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**Risk supply Chain management of Hazardous chemical products in Saudi
Petrochemical Companies**

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1. Introduction

Although it is popular that Chemical industry is considered coordinated and organized, but , there is still a limitations of existence for risk precautions related dangerous materials and the commodities that are utilized. Chemicals are dangerous materials and challenges relating the buying , procurement, delivering , and transportation to safe locations is essential to address (Dacanay et al,2023) .

A supply chain is a grid that is starts from suppliers to distributors and end consumers. (Paul et al. 2017). A chemical supply chain (CSC) expresses a grid that acts on achieving incorporation among suppliers, fabricators , distributors, retailers and consumer into one system. The risks developed from the inner system and the circumference ecology can results in disruption to substances , information and financial flows. Therefore, supply chain members have to implement a variety of methods to prepare for, respond to and recover from potential damages caused by different kinds of hazards (Li, 2016)

Petrochemical supply chains in the Kingdom of Saudi Arabia are considered among the most important chemical supply chains. The petrochemical SC categorized into two key fields : The upstream includes discover raw oil , manufacture and carriage and the final stage where final manufacture involve production refining, carriage , stock pilling, allocation and retail. a wide matrix of tankers, ships , oil tubes, railroads and lorries carriage raw oil from the oil fields to

the strainers, oil tubes, lorries, ships and trains carriage treated products to distribution points and lastly to retails that comprise fuel stations comprising oil and gas , plant , several public services as hotels or hospitals that can immediately consume the product or retail it to the final customer. stocking facilities comprising bottom and top tanks, that are located bottom or upper the land ,caverns and marine stocking , are placed along carriage passages permitting maximizing or minimizing of batches to comply with the abilities of the next carriage model as illustrated in Figure 1(Fernandes et al,2010), (Amor & Ghorbel,2018).

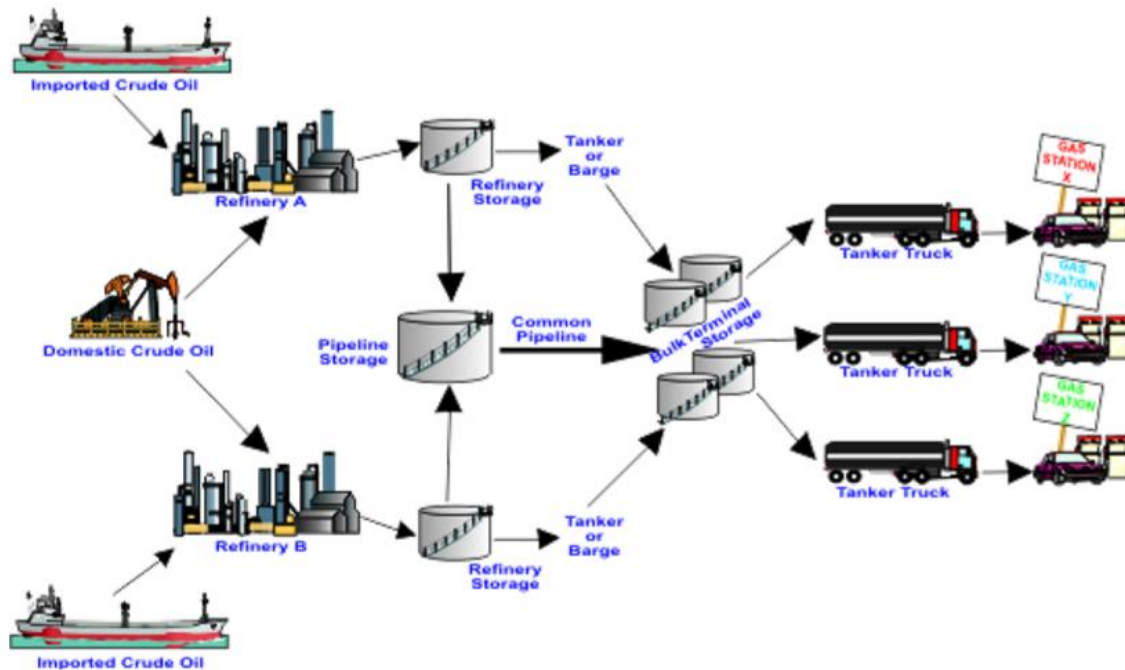


Figure 1 Explanation of mechanism of petroleum supply chain (Fernandes et al,2010).

developing an effective and successful (SC) makes it more weakness and susceptible to hazards. The hazards in the novel SC is variety and can lead to dangerous negative consequences like worse quality of product , destruction and damage of property and equipment , loss of company 's reputation, time overrun delivery. Due to the problems faced by supply chain management, the term “supply chain risk management” has emerged, as it is

concerned with identifying risks, evaluating them, analyzing them, and proposing solutions and strategies to mitigate and reduce them. Given the importance of the risks of chemical supply chains that result in hazardous materials, this study focused on addressing the risk management of petrochemical supply chains in the Kingdom of Saudi Arabia.

2. Problem Statement

The supply chain of the petrochemical companies is very complicated comparing to other fields . It is classified into two sections: the initial and final supply chains. The initial SC comprise the obtaining of raw oil, that is executed by the oil firms . The initial procedures comprises the detection , prediction , manufacture, and logistics administer of delivering raw oil from far oil reservoir to strainers. The final SC begins at the refinery, where the raw oil is made into the products in forms of gas and fuel that are the specialty of strainers and petrochemical firms . The final SC comprise the operations of prediction , manufacture , and the logistics administer of delivering the raw oil subsidiary products to consumers all over the world. Given that the Kingdom of Saudi Arabia is an oil-producing country and includes many petrochemical companies in which supply chains may face risks at all stages from the beginning of manufacturing petroleum products until their delivery, and given the lack of studies and academic research that address the problems facing petrochemical supply chains in Saudi Arabia, this study is concerned with By studying supply chain risk management in Saudi petrochemical companies, assessing the risks, and then finding effective solutions to mitigate or avoid these risks.

3. Literature Review

Numerous studies all over the world has been addressed risk supply chain management in petrochemical companies. This studies can be as database to enrich this studies by collecting the potential hazards in petrochemical supply chains in Saudi Arabia:

Honarvar et al (2013) published paper seeks to determine the SC hazards of Zagros Petrochemical firm, to determine the most significant hazards, and to provide recommendations to administers to face them. the author used Analytic Network Processes to achieve this. The research depend on applying survey utilizing questionnaires targeting administers and the study found that the most significant risks can impact the petrochemical (SC) are : boycott, lack of human resource management, policies fluctuations, unsuitable equipment, human errors .

Ghasemzadeh et al (2017) carried out a study to determine solutions for risk administer in petroleum supply chain and convenient standard to prioritize them through Balanced Score Card method standards and the results showed that the most effective strategies to manage risks in petroleum supply chains are: raise transparency and organization, flexibility in transportation, monitor the weather forecast, effective management of human resource, selecting proper transportation and managing Excess inventory.

Tarei et al, (2018) directed a research to determine variety of hazards and secondary hazards that impact the (SC) performance and to suggest a methodology to determine the SC hazard index taking into account significance the of each hazard and secondary hazard .the researcher selected Indian (PSC) as case study and the result found that carriage and delivery system, quality of the petroleum products, raw oil supply, consumer's order and the policies are the most important hazards impact on petroleum supply chains. The researcher also identified secondary risks

represented by natural disasters such as earthquakes and hurricanes , regulations that impact performance of company as reducing salaries , pricing instructions, demonetization, lack of skilled labors , lack of crude substances as industrial gas and coal, disturbance in raw supplying, delay in arrival of raw oil owing to offshore logistics, the petroleum products are inferior, lack of cost management that comprises refining, mixing and stocking, failures in tools or machines or equipment, incidents , bad weather conditions, vandalism via carriage, lack or over-usage of ability of plant , Demand changes of the petroleum products.

Amor and Ghorbel (2018) identified major hazards regarded to each phase of the SC in petroleum industry. Also, the author shed light on the model strategies to mitigate these risks and the outcomes proved that the risk kind based on specific operation of petroleum SC and based on the importer or exporter country and that the techniques of the hazards management categorized into three kinds : qualitative, quantitative and both types and the results affirmed that carriage hazards and price hazard are significant for petroleum .

4. Research hypotheses

- 1- There is a significant correlation between environmental risks and performance of petrochemical supply chains.
- 2- There is a significant correlation between upstream risks and performance of petrochemical supply chains.
- 3- There is a significant correlation between downstream risks and performance of petrochemical supply chains.
- 4- There is a significant correlation between process risks and performance of petrochemical supply chains.
- 5- Adopting strategies to mitigates petrochemical supply chains can significantly impact performance of petrochemical firms.

5. Research significance

Due to the lack of studies and research that address the risks related to petrochemical supply chains, this study is concerned with studying and finding all the potential risks facing petrochemical supply chains at all stages. This study is also charged with preparing a framework to identify solutions and strategies to mitigate these risks. These risks also provide recommendations to supply chain managers and petrochemical companies that is useful in developing systematic plans to avoid potential petrochemical supply chain risks.

6. Research Objectives

This study aims to provide a comprehensive methodology for managing supply chain risks in the petrochemical industries in the Kingdom of Saudi Arabia. To achieve this goal, the following secondary objectives must be achieved:

- 1- To identify all potential risks in petroleum supply chains starting from risk arises from upstream and ends in downstream
- 2- To determine the most significant hazards negatively impact in petroleum supply chains.
- 3- To suggest strategies related to manage petrochemical supply chains in Saudi petrochemical firms .
- 4- To determine the most efficient strategies that contributes to mitigate or prevent arising petrochemical supply chains hazards
- 5- To provide recommendations and guidelines in order to achieve efficient petrochemical supply chain management.

7. Research questions

This study will be executed to answer the following questions:

- 1- What are the most significance risks of petrochemical supply chains in Saudi Arabia?

2- What are the most effective strategies to mitigate risks to petrochemical supply chain?

8. Research limitations

This research is based on quantitative analysis by conducting a questionnaire targeting a number of petrochemical companies in Saudi Arabia. The limitation in the surveying study is distributing the questionnaire to the management and employees of the companies, given that these companies are located in separate places in Saudi Arabia and far from the center of Saudi cities. To facilitate the matter, communication will be made with Management of selected petrochemical companies to assist in distributing the questionnaire via social media sites.

9. Research Methodology

The study methodology adopts quantitative method to study Risk Supply Chain management of Hazardous chemical products in Saudi Petrochemical Companies. In order to achieve the objective of the study, the following procedures will be done:

- 1- Executing extensive literature review comprises all potential risks face petrochemical supply chains and mitigation strategies.
- 2- Executing questionnaire targeting Saudi Petrochemical Companies comprise potential risks, mitigation strategies moreover, sets of questions to investigate impact of risks on performance of petrochemical supply chains addition to impact of mitigation strategies on performance of petrochemical supply chains.
- 3- Performing statistical analysis to the data of questionnaire using SPSS software. Pearson correlations, means, frequencies ,standard deviation, regression analysis will be conduct to perform the analysis.

4- Discussion of results and recommendations.

10. Organization of the study

Chapter one will provide introduction about research contents.

Chapter two will introduce extensive literature review comprises all potential risks face petrochemical supply chains and mitigation strategies.

Chapter three will explain the research methods ,tools and statistical tests used to conduct the analysis

Chapter four will provide the result of statistical analysis and discussion of the results.

Chapter five will summarize the study and introduce conclusions and recommendations.

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