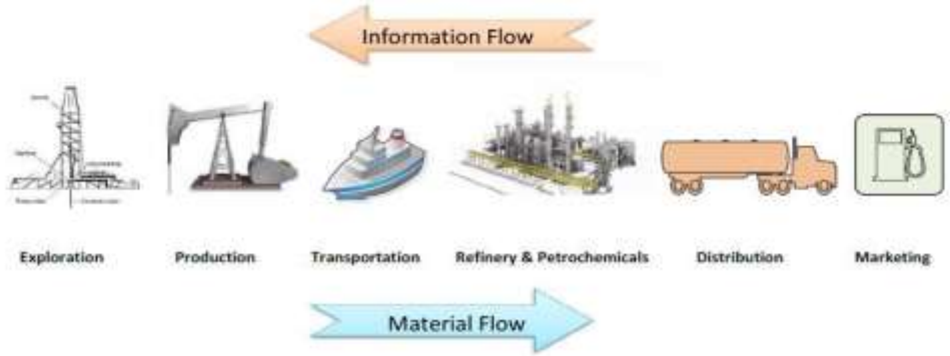
The total primary energy supply (TPES) in 2021, ***International Energy Agency 2021***

Due to the expanding global population and continuous economic growth, the demand for petroleum products will remain elevated. In order to fulfill this need, the oil industry must engage in strategic planning and allocate significant financial resources towards optimization technologies.

Petroleum supply chain Overview:

Supply chain management, also known as SCM, is the systematic arrangement of the movement of resources and completed items to meet the demands of end customers for products and services. According to Christopher and Gattorna (2005), the supply chain refers to the network of companies that are connected through both upstream and downstream linkages in various processes and activities that generate value in the form of products and services provided to the final consumer.

Supply chain management involves efficiently coordinating the movement of materials and goods to guarantee that the end customers receive the products and services promptly, while also being cost-effective and efficient. According to Christopher (2010), supply chain management (SCM) refers to the management of links with suppliers and consumers in both the upstream and downstream directions. The goal of SCM is to provide greater customer value while minimizing costs across the entire supply chain. Lambert and Cooper (2000) define value creation as the act of integrating crucial business processes, starting from the initial supplier and extending to the end user, in order to provide products, services, and information that enhance value for customers and other stakeholders. As per the definitions, the supply chain is a cohesive process where various separate business entities, including customers, suppliers, manufacturers, distributors, and retailers, collaborate to: (1) acquire raw materials; (2) transform these raw materials into the desired end products; and (3) distribute these products to retailers/customers. The movement of materials in the chain often follows a clockwise direction, whereas the transfer of knowledge goes in the opposite, counter-clockwise direction (Beamon, 1998). Refer to figure 7 for a representation of a typical petroleum supply chain.



Petroleum industry supply chain (SC) under uncertainties:

Uncertainty arises when individuals involved do not possess the requisite information to accurately depict the present state of affairs or predict the future outcomes of events. Uncertainty regarding objectives, insufficient knowledge about the supply chain and its environment, limited capacity to process information, inability to accurately predict the consequences of control actions on supply chain behaviors, and absence of effective control measures can all potentially influence decision making in the supply chain (Van der Vorst et al). The year 2002. Prolonged uncertainty might pose a persistent challenge.

According to Sahinidis et al (1989), the effects of price fluctuations in raw materials, market demand, and production rates may take from five to 10 years to manifest. instant challenges in the short term involve fluctuations in processing on a daily or weekly basis, such as equipment malfunctions or cancelled orders, which demand an instant reaction (Gupta & Maranas, 2003). The presence of mid-term uncertainties might impact operations over a duration of one to two years. Subrahmanyam and colleagues (1994).It is crucial for individuals employed in the petroleum processing industry to anticipate and plan for a substantial level of unpredictability. As previously said, the business is prone to several risks, with the most significant ones being the unpredictable reserves, production difficulties, and changes in the pricing of raw materials, refined products, and market demand. Lababidi et al. (2004) conducted a study to examine how uncertainties in demand, market pricing, raw material costs, and production yields impact planning decisions in the petrochemical supply chain. In their study, Ghatee and Hashemi (2009) proposed a modeling framework to optimize the transportation of crude oil, taking into account uncertainties in tank and pipeline capacity, oil field output, refinery demand, and export terminal.

Exogenous or External Uncertainty	Endogenous or Internal Uncertainty
• Location • Crude oil supply • Production costs • Distribution costs • Market demand • Processing investment costs Prices of crude oil and chemicals • Production demands (product volume & specification) • Budget available for capital investment in purchasing new equipment or replacing existing equipment and expanding capacity	• Product/process yield • Machine availabilities • Properties of components • Processing and blending options

The scope of supply chain resilience:

Keep in mind that the "next objective property of the supply chain" is the "ability to maintain, execute, and recover (adapt) planned execution along with achievement of the planned (or adapted, but still acceptable) performance" (Ivanov 2018a). In this regard, may serve as an example. Maintaining an acceptable level of performance in spite of disruptions is the focus of supply chain resilience. A supply chain can mitigate the effects of disruptive events (such as a shortage in supplies) by employing some preventative measures (such as stockpiling). In contrast, performance (such as on-time delivery or revenue) can suffer if proactive capabilities are not utilised. To get things back up and running, reactive abilities need to be used here. This is a time-consuming and expensive process. So far, risk reduction, disruption readiness, supply chain stabilization, and rapid recovery have been the cornerstones of a resilient supply chain.

The most commonly cited SCRES strategies involve:

Increasing flexibility, creating redundancy, forming collaborative supply chain relationships and improving supply chain agility.

This is consistent with previous researchers who have considered these strategies as the most critical for SCRES (e.g. Longo & Oren, 2008; Jüttner & Maklan, 2011; Ponis & Koronis, 2012). These four key strategies – some of which are inter-related – are briefly discussed below before a broader discussion and assessment of resilience strategies follows.

Increasing Flexibility:

According to Erol et al. (2010), flexibility is the capacity of a business to adjust to the evolving demands of its surroundings and stakeholders with minimal time and effort. Literature highlights several techniques that can improve supply chain responsiveness and agility, including postponement, a flexible supplier network, adaptable transportation, flexible labor arrangements, and order fulfillment flexibility (Tang, 2006b; Christopher & Holweg, 2011; Pettit et al., 2013). An example of this is the argument that flexibility achieved by postponement improves resilience in times of crisis by delaying demand to a future period, specifically 70 (Tang, 2006b). Flexibility contributes to the creation of Supply Chain Resilience (SCRES) by improving the ability to quickly react to unpredictable situations, such as turbulence (e.g. Christopher & Holweg, 2011). Additionally, it assists in the swift response and restoration of a supply chain, which can be aided by having other options (redundancy), such as alternate suppliers (e.g. Sheffi & Rice, 2005). Flexibility facilitates the seamless reallocation of resources, such as transportation and labor resources (Pettit et al., 2013). In a broader sense, flexibility is essential because the challenges to resilience are constantly changing, which calls for remedies that can also adjust accordingly..

Creating Redundancy:

Redundancy refers to the deliberate and careful utilization of extra capacity and inventory that can be utilized in times of crisis to manage situations such as supply shortages or sudden increases in demand (Christopher & Peck, 2004). Establishing redundancy can be a costly method of constructing resilience. For instance, it is necessary to have extra capacity along the most important tasks in order to decrease the possibility of susceptibility and enhance the ability to recover from disruptions (Christopher & Rutherford, 2004). However, it is crucial to consider elements such as geographical location and the overall global demand when relying on redundancy to construct SCRES.

In instances where redundant suppliers are located near the interrupted supply network, they may also be impacted by the event, such as after an earthquake or flood.

Moreover, redundancy is defined as the replication of resources to ensure uninterrupted operations in the event of a breakdown (Rice & Caniato, 2003). Consequently, redundancy can be regarded as a means to achieve flexibility (e.g. Jüttner & Maklan, 2011; Kristianto et al. 2014). Johnson et al. (2013) discovered that redundancy enhances flexibility, enabling a more adaptive allocation of resources that enables reaction. This 71 assists in preventing any form of delay, thereby leading to an increase in SCRES. While the development of redundancy is strongly associated with the establishment of flexibility, there are alternative methods to obtain flexibility. These include utilizing a workforce with diverse skills, implementing versatile machinery, and establishing adaptable contractual agreements. Many scholars have chosen flexibilities that do not rely on redundancy because they save firms' resources. Examples of such flexibilities may be found in the works of Christopher & Holweg (2011) and Thun et al. (2011).

Supply Chain Collaboration:

Pettit et al. (2013) define supply chain cooperation as the capacity to efficiently cooperate with other entities for mutual advantage in various aspects, including forecasting, postponement, and risk sharing. Collaboration may encompass the interchange of information, leading to a reduction in uncertainty, an enhancement in transparency, and the facilitation of knowledge production and sharing. This can be particularly useful in the context of understanding and managing supply chain risks and uncertainties (Christopher & Peck, 2004). Collaboration can facilitate the sharing of expenses among supply chain partners for the establishment of security and resilience (Bakshi & Kleindorfer, 2009). Furthermore, it has an impact on the strategies implemented by supply chain partners to achieve supply chain recovery (Ghadge et al., 2012). Collaboration enables the exchange of resources and complementary abilities that are essential for recovering from a disruption (Scholten et al., 2014; Scholten & Schilder, 2015). Collaboration improves supply chain resilience (SCRES) by facilitating mutual support among partners after a disruptive event (Jüttner & Maklan, 2011) and enabling a flexible and coordinated response. As an illustration, the cooperation between Toyota and its suppliers after the 1997 Aisin Seiki Kariya plant fire is mentioned in a study by Nishiguchi and Beaudet (1998). This example serves as a reminder of how certain practices in supply chain relationships, such as just-in-time supply and single-sourcing supply partnerships, can create vulnerabilities that need to be balanced against the benefits of these practices, such as strong networks that can enable a quick response to a crisis. However, this partnership can also result in vulnerability, such as when forming societal obligations that must be fulfilled even if they are counterproductive. This was apparent in the results of this study, where companies were required to exercise patience in the event of supplier delivery delays and failures. This restriction on the ability to swap suppliers limited flexibility and had a corresponding impact on downstream operations by causing delays in delivering products to customers.

Supply Chain Agility:

According to Christopher & Peck (2004), supply chain agility is the capacity to promptly adapt to unforeseen fluctuations in demand or supply. This can be accomplished by swiftly modifying corporate processes and systems (Erol et al., 2010). According to Christopher & Peck (2004), supply chain agility primarily consists of visibility and velocity. Supply chain visibility pertains to the capacity to gain insight into the entirety of the supply chain (Christopher & Peck, 2004). It provides a comprehensive perspective of the entire chain, which can aid in identifying indications of imminent problems. Visibility refers to the understanding of the condition of a supply chain's assets and surroundings (Pettit et al., 2013). This understanding helps prevent excessive responses, superfluous activities, and poor choices in risky situations (Christopher & Lee, 2004). Moreover, it facilitates the supply chain's ability to promptly and efficiently address and overcome interruptions by, for instance, pinpointing susceptible suppliers, thus affording adequate opportunity to devise strategies to mitigate prospective breakdowns (Jüttner & Maklan, 2011). Procter & Gamble planners have enhanced their supply chain visibility by implementing monitoring technologies to create a map of the supply chain. This allows them to better understand potential risks and receive timely alerts about any interruptions (Saenz & Revilla, 2014). Saenz & Revilla (2014) elaborate on the ways in which supply chain visibility assisted Cisco in enhancing its ability to adapt quickly and recover from the impact of the Japanese earthquake and tsunami in 2011. Within a span of twelve hours following the tragedy, Cisco successfully delineated its supply chain beyond the primary suppliers, encompassing over 300 suppliers. Furthermore, within twenty-four hours, the company managed to track its customers and address a total of 118 customer inquiries. This enabled it to establish a robust Strategic Crisis Response and Emergency Management (SCRES) plan and endure the consequences of the catastrophe (Saenz & Revilla, 2014). The second aspect of agility discussed by Christopher & Peck (2004) is supply chain velocity, which pertains to the speed at which the supply chain can make flexible adjustments (Stevenson & Spring, 2007). This factor ultimately influences how quickly the supply network can recover from a risk event (Jüttner & Maklan, 2011).

The four core strategies discussed above have received the majority of the attention in the SCRES literature. Beyond these four strategies, the literature on means of developing resilience to supply chain threats or disruptions is broad but limited in depth (see Table 2.9). Moreover, although the SCRES literature has identified many strategies for creating SCRES, few studies have gone beyond this to focus on how firms can actually develop or implement these strategies (Blackhurst et al., 2011). Yet, SCRES research should not only be about identifying strategies, but also about understanding how they can be successfully implemented. For example, it is abundantly clear that SCRES strategies have financial implications that may limit their implementation. Other issues, such as corruption, sociopolitical instability, and unethical competitive practices, which are common sources of business risks (Lakovou et al., 2007), may also pose a threat to a SCRES strategy implementation. Similarly, how firms can choose between different SCRES strategies is under-researched. Given that a firm has limited resources to deploy, what factors should a manager take into consideration when deciding how to improve SCRES? One of the factors influencing the choice of strategy to adopt is likely to be a firm's or individual's perceptions of risk (Martin et al., 2009; Park, 2011). Cox et al. (2011) argued that the perception of a threat plays a fundamental role in building SCRES. Thus, perceptions of supply chain threats and how such perceptions shape decisions concerning the choice of certain SCRES strategies over others could be an important consideration for future research.

Although, clearly, several SCRES strategies have been proposed, the relationships between them remain ambiguous (Jüttner & Maklan, 2011; Ponis & Koronis, 2012; Johnson et al., 2013; Hohenstein et al., 2015). There are varying views on the exact relationship between constructs such as flexibility, redundancy, collaboration and agility (e.g. Tang &Tomlin 2008; Zsidisin & Wagner, 2010; Jüttner & Maklan, 2011; Ponis & Koronis, 2012; Johnson et al. 2013). All can be considered as antecedents of SCRES (e.g. Zsidisin & Wagner 2010; Carvalho et al. 2012b; Ponis & Koronis 2012). But, for example, while some SCRES scholars consider constructs like flexibility and redundancy to be independent (Sheffi & Rice,2005; Zsidisin &Wagner, 2010), others argue they are interrelated (e.g. Jüttner & Maklan, 2011; Ponis & Koronis, 2012; Johnson et al., 2013). Further, it is argued that supply chain collaboration and redundant resources facilitate flexibility (Jüttner & Maklan, 2011; Scholten & Schilder, 2015; Tukamuhabwa et al., 2015); and that both flexibility and collaboration can improve agility (Carvalho et al., 2012b) – suggesting these strategies can complement each other. Nevertheless, it seems equally possible that different strategies for building SCRES can conflict with one another. For example, it has been argued that building close collaborative relationships can conflict with some aspects of flexibility (Stevenson & Spring, 2007; Scholten & Schilder, 2015). Collaboration through information sharing may facilitate the disclosure of sensitive information leading to loss of confidentiality (Jüttner & Maklan, 2011) and enhancing redundancy to facilitate flexibility may result in a liquidity risk (Jüttner & Maklan, 2011). Based on the above discussion, it can be argued that enhancing each SCRES strategy in isolation may be counterproductive, raising the possibility of a moving problem known as risk migration (e.g. Grabowski & Roberts, 1997; Alcock & Busby, 2006). In other words, in a bid to achieve one facet of resilience – by enhancing one of its antecedents – other facets are likely to be degraded through the effects on other antecedents. This – which is likely to reduce the effectiveness of SCRES strategies – requires a more holistic approach and should be investigated further.

Supply Chain Resilience (SCRES) Strategies:

The SCRES strategies identified from the data were broadly grouped into higher level categories and respective lower level categories as illustrated in following Table

SCRES Strategies	
Higher Level Categories	*Lower Level Categories*
Increasing Flexibility	local sourcing, order splitting, alternative transportation, Manufacturing flexibility, buying instead of making (temporarily) Postponement ,Creating customer flexibility
Creating Redundancy	maintaining strategic stocks, inventory management, Backward integration, , outsourcing, , appropriate supplier selection, multiple sourcing, supplier development, ,effective contracting, procurement management, quality management, exclusive sourcing.

Supply Chain Collaboration	Co-opetition, collaboration with government, collaboration with government, collaboration with customers, collaboration with suppliers, Informal networking, demand forecasting, information communication technology, Risk communication.
Supply Chain Agility	Improving visibility, , market intelligence, , increasing product knowledge. ensuring product security

Summary of the Research Gaps:

The global crisis caused by the Corona virus pandemic has direct Impact on global crude oil supply chains, which led to an unprecedented collapse in prices as global fuel consumption shrinks due to the Corona virus pandemic.

Where the petroleum industry faces a real challenge, especially the refining industry, because it is directly linked to the global supply chains of crude oil and petroleum products, and any instability of these supplies will have a significant impact on the activities of the refining and petrochemical companies.

This was evidenced by the instability of crude oil supplies to the refineries in the period starting from April 2020, which caused a major unexpected surplus supply of crude oil and petroleum products that did not occur in the history of the oil industry, which caused a significant reduction in the operating utilization of the refineries, expose them to a shutdown, As opposite to all previous crises represented due to lack of crude oil and petroleum products supplying that used to lead to sharp increase in prices.

However, this crisis caused a sharp drop in crude oil prices, in the second quarter of 2020 recorded the largest loss in crude oil prices in history, as prices fell by about 200%, and the price of a barrel of oil fell to minus $ 40, which is the largest loss ever .

The concept of the supply chain has received increasing attention over the last twenty years. In the oil and gas sector, we have focused our interest on the petroleum SC and its logistics. This literature review 89 highlights the various resilience strategies that have been used to mitigate the SC and logistics in the petroleum industry under different types of uncertainty.

The correlations between uncertainty type as internal or external and the supply chain resilience strategy we can implement during the uncertainty events will depend on the outcome due to strategy implementation.

After Coved 19 as pandemic which is one of the uncertainties face refinery industry we found it's essential to focus more on main points can be summarized as follows:

- Many authors have sought to address the problem by introducing solutions designed for segments of the supply chain a few of them have taken a holistic view of the chain from exploration field to distribution centre.
- Most of the studies reviewed above treat the planning problem on the tactical and operational levels few have considered the strategic level.

- Further research is required into how the petroleum SC might deal with different types of uncertainty such as resource availability, raw material prices, product demand etc.
- There are a small number of researches considered specific resilience strategies (SCREC) for petroleum supply chain problems.
- There is a need for further empirical work on SCRES, particularly across a network of firms and in a oil refinery supply chain.
- There is a need to understand the relationships between the various strategies proposed for building resilience. Strategies may reinforce or contradict each other, potentially affecting their implementation outcomes.
- Further research is needed in which appropriate theory frames are used to interpret and enhance understanding of empirical findings as it was found that there is limited use of theoretical frames in the current SCRES empirical work.

Building on the above gaps, this thesis seeks to firstly investigate the elements of SCRES in a developing country context by investigating what oil refineries in Egypt perceive to be the threats to their supply chains, what strategies they adopt to build resilience, and what the outcomes are of implementing these strategies. Secondly, there is need to investigate how threats and strategies are interrelated, and what such interrelatedness means for SCRES.

Research Strategy and Choice: Case Study:

Following Saunders et al. (2009)'s research design framework, research strategy can be in the form of survey, case study, grounded theory, ethnography, action research, experiment or archival research. Research choice on the other hand can be mono-methods, multiple methods or mixed methods (Saunders et al., 2009). The choice of a research strategy can be determined by the research question(s), the extent of existing knowledge, the available time and other resources as well as the researcher's philosophical underpinnings (Saunders et al., 2009).

Techniques and Procedures:

This subsection mainly explains how the data was collected and analysed. It highlights the choice of the cases, interview protocol, ethical concerns, pilot study, main data collection, data analysis and the quality of the research design.

Selection of the Cases:

In qualitative research, the researcher's judgment in selecting appropriate respondents is arguably more effective than the use of probability sampling (Malhotra & Birks, 2007). From the SCRES literature, there was a clear need to conduct research on the resilience of supply chains under different uncertainties, using a network as the unit of analysis. Thus based on the principles of theoretical sampling, where cases should be selected based on their theoretical relevance, while allowing for flexibility to change cases during the research process (Eisenhardt, 1989; Stuart et al., 2002; Dubois & Araujo, 2007), the first criterion was to study firms in the developing country context (EGYPT). Secondly, firms that depend on a supply network were to be chosen, and these firms must have experienced supply chain uncertainties. Further, these firms were to be located in all over EGYPT.

Egypt Oil Refining Background:

Egypt is the biggest oil refiner in Africa with a total of ten refining companies operating 12 refineries. This is compared to second-place South Africa, which has six refineries, according to an article in Oil & Gas Journal published in 2015. Interestingly, Egypt's oil refining business could have been much bigger had the government adhered to the plan to build an oil refinery every five years starting 2000 to meet rising demand. Only one was built since; Egyptian Refining Company (ERC) in 2015. Meanwhile, sporadic upgrades have pushed Egypt's maximum oil refining capacity to 732,550 barrels a day by the end of 2016, according to the Egyptian General Petroleum Corporation (EGPC).

This production capacity was only sufficient to cover 65% of local demand from petroleum products throughout 2016, according to the head of EGPC . Consumption throughout 2016 has been 7% higher than in 2015.

Middle East Oil Refinery (MIDOR):

MIDOR was established in 1994 by EGPC, which owns 98% of its shares and Suez Canal Bank owning the rest. It is widely regarded as the most advanced oil refinery in Egypt with state-of-art equipment. The refinery, whose capital is $1.1 billion, is being considered for an IPO estimated to raise $400 million, according to Reuters in 2015. MIDOR, which is located in the Ameryia specialized free zone in Alexandria, has 16 production units with a combined maximum refining capacity of 100,000 barrels a day, according to EGPC. (Crude and vacuum distillation capacity is 100,000 barrels a day; two types of naphtha have a production capacity 102 of 64,900 barrels a day; catalytic reforming is 21,700 barrels a day; and kerosene is 10,150 barrels a day, according to the company's official annual reports .) By the end of 2016, MIDOR had refined a total of around 33.3 million barrels in the first quarter of 2017, production was up by 109% compared to the previous year.

Cairo Oil Refining Company (CORC):

In terms of refining capacity, CORC is Egypt's biggest refinery. It was established in 1982 by EGPC, which owns 100% of its shares. CORC has two refineries. One is in Mostorod with a maximum production capacity of 142,000 barrels a day. The other is in Tanta whose production capacity is 35,000 barrels a day. Around 75% of CORC's revenue comes from the Mostorod refinery. market share does CORC have with estimates ranging from 20% to 25%.

Egyptian Refining Company (ERC):

Unique among Egypt’s refineries, ERC is run by the private sector, which makes up 76.2% of its shares. The biggest shareholder is Qatar Petroleum International (17.9% of shares). Qalaa Holding has 18.8% while IFC holds 6.4% and Dutch Development bank owns 2.2%. EGPC owns 33.8% of shares.

ERC was commissioned in 2007 as a public private partnership project. Its current maximum refining capacity is around 28 million tons a year, as 2.3 million tons are Europe-compliant diesel, which is half of Egypt’s diesel imports, 800,000 tons of gasoline and 600,00 tons of IATA-spec jet fuel. The rest of the production portfolio includes kerosene, reformate, naphtha, liquefied petroleum gas and fuel oil, according to the ERC website.

Alexandria Petroleum Company (APC):

Opened in 1954 as another refinery wholly owned by EGPC, APC was a small oil refinery aiming to meet the needs of Alexandria governorate and Delta. However, it has grown over the following decades, becoming the second biggest single shareholder in Alexandria Minerals and Oils, the only EGX-listed refinery in Egypt, with 20% share ownership. It also owns 72% of Alexandria National Refining and Petrochemicals Company. APC capital is currently EGP 1 billion.

Alexandria Minerals and Oils Company (AMOC):

Unique in several ways, AMOC was commissioned in 1997 and listed on EGX in 2004. It is currently the only refinery in Egypt to be publically traded and one of only two where EGPC doesn't have a direct stake. As it stands, 53% of the company is owned by state-owned banks, the biggest of which is the National Bank of Egypt through its investment arm, Al-Ahly Capital Holding (25.3% of shares), and Misr Bank (14.3% of shares). Other oil refining firms hold 27% of AMOC's shares, the biggest of which is APC with a 20% share.

Alexandria National Refining and Petrochemicals Company (ANRPC):

The other oil refinery not be directly owned by EGPC is ANRPC, which was established in 1999. APC is the majority owner with 72% of shares. The National Bank of Egypt owns 18% and Alexbank owns 1% of the company. As it stands, the refinery's capital is EGP 713 million.

Nasr Petroleum Company (NPC):

The oldest refinery in Africa, NPC was commissioned in 1913. It was nationalized after the July 1952 revolution and 100% owned by EGPC. Its production capacity stands at 146,000 barrels a day, according to the company website. However, EGPC estimates it at 107,550 barrels a day. In addition to its own Suez-based refinery (99,000 barrels a day), NPC operates the

Wadi Feran refinery (8,550 barrels a day) in the Gulf of Suez, overlooking the Red Sea.

Amreya Petroleum Refining Company (ARPC):

ARPC was opened in 1984, under full ownership of EGPC, after splitting from NPC. However, the refining facility itself had been operational since 1972. Its current maximum production capacity is 81,000 barrels a day, according to EGPC. In 2016, ARPC produced four million tons of refined oil-based products

Suez Oil Processing Company (SOPC):

SOPC is the second oldest oil refinery in Egypt, built in 1921. Its ownership was transferred to EGPC in 1953, when its name became Government Oil Processing Company. In 1962, it became El Nasr for Oil Manufacturing and Petrochemicals. In 1963 it merged with a Suez-based refinery to become SOPC. The refinery currently employs over 5280 workers.

Assuit Oil Refining Company (AORC):

ASORC was built in 1987 by EGPC to meet demand from Upper Egypt. Its current maximum production capacity is five million tons, according to the company website. EGPC sets it at 47,000 barrels a day in 2016. The company’s production complex is an integrated facility with a dedicated oil pipeline connecting the factory with its main supplying field in the Shokeir region.

Suez-Mediterranean Pipeline SUMED:

The Sumed Pipeline (also known as the Suez-Mediterranean Pipeline) is an oil pipeline in Egypt, running from the Ain Sokhna terminal in the Gulf of Suez, near the Red Sea, to offshore Sidi Kerir port, Alexandria in the Mediterranean Sea. It provides an alternative to the Suez Canal for transporting oil from the Persian Gulf region to the Mediterranean. The Sumed pipeline is 320 kilometres (200 mi) long. It consists of two parallel lines of 42 inches (1,070 mm) diameter. Its capacity is 2.5 million barrels per day (400×103 m3/d).

Western Desert Operating Petroleum Company WEPCO:

Established at El-Hamra Terminal on 1968 at the Mediterranean coast and 120 km west of the Alexandria city for handling all western desert crude oil production which is represent about 50% of Egypt crude oil production. All Western Desert production is transported to ElHamra Terminal thru three main pipelines where these pipelines are automatically controlled and well monitored by metering stations.

Prove the hypothesis research:

The researcher Focuses on test three Hypotheses essential, at the level of each group of companies in order to address the various dimensions of the research problem and objectives, as follows:

1-**Hypotheses one H1**: (Exogenous Threats) x1 has a s statistically significant impact on (Strategies in oil industry) y.

Derived from this hypothesis the following 4 sub-hypotheses

H_{1a}: (Exogenous Threats) x1 has a s statistically significant impact on (Increasing Flexibility) y1.

H_{1b}: (Exogenous Threats) x1 has a s statistically significant impact on (Creating Redundancy) y2.

H_{1c}: (Exogenous Threats) x1 has a s statistically significant impact on (Supply chain collaboration) y3.

H_{1d}: (Exogenous Threats) x1 has a s statistically significant impact on (Supply chain agility) y4.

2-Hypotheses two H_2: (Endogenous Threats) x2 has a s statistically significant impact on (Strategies in oil industry) y.

Derived from this hypothesis the following 4 sub-hypotheses

H_{2a}: (Endogenous Threats) x2 has a s statistically significant impact on (Increasing Flexibility) y1.

H_{2b}: (Endogenous Threats) x2 has a s statistically significant impact on (Creating Redundancy) y2.

H_{2c}: (Endogenous Threats) x2 has a s statistically significant impact on (Supply chain collaboration) y3.

H_{2d}: (Endogenous Threats) x2 has a s statistically significant impact on (Supply chain agility) y4.

3-Hypotheses three H3-There is statistically significant difference for dimensions (Supply chain resilience strategies in oil industry) on level companies as study sample.

<u>Group 1</u>

It is accepted that the statistical alternative hypothesis of a relationship between Independent variable (Exogenous Threats) and Dependent Variables (Strategies in oil industry).In most parts.

Table (1)Effect of the **"Exogenous Threats x1"** on "Strategies in oil industry" using Liner Regression

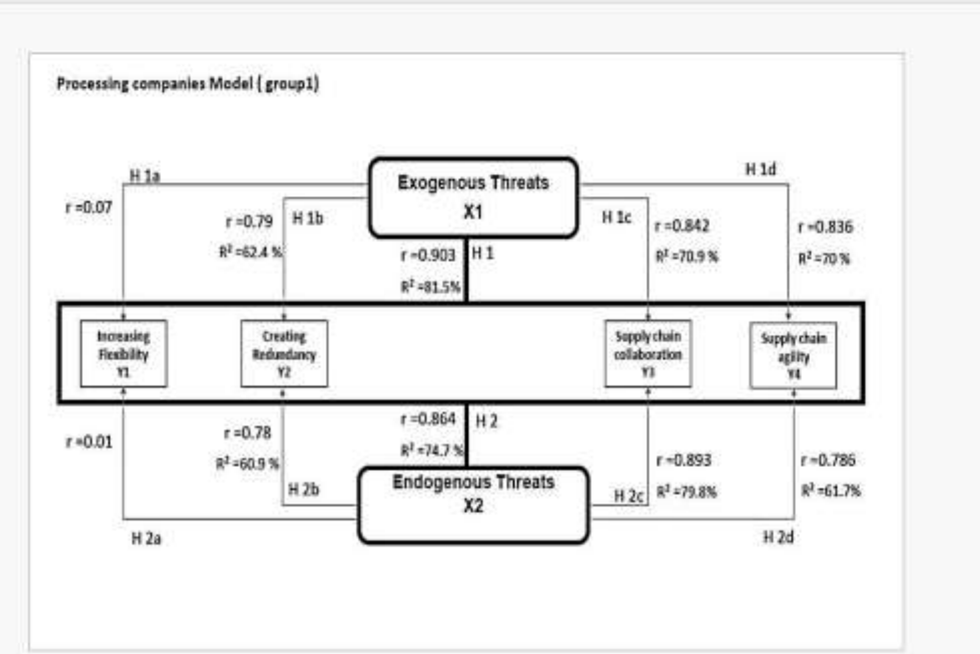
Independent	Path →	dependent	B	t. test		F. test		R2
				Value	Sig.	Value	Sig.	
Exogenous Threats	→	y. Strategies in oil industry	0.903	8.398	0.01**	70.520	0.01**	81.5%
Exogenous Threats	→	Y2. Creating Redundancy	0.790	5.158	0.01**	26.608	0.01**	62.4%
Exogenous Threats	→	Y3. Supply chain collaboration	0.842	6.242	0.01**	38.957	0.01**	70.9%
Exogenous Threats	→	Y4. Supply chain agility	0.836	6.106	0.01**	37.279	0.01**	70%

Table (2) Correlation matrix between: Independent variables **(Endogenous Threats)** and Dependent Variables (Strategies in oil industry) using Pearson correlation

1- Processing companies		
Dependent Variables	Independent Variable (Endogenous Threats) x2	
	r	**Sig.**
Y- Strategies in oil industry	0.864	0.01**
y1-Increasing Flexibility	0.010	0.96
y2- Creating Redundancy	0.780	0.01**
y3- Supply chain collaboration	0.893	0.01**
y4- Supply chain agility	0.786	0.01**

Table (3) Effect of the "Endogenous Threats x2" on "Strategies in oil industry" using Liner Regression

independent	Path →	dependent	B	t. test		F. test		R2
				Value	Sig.	Value	Sig.	
Endogenous Threats	→	y. Strategies in oil industry	0.864	6.865	0.01**	47.130	0.01**	74.7%
Endogenous Threats	→	Y2. Creating Redundancy	0.780	4.990	0.01**	24.896	0.01**	60.9%
Endogenous Threats	→	Y3. Supply chain collaboration	0.893	7.958	0.01**	63.335	0.01**	79.8%
Endogenous Threats	→	Y4. Supply chain agility	0.786	5.079	0.01**	25.797	0.01**	61.7%



group 2

Table (4) Correlation matrix between: Independent variables (Exogenous Threats) and Dependent Variables (Strategies in oil industry) using Pearson correlation

	Refining companies (n=42)	
Dependent Variables	**Independent Variable (Exogenous Threats) x1**	
	r	**Sig.**
Y- Strategies in oil industry	0.602	0.01**
y1-Increasing Flexibility	0.181	0.25
y2- Creating Redundancy	0.267	0.08
y3- Supply chain collaboration	0.178	0.25
y4- Supply chain agility	0.771	0.01**

Table (5) Effect of the "Exogenous Threats x1" on "Strategies in oil industry" using Liner Regression

independent	**Path →**	**dependent**	**B**	**t. test**		**F. test**		**R2**
				Value	**Sig.**	**Value**	**Sig.**	
Exogenous Threats	→	y. Strategies in oil industry	0.602	4.769	0.01**	22.744	0.01**	36.2%
Exogenous Threats	→	Y4. Supply agility	0.771	7.662	0.01**	58.701	0.01**	59.5%

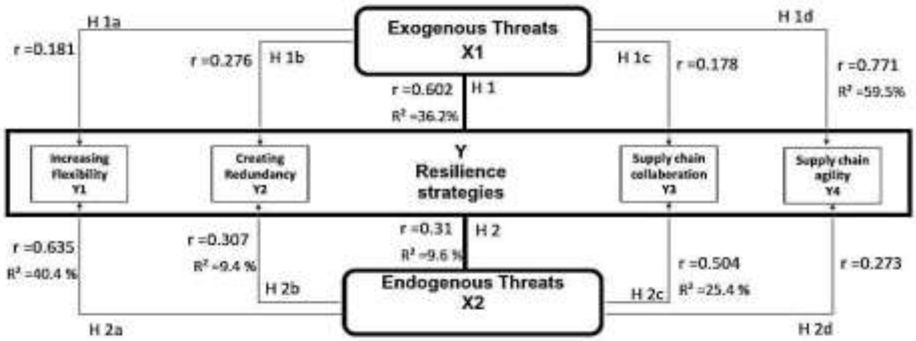
Table (6) Correlation matrix between: Independent variables (Endogenous Threats) and Dependent Variables (Strategies in oil industry) using Pearson correlation

2- Refining companies (n=42)		
Dependent Variables	Independent Variable (Endogenous Threats) x2	
	r	**Sig.**
Y- Strategies in oil industry	0.310	0.05*
y1-Increasing Flexibility	0.635*	0.01**
y2- Creating Redundancy	0.307	0.05*
y3- Supply chain collaboration	0.504	0.01**
y4- Supply chain agility	0.273	0.08

Table (7) Effect of the "Endogenous Threats x2" on "Strategies in oil industry" using Liner Regression

independent	**Path →**	**dependent**	**β**	**t. test**		**F. test**		**R2**
				Value	**Sig.**	**Value**	**Sig.**	
Endogenous Threats	→	y. Strategies in oil industry	0.310	2.061	0.05*	4.248	0.05*	9.6%
Endogenous Threats	→	y1- Increasing Flexibility	0.635	5.203	0.01**	27.069	0.01**	40.4%
Endogenous Threats	→	Y2. Creating Redundancy	0.307	2.043	0.05*	4.173	0.05*	9.4%
Endogenous Threats	→	Y3. Supply chain collaboration	0.504	3.686	0.01**	13.587	0.01**	25.4%

Refining companies Model (group2)



<u>Group 3</u>

Table (8) Correlation matrix between: Independent variables (Exogenous Threats) and Dependent Variables (Strategies in oil industry) Using Pearson correlation

Handling and logistics companies (n=12)		
Dependent Variables	**Independent Variable (Exogenous Threats) x1**	
	r	**Sig.**
Y- Strategies in oil industry	0.751	0.01**
y1-Increasing Flexibility	0.793	0.01**
y2- Creating Redundancy	0.219	0.49
y3- Supply chain collaboration	0.801	0.01**
y4- Supply chain agility	0.812	0.01**

Table (9) Effect of the "Exogenous Threats x1" on "Strategies in oil industry" using Liner Regression

independent	Path →	dependent	B	t. test		F. test		R2
				Value	Sig.	Value	Sig.	
Exogenous Threats	→	y. Strategies in oil industry	0.751	3.596	0.01**	12.932	0.01**	56.4%
Exogenous Threats	→	Y1. Increasing Flexibility	0.793	4.110	0.01**	16.889	0.01**	62.8%
Exogenous Threats	→	y3- Supply collaboration	0.801	4.226	0.01**	17.859	0.01**	64.1%
Exogenous Threats	→	Y4. Supply chain agility	0.812	4.404	0.01**	19.393	0.01**	66%

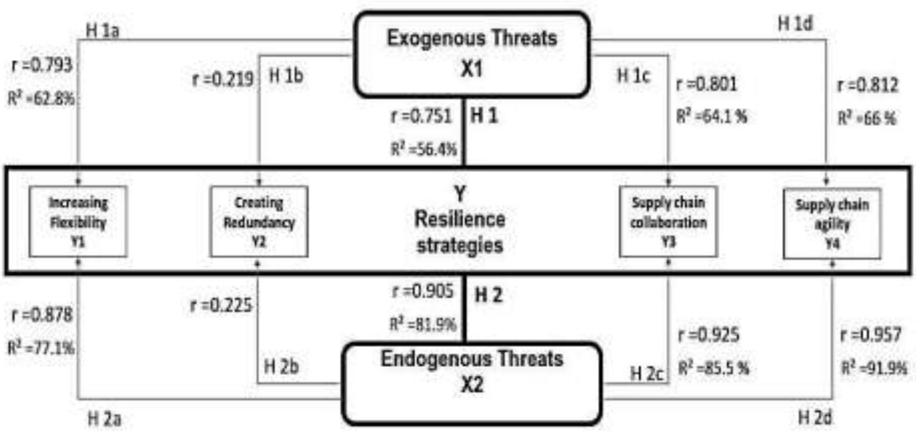
Table (10)Correlation matrix between: Independent variables (EndogenousThreats) and Dependent Variables (Strategies in oil industry) using Pearson correlation

3-Handling and logistics companies (n=12)		
Dependent Variables	Independent Variable (Endogenous Threats) x2	
	r	Sig.
Y- Strategies in oil industry	0.905	0.01**
y1-Increasing Flexibility	0.878*	0.01**
y2- Creating Redundancy	0.225	0.48
y3- Supply chain collaboration	0.925	0.01**
y4- Supply chain agility	0.957	0.01**

Table (11)Effect of the "Endogenous Threats x2" on "Strategies in oil industry" using Liner Regression

independent	Path →	dependent	β	t. test		F. test		R2
				Value	Sig.	Value	Sig.	
Endogenous Threats	→	y. Strategies in oil industry	0.905	6.717	0.01**	45.121	0.01**	81.9%
Endogenous Threats	→	y1-Increasing Flexibility	0.878	5.809	0.01**	33.750	0.01**	77.1%
Endogenous Threats	→	Y3. Supply chain collaboration	0.925	7.676	0.01**	58.915	0.01**	85.5%
Endogenous Threats	→	y4- Supply chain agility	0.957	10.450	0.01**	109.20	0.01**	91.9%

Logistics and handling companies Model (group3)



Relation between threats and resilience strategies according to companies’ activities

H3-There is statistically significant difference for dimensions (Supply chain resilience strategies in oil industry) on level companies as study sample

Table (12) Comparison between (companies) according to the dimensions of The (Supply chain resilience strategies in oil industry) by use One way ANOVA (F- test)

Variables	companies	N	Mean	Std.	F-test	P-value	Result
X1-Exogenous Threats	Processing companies	18	3.18	0.52	84.976	0.01**	H. sig.
	Refining companies	42	3.75	0.23			
	Handling and logistics companies	12	2.43	0.06			
X2- Endogenous Threats	Processing companies	18	3.45	0.52	14.174	0.01**	Sig.
	Refining companies	42	3.14	1.02			
	Handling and logistics companies	12	1.87	0.13			
Y1: Increasing Flexibility	Processing companies	18	1.98	0.18	24.282	0.01**	H. sig.
	Refining companies	42	2.00	0.30			
	Handling and logistics companies	12	1.42	0.1			

Y2: Creating Redundancy	Processing companies	18	1.75	0.26	13.230	0.01**	H. sig.
	Refining companies	42	1.93	0.16			
	Handling and logistics companies	12	2.11	0.07			
Y3: Supply chain collaboration	Processing companies	18	2.47	0.29	7.619	0.01**	H. sig.
	Refining companies	42	2.58	0.30			
	Handling and logistics companies	12	2.87	0.13			
Y4: Supply chain agility	Processing companies	18	1.68	0.57	78.740	0.01**	H. sig.
	Refining companies	42	1.19	0.24			
	Handling and logistics companies	12	2.83	0.52			

Based on previous results:

There is a statistically significant effect of the dimensions of (**Threats in oil industry**) on (**Strategies in oil industry**) from the **level companies** study sample.

Model multiple regressions:

Coefficient of Regression Multiple (Model Stepwise) to find The Impact of independent (Threats in oil industry) x, included: (ExogenousThreats) x1, and (Endogenous Threats) x2, on dependent variable (Strategies in oil industry). Y

Group 1

Table (13) The Impact of The "Threats in oil industry" on "Strategies in oil industry" according Processing companies By Using multiple regressions

Independent variables	β	t. test		F. test		R2	r	VIF
		Value	Sig.	Value	Sig.			
Constant	1.494	1.940	0.07	35.899	.01**	82.7%	.909	-
X1-Exogenous Threats	0.668	2.645	.02*					5.540
X2- Endogenous Threats	0.259	1.025	0.32					3.613

$Y = \beta0 - \beta x1$

Strategies in oil industry = 1.494 - .668 x1

Group 2

Table (14) The Impact of The "Threats in oil industry" on "Strategies in oil industry" according Refining companies By Using multiple regressions

Independent variables	B	t. test		F. test		R2	r	VIF
		Value	Sig.	Value	Sig.			
Constant	3.372	13.206	0.01**	22.825	.01**	53.9%	.734	-
X1-Exogenous Threats	0.676	6.126	0.01**					5.540
X2- Endogenous Threats	0.427	3.869	0.01**					3.613

$Y = \beta0 - \beta x1 + \beta x2$ (Strategies in oil industry = 3.372 - .676 x1 + .427 x2)

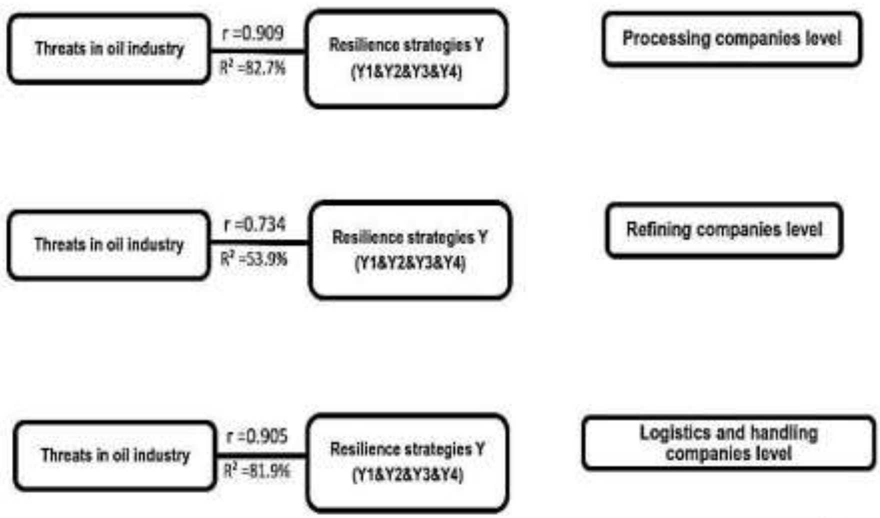
Group 3

Table (15) The Impact of The "Threats in oil industry" on "Strategies in oil industry" according Handling and logistics companies By Using multiple regressions

Independent variables	B	t. test		F. test		R2	r	VIF
		Value	Sig.	Value	Sig.			
Constant	3.767	7.833	0.01**	20.315	.01**	81.9%	.905	-
X1-Exogenous Threats	0.016	0.063	.06					3.310
X2- Endogenous Threats	0.918	3.556	0.01**					2.564

$Y = \beta 0 - \beta\ x2$

Strategies in oil industry = 3.767 - .918 x2



MODEL of Significant relation between threats and resilience strategies according to companies activities

Conclusion:

The above findings provide important insights for furthering our understanding of SCRES. It was found, for example, that threats and strategies are interrelated in the sense that strategies to build SCRES may produce adverse impact in the form of new or former threats, either at the same or a different point of the supply network. Equally, resilience strategies may conflict or mutually reinforce each other. The relationships between supply chain phenomena, and the points where they occur in the supply chain. This suggests the supply chain becomes a system depend on the nature of the relationships between threats, strategies according to the type of industry specially oil industry under uncertainty conditions as covide19 there are a variety of supply chain resiliencies valid to use in these conditions but referring to the statistical have been carried out in this research the strategy will be different according to the type of activates of the company and the most optimum package of SRES are suitable to the company activity in addition to ,research prove that referring to the percent of usage of each strategy the combination of group of strategies will give the best solutions .

Recommended future Research:

In addition to the research contributions discussed above, this study has provided new insights for managers wishing to make their supply chains resilient. Managers should be aware that the threats to the resilience of their supply chains are not necessarily large-scale discrete events – they are also events of continuous possibilities. Hence, they should not underestimate seemingly small but chronic events because they are capable of gradually weakening the supply network, resulting in either major consequences (due to non-linearity) or a reduced capability to respond to future catastrophic events.

Managers should also be aware of potential migration of supply chain threats when crafting strategies to build SCRES. This means their adaptation decisions, and those of managers at other points in the supply network, contain latent threats that can potentially hinder SCRES. Rather than looking at their operation in isolation, managers should look at the supply chain holistically because actors along the chain are so interconnected. This holistic analysis is important to identify endogenous threats, which this study finds important for SCRES. This may be implemented through supply chain mapping to have a clear visibility of the entire relevant network, such that before adopting and implementing a SCRES strategy. Further, risk migration presupposes that managers should understand how threats and strategies are interconnected and what this could mean for their SCRES strategy implementation. The fact that SCRES strategies produce unexpected adverse outcomes informs managers that SCRES should not be viewed as a static phenomenon; and the capacity to adapt should be built into the system, so it has the flexibility to respond to different manifestations of threats.

References:

- Berman, A (2015) Risk Management and Business Continuity: Improving Business Resiliency. Retrieved February 25, 2017.
- ERIA(2017), ‘Oil Supply Resilience in Japan’,in Kimura, S., T. Morikawa and H. Phoumin(eds.), Oil Supply Resilience in ASEAN.ERIA Research Project Report 2016-03, Jakarta: ERIA, pp.1-10.
- ERIA(2017), ‘Oil Supply Resilience in Selected Countries in the ASEAN’,in Kimura, S., T. Morikawa and H. Phoumin(eds.), Oil Supply Resilience in ASEAN.ERIA Research Project Report 2016-03, Jakarta: ERIA, pp.11-28.
- I. Rosolio, B. Ronen & N. Geri (2008) Value enhancement in a dynamic environment—a constraint management expert system for the oil refinery industry, International Journal of Production Research, 46:16, 4349-4367, DOI: 10.1080/00207540701199685.
- BP’s 2010 Deepwater horizon oil spill Crisis Communication Management.
- Hiles, A. and Barnes, P. (2001) The Definitive Handbook of Business Continuity Management,J. Wiley & Sons, Chichester.
- Norrman, A. and Jansson, U. (2004) ‘Ericsson’s proactive supply chain risk management approach after a serious sub-supplier accident’, International Journal of Physical Distribution & Logistics Management, Vol. 34, No. 5, pp.434–456.
- Zurich, N.A. (2011) Supply Chain Resilience 2011 – BCM and Supply Chain Continuity Risk, White paper, from Zurich NA [online] http://www.zurichna.com/zna/risk_engineering/ strategic risk services and enterprise risk management.htm (accessed 17 May 2012).
- Rowbottom, U., Buntrock, C. and Hannesson, H. (2011) ‘Three steps to supply chain resilience’, Logistics & Transport Focus, Vol. 13, No. 7, pp.42–44.

- Bernstein J (2004) The 10 Steps of Crisis Communications. Crisis Response, prevention, planning and, Training, 106.
- Chair of Logistics Management, Department of Management, Technology, and Economics, Swiss Federal Institute of Technology Zurich, Scheuchzerstrasse 7, 8092 Zurich, Switzerland .
- Mani, V.; Delgado, C.; Hazen, B.T.; Patel, P. Mitigating Supply Chain Risk via Sustainability Using Big Data Analytics: Evidence from the Manufacturing Supply Chain. Sustainability 2017, 9, 608.
- ,"The International Journal of Logistics Management 80 – From Volume: 1 Issue: 1, to Volume: 31 Issue: 3"
- "Federal Financial Institutions Examination Council (FFIEC) Business Continuity Planning booklet"
- " Daniel De Wolf1, Mohamed Mejri2,University of Littoral Côte d’Opale (ULCO)/Management & Economics, Dunkerque, France "
- "John Lindstro¨m, So¨ren Samuelsson and Ann Ha¨gerfors Lulea° University of Technology, Lulea° , Sweden"Disaster Prevention and Management Issue(s) available: 139 – From Volume: 1 Issue: 1, to Volume: 29 Issue: 3, 2020
- Abe, M., and Ye, L., 2013. Building Resilient Supply Chains against Natural Disasters: The Cases of Japan and Thailand. Global Business Review 14 (4), 567–586.
- Adtiya, S., Kumar, S., Kumar, A., Datta, S., and Mahapatra, S., 2014. A Decision Support
- System towards Suppliers’ Selection in Resilient Supply Chain: Exploration of FuzzyTOPSIS. International Journal of Management and International Business Studies 4 (2): 159-168.
- Alcock, R., and Busby, J., 2006. Risk Migration and Scientific Advance: The Case of FlameRetardant Compounds. Risk Analysis 26 (2), 369-381.

- Amaratunga, D., and Baldry, D., 2001. Case Study Methodology as a Means of Theory
- Building: Performance Measurement in Facilities Management Organisations. Work Study 50 (3), 95 – 105.
- Ambulkar, S., Blackhurst, J., and Grawe, S., 2015. Firm's Resilience to Supply Chain Disruptions: Scale Development and Empirical Examination. Journal of Operations Management 33–34, 111–122.
- Asbjørnslett, B., 2009. Assessing the Vulnerability of Supply Chains. In: G.A. Zsidisin and B. Ritchie, eds. Supply Chain Risk: a Handbook of Assessment, Management and Performance. New York:Springer, 15–33.
- Azevedo, S., Govindan, K., Carvalho, H., and Cruz-Machado, V., 2011. GResilient index to Assess the Greenness and Resilience of the Automotive Supply Chain (8), 2011. Discussion Papers of Business and Economics. ISBN 978-87-91657-51-1.
- Azevedo, S., Govindan, K., Carvalho, H., and Cruz-Machado, V., 2013. Ecosilient Index to Assess the Greenness and Resilience of the Upstream Automotive Supply Chain. Journal of Cleaner Production 56, 131-146.
- Bandelj, N., 2008. Economic Objects as Cultural Objects: Discourse on Foreign Investment in Post-socialist Europe. Socio-Economic Review 6, 671–702
- Barksh, N., and Kleindorfer, P., 2009. Co-opetition and Investment for Supply Chain Resilience. Production and Operation Management 18 (6), 583-603.
- Barnes, P., and Oloruntoba, R., 2005. Assurance of Security in Maritime Supply Chains:
- Conceptual Issues of Vulnerability and Crisis Management. Journal of International Management 11(4), 519–540.

- Barney, J., 1991. Firm Resources and Sustained Competitive Advantage. Journal of Management 17 (1), 99–121.
- Barratt, M., Choi, T., and Li, M., 2011. Qualitative Case Studies in Operations Management: Trends, Research Outcomes, and Future Research Implications. Journal of Operations Management 29 (4), 329–342.
- Barroso, A., Machado, H., Barros, R., and Cruz-Machado, V., 2010. Toward a Resilient Supply Chain with Supply Disturbances. Proceedings of the 2010 IEEE IEEM: 245-249.
- Bernardes, S ., 2010. The Effects of Supply Management Strategies on Aspects of Social Capital and the Impact on Performance. A Social Network Analysis Perspective. Journal of Supply Chain Management 46 (1), 45-56.
- Bhamra, R., Dani, S., and Burnard, K., 2011. Resilience: the Concept, a Literature Review and Future Directions. International Journal of Production Research 49 (18), 5375-5393.
- Blackhurst, J., Dunn, S., and Craighead, W., 2011. An Empirically Derived Framework of Global Supply Resiliency. Journal of Business Logistics 32 (4), 374–391.
- Blackhurst, J., Scheibe, P., and Johnson, J., 2008. Supplier Risk Assessment and Monitoring for the Automotive Industry. International Journal of Physical Distribution & Logistics
- Management 38 (2), 143–165.
- Blome, C., and Schoenherr, T., 2011. Supply Chain Risk Management in Financial Crises— A Multiple Case-Study Approach. International Journal of Production Economics 134 (1), 43-57.
- Blos, M., Quaddus, M., Wee, M., and Watanabe, K., 2009. Supply Chain Risk Management
- (SCRM): A Case Study on the Automotive and Electronic Industries in Brazil. Supply Chain Management: An International Journal 14 (4), 247 – 252.

- Boin, A, Kelle, P., and Whybark, C., 2010. Resilient Supply Chains for Extreme Situations: Outlining a New Field of Study. International Journal of Production Economics 126 (1), 1-6.
- Boone, C., Craighead, C., Hanna, B., and Nair, A., 2013. Implementation of a System
- Approach for Enhanced Supply Chain Continuity and Resiliency: A Longitudinal Study. Journal of Business Logistics 34 (3), 222–235.
- Borekci, D., Rofcanin, Y., and Gürbüz, H., 2014. Organisational Resilience and Relational
- Dynamics in Triadic Networks: A Multiple Case Analysis. International Journal of Production Research DOI:10.1080/00207543.2014.903346, 1-29.
- Boyer, K., and Swink, M., 2008. Empirical Elephants—Why Multiple Methods are Essential to Quality Research in Operations and Supply Chain Management. Journal of Operations Management 26, 337–348.
- Brandon-Jones, E., Squire, B., Autry, C., and Petersen, K., 2014. A Contingent ResourceBased Perspective of Supply Chain Resilience and Robustness. Journal of Supply Chain Management 50 (3), 55-73.
- Brownlee, J., 2007. Complex Adaptive Systems. Complex Intelligent Systems Laboratory.