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Risk Management: A Qualitative Study of the Moroccan Downstream Petroleum Supply Chain

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Abstract: Supply chain risk management is paramount to anticipating, controlling, and minimizing SC risk impacts on every company, especially petroleum companies. The petroleum supply chain has attracted interest for many reasons. This supply chain is long, complex, and highly developed, which makes it vulnerable to several uncertainties. However, few studies have examined supply chain risks in non-oil-producing countries. Morocco is one of those nations because it is a net importer of hydrocarbons, but no research has tackled the risks associated with its oil supply chain. For this purpose, we conducted a qualitative study through semi-structured interviews with executives of ten petroleum companies based in Morocco (national and international). The goals were to explore how these companies manage their supply risks and compare this real-life case with the literature and ISO 31000 risk management standard. It also attempts to assess each petroleum product's supply chain's criticality. The findings demonstrate that Moroccan petroleum companies consider risk management when handling supply chain risks. However, there is still a lack of application of quantitative risk methodologies and IT tools for supply risk management. Furthermore, based on this exploratory study, it appears that some products, such as fuel oil, diesel, and LPG, have a far more crucial supply chain than other petroleum products.

Keywords: risk management, supply chain uncertainties, oil industry, Morocco.

风险管理：摩洛哥下游石油供应链的定性研究

摘要：供应链风险管理对于预测、控制和最小化供应链风险对每个公司（尤其是石油公司）的影响至关重要。石油供应链由于多种原因引起了人们的兴趣。该供应链漫长、复杂且高度发达，因此容易受到多种不确定性的影响。然而，很少有研究考察非石油生产国的供应链风险。摩洛哥是这些国家之一，因为它是碳氢化合物的净进口国，但没有研究解决与其石油供应链相关的风险。为此，我们通过半结构化访谈对摩洛哥（国内和国际）十家石油公司的高管进行了定性研究。目标是探索这些公司如何管理其供应风险，并将这一现实案例与文献和国际标准化组织31000风险管理标准进行比较。它还试图评估每种石油产品供应链的重要性。研究结果表明，摩洛哥石油公司在处理供应链风险时考虑了风险管理。然而，供应风险管理仍缺乏定量风险方法和IT工具的应用。此外，根据这项探索性研究，某些产品（例如燃油、柴油和液化石油气）似乎拥有比其他石油产品更为重要的供应链。

关键词：风险管理、供应链不确定性、石油工业、摩洛哥。

1. Introduction

Nowadays, companies are increasingly prone to many risks in their supply chains due to changes such as globalization, expansion in emerging markets, outsourcing, the digital economy, and new technologies [1-3]. Broader geopolitical uncertainties [4], trade disputes such as Brexit, and threats of pandemics such as COVID-19 [5, 6] are the new threats that have seriously impacted the global supply chain during the last few years.

In such an uncertain environment, companies have to deal with many issues during supply chain disruptions, such as temporary shortages, the time needed to recover after them, and the contingency plans and measures to put in place [7]. In addition, proactive risk mitigation strategies must be added in the event of a recurrence of these disruptive issues. This underlines the crucial importance of supply chain risk management and explains why professionals and researchers are interested in this emerging discipline.

Following the lead of supply chain scholars abroad, several academics in Morocco have expressed an interest in carefully analyzing risks of the Moroccan supply chain. Among the industries studied are automotive [8-10], health services, pharmaceutical industries [11-15], and agro-food and textiles [8], [10].

On the other hand, little research has been devoted to the Moroccan energy supply chain and even less to the supply chain of petroleum products.

Through a qualitative study, this article provides an overview of challenges the Moroccan petroleum supply chain (PSC) faces. This study explores the SCRM process and compares the real-life case of the Moroccan downstream PSC to the literature and ISO 31000 risk management standard.

The originality of this study lies in observing how companies involved in the import, storage, distribution, and transportation of petroleum products in Morocco handle the risk management process. Morocco is a net hydrocarbon importer country; therefore, the choice of the oil supply chain stems from the fact that petroleum is at the top of the list of imported products in 2023 (February) [16].

In the second part of this paper, we illustrate the research methodology used for this qualitative study. Section 3 presents the study's findings, and section 4 concludes the essay.

2. Literature Review

The risks faced by supply chains are increasing. In a world where production methodologies are continuously updated, product lifecycles have become shorter, supply chains are interconnected [17], and the desire to improve efficiency is stronger. As a result, companies must deal with uncertainties through supply chain risk management to maintain their sustainability and decrease supply chain vulnerability.

2.1. SCRM

Ho et al. [18] defined SCRM as a multi-combined effort that employs quantitative and qualitative risk management methods to manage unpredicted events that could negatively impact the supply chain.

Most studies have pointed out that SCRM has four main stages: identification, evaluation, mitigation, and risk monitoring [18-21]. These steps are similar to the risk management process described in ISO 31000 [22]. They allow the decision-maker to evaluate the risk and take appropriate measures to deal with it. Even if the risk is acceptable, it should be monitored. If not, risk mitigation is required [1].

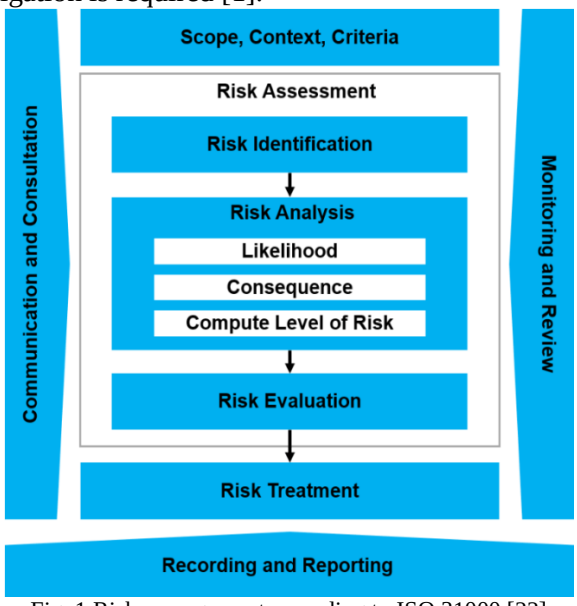

Fig. 1 Risk management according to ISO 31000 [22]

3. Methods

The purpose of this study is to answer the following three questions regarding Morocco's supply chain risk management for petroleum products:

- How are supply chain risks managed by companies in the oil sector in Morocco?
- Is there a similarity between the literature, ISO 31000 standard, and what is present in the field?
- How well-known is ISO 31000 and how applicable are the risk assessment tools described in ISO 31010?

Literature reviews and semi-structured interviews were the two approaches used to collect the data for this study.

3.1. Interviews

The questionnaire used for the interview began with open-ended questions concerning general information

about the company. The rest was a series of closed-ended questions. The purpose was to obtain an idea of the interviewee's profile, their involvement in the risk management process, and how the company managed risks linked to the petroleum products supply chain.

3.2. Data Collection Tool

To explore the Moroccan downstream petroleum supply chain, we collected data from 10 companies of different sizes, as described in the chart below. We collected the information through semi-structured interviews with ten participants from various Moroccan petroleum companies. The participant's profile was a criterion to consider when defining the targeted population. As a result, only engineers, managers, and directors were selected. We chose this category because it is the most involved in risk management by these companies.

We conducted face-to-face interviews with some of the respondents, which enabled us to obtain more detailed opinions and comments, as highlighted by S.N. Khan [23]. We also contacted some of the participants via LinkedIn after conducting the research based on two criteria: the company's name and their profile (position held).

3.3. Data Analysis

3.3.1. Characteristics of the Companies

The companies where the respondents operate are involved in several stages of the supply chain; at the same time, some manage the storage, importation, and distribution of petroleum products.

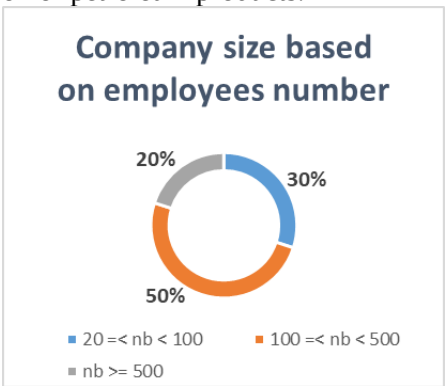

Fig. 2 Company size based on the number of employees (Developed by the authors)

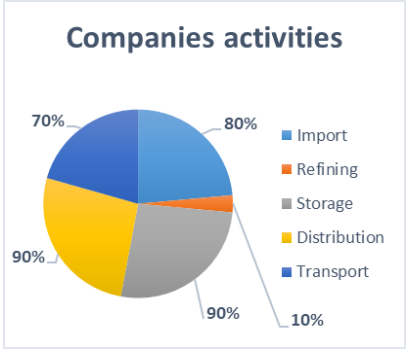

Fig. 3 Company activities (Developed by the authors)

3.3.2. ISO Certifications

It was necessary to determine whether the company has a standardized management system based on international standards. The latest versions of these standards incorporate the risk-and-opportunity approach. Therefore, if companies base their management systems on one of the standards below, they undertake a risk analysis of their processes.

Through a statistical study, D. Zimon and P. Madzk [24] demonstrated the positive impact of implementing a standardized management system in minimizing certain supply chain risk aspects, including delays, quality control errors, and information flow problems.

In our case study, we asked participants if their companies were certified according to ISO 9001, ISO 14001, ISO 45001, or ISO 50001. All these firms have been certified to the ISO 9001 standard for quality management; 50% of them are or have already been certified to the ISO 14001 standard for environmental management. Furthermore, 30% have been certified to the ISO 45001 or OHSAS 18001 standards.

3.3.3. Respondents' Characteristics

As for the profile of participants by gender, Table 1 shows that 90% are men. This is because this is a primarily male-dominated industry. In addition, approximately half of the people interviewed had over 20 years' experience, which may positively influence the quality of our findings. We have also chosen participants who work in different departments related to the supply chain to obtain various intakes.

Table 1 Interviewees' profiles (Developed by the authors)

Characteristics of the participants		**Percentage of the sample (%)**
Gender	Female	10
	Male	90
Job position	Responsible Engineer	30
	Manager	20
	Director	50
Years of experience in the company	Less than 5 years	10
	5-10 years	10
	10-20 years	30
	More than 20 years	50
Assigned direction	Executive Management	10
	Quality Department	10
	Sales and Marketing Department	20
	Planning and Business Analysis Department	10
	Operations	20
	Logistics and Customer Services	30

4. Results and Discussion

4.1. Participant Involvement in risk management

First, we asked participants if they knew the ISO 31000 standard for risk management. It turned out that

barely 40% of them were familiar with it. Next, we asked them which risk management stage(s) they were involved in, and the results were as follows:

Table 2 Participant involvement in risk management (Developed by the authors)

Process	Participation rate
Risk Identification	90%
Risk Assessment	80%
Risk Mitigation	60%
Risk Monitoring and Review	70%

4.2. Risk Management by the Companies

Concerning the risk management process, 90% of the participants stated that their companies identify the risks associated with the supply chain of their petroleum products. A multidisciplinary team composed of the Departments of Import and Export, Finance and Management Control, SHEQ, Planning, Production, Receiving, and Shipping performs the identification and assessment of risk. It would be more interesting if the risk analysis involved not only the departments within the company but also all the global supply chain stakeholders. This aspect is one of the eight principles of ISO 31000, which requires risk management to be inclusive. In other words, all supply chain stakeholders should be involved in risk management. This allows them to guarantee relevant and updated risk management reports.

4.3. Use of IT for Risk Management

As previously mentioned, the oil supply chain remains one of the most complex SCs. It uses highly developed technologies at various stages. Companies often use IT tools in different sectors for many reasons, including competitiveness and improved performance. Moreover, deploying an appropriate IT strategy in business in general and within the supply chain in particular can improve the supply chain operations and lower the risks of disruptions [25].

Therefore, it was necessary to determine whether companies in Morocco were using IT tools as part of their risk management. We asked participants if their organization employed these tools during various phases of risk management and found that only 20% of the companies in question used them. These poor results made it difficult for us to study the impact of using these tools on the supply chain performance, robustness, and resilience.

4.4. Risk Assessment Criteria

As revealed by the responses obtained (70%), the criticality of risks was the most significant risk assessment criteria for the petroleum product supply chain. In addition, 40% of the participants believed the likelihood of risk to be a significant factor in risk assessment. Meanwhile, 50% believed cost and severity to be equally important. Some interviewees emphasized the need to evaluate SC risks on the basis of their potential effects on the environment and company's reputation.

In the literature, risk probability and severity are the most studied assessment criteria. Both practitioners and academics have used them in the classic risk matrix approach, but they do not measure up to the complexity of risks according to Li et al. [26]. Therefore, Li et al. added two additional pertinent factors. The first is the detectability of the risk, a crucial component of the failure mode effect and criticality analysis (FMECA) risk assessment method. The second factor is recoverability, which refers to the ability of a system to return to an acceptable operational level after a risk event. Based on these four factors: risk probability, severity, detectability, and recovery, the assessment will be more pertinent [26].

4.5. Risk Assessment Frequency

When asked about the frequency of risk assessment operations, 30% of companies assess their risks yearly, while 40% assess them monthly. Some stressed that the evaluation was carried out on an ongoing basis or during each operation.

4.6. Comparison of Supply Chain Risks for Different Petroleum Products

As for comparing the risks associated with the supply chain of different petroleum products, 80% of the participants said that the SC risks differ from one product to another. We advanced the analysis further by asking them why the risks were not the same, and the answers were as follows:

- Product market size, market needs (supply and demand);
- Severity and criticality of each product;

Each product has specific risks that require appropriate measures and actions.

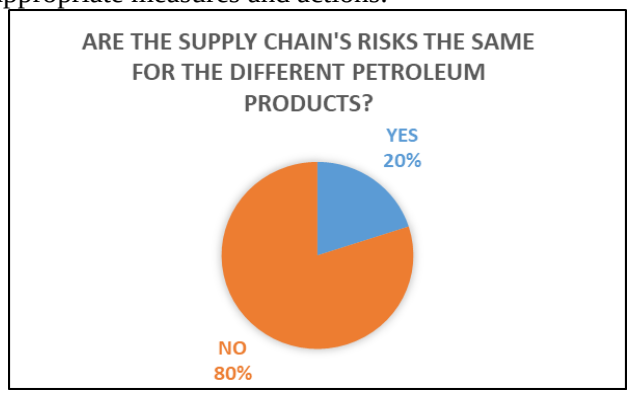

Fig. 4 Comparison of SCR for different petroleum products (Developed by the authors)

To evaluate the supply chain criticality of each petroleum product, we use a 5-point Likert scale. Each point corresponds to a degree of criticality:

1: not critical at all;
2: slightly critical;
3: moderately critical;
4: very critical;
5: extremely critical.

Table 1 Criticality of petroleum products (Developed by the authors)

Petroleum Product	Criticality				
	1 - Not critical at all	2 - Slightly critical	3 - Moderately critical	4 - Very critical	5 - Extremely critical
Propane	-	-	10%	20%	60%
Butane	-	-	-	10%	80%
Gasoline	-	10%	20%	20%	50%
Kerosene Jet A-1	-	10%	20%	20%	40%
Diesel	-	-	-	40%	60%
Lubricants	10%	40%	20%	20%	10%
Fuel Oil	-	-	40%	30%	20%
Bitumen	10%	30%	10%	40%	-

The table above shows that diesel has the most critical supply chain, followed by butane, propane, gasoline, kerosene, fuel oil, lubricating oils, and bitumen. The score assigned to SC bitumen criticality ranges from 1 to 4. In other words, for some, it is not at all critical, whereas for others, its chain is very critical. Because the demand for bitumen is mainly seasonal, we often use it in summer for road construction.

If we compare all these results to the distribution of petroleum product sales in Morocco (cf. the charts below), it turns out that diesel accounts for around half of all petroleum products, followed by butane, fuel oil, gasoline, jet fuel, and propane.

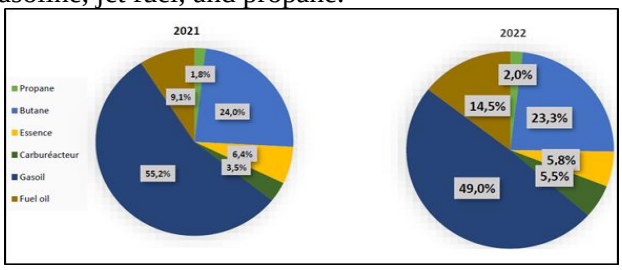

Fig. 1 Structure of sales of petroleum products in Morocco [27]

According to the data in the Moroccan Ministry's report for 2022, coal and petroleum coke represent a large proportion of imports due to their extensive use in generating electricity. They were excluded from this study. Gasoil and fuel oil come in second in terms of imports, with a volume of 7,422.2 KT in 2022. Imports of petroleum gas and other hydrocarbons (propane, butane, and kerosene) amount to 4,893.3 KT, followed by oils, lubricants (greases), and, last but not least, gasoline.

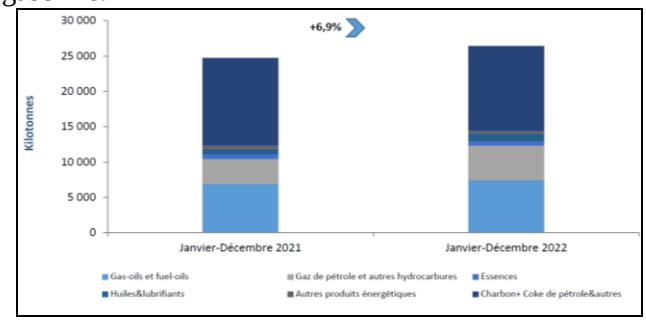

Fig. 2 Evolution of energy imports in volume in Morocco [27]

4.7. Tools/Methods Used for Risk Assessment Based on ISO 31010

Due to the growing importance of SCRM in the volatile, uncertain, complex, and ambiguous (VUCA) environment, there is an urgent need for practical decision-support tools [28].

Therefore, we asked participants if they knew some of the risk assessment tools described in ISO 31010 [29] and if their companies applied them.

Among the risk analysis tools used by more than 50% of these companies are brainstorming, checklists, process hazard analysis (PHA), environmental risk assessment, scenario analysis, business impact analysis, cause-effect analysis, reliability-centered maintenance (RCM), and cost-benefit analysis.

In addition, only a few companies use hazard and operability study (HAZOP), failure mode, effect, and criticality analysis (FMECA), fault tree analysis, decision tree, and multi-criteria decision analysis (MCDA) methods. However, none of these companies used methods such as the Markov analysis, Monte Carlo simulation, or Bayesian statistics. These techniques are also unknown to the participants.

In the literature, several researchers have shown a significant interest in MCDA methods such as ANP and TOPSIS for assessing supply chain risks [30], [31]. Ishizaka et al. [32] defined MCDA as a field that assists decision-makers when numerous criteria should be assessed.

Other academics have used quantitative methods (the Markov analysis, Monte Carlo simulation, and Bayesian statistics) to quantify supply chain risks. For instance, Hossain et al. [33] assessed the overall O&G supply chain resilience by adopting a Bayesian network.

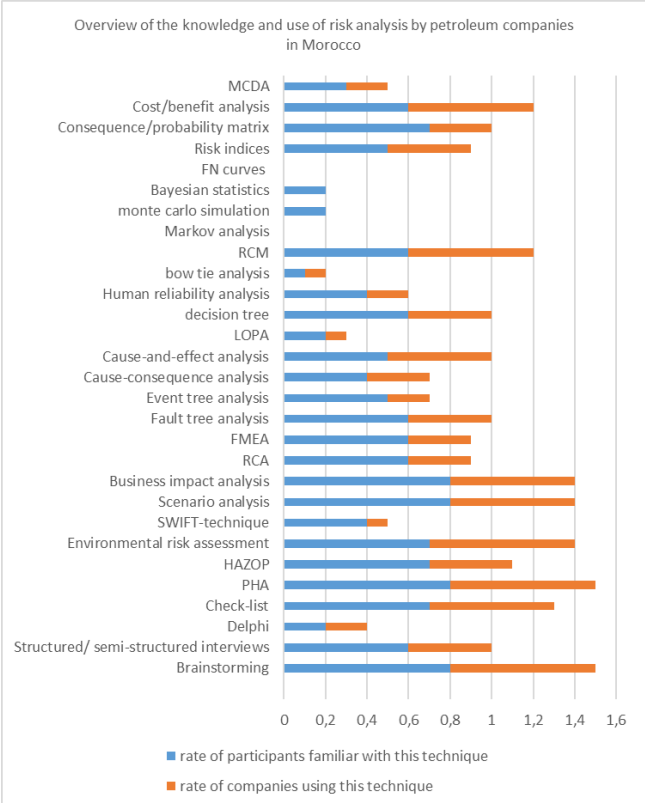

Fig. 7 Overview of the knowledge and use of risk analysis by petroleum companies in Morocco (Developed by the authors)

5. Conclusion

This qualitative study shows that risk management is one of the policies of petroleum companies in Morocco because they all have at least one management system based on international standards such as ISO 9001. These standards incorporate a risk management approach into their systems. As there is no such thing as zero risk, companies devote particular attention to supply chain risk management to reduce risks. Furthermore, these companies identify the risks affecting their supply chains. They frequently assess them according to their likelihood and severity. However, to improve supply chain vulnerability, today's decision-makers should add other criteria to their risk analysis, such as detectability and recoverability. They should also supplement their risk assessment, which is mainly based on qualitative methods, with quantitative ones. In-depth analysis will enable them to adopt reactive and proactive mitigation strategies that are relevant and efficient. Regarding the use of IT tools for risk management, it appears that they are less used. These tools can positively impact SC operations and reduce disruption risks.

In addition, we discovered that supply chain risks of different petroleum products are not the same for many reasons. Petroleum products have different severity levels and probabilities of occurrence. In addition, the market's needs differ from one petroleum product to another. This exploratory investigation also indicates that diesel has the highest critical SC, followed by LPG (propane) and fuel oil. This is because these fuels are used by industrial and service (transport) enterprises and individuals for their daily needs. Hence, the improvement in supply chain vulnerability is undeniable, particularly for essential petroleum products such as diesel and fuel oil.

The practical contribution of this study is to show managers that using the ISO 31000 risk management standard, which is still little known to some, can help them manage risks effectively throughout the chain. In addition, the assessment methods and tools proposed by the ISO 31010 standard will enable them to identify and assess potential risks and adopt appropriate mitigation strategies. As far as academics are concerned, this study confirms that there is a gap between the literature and what happens in the field. Moreover, this qualitative study shows that the criticality of the supply chain differs from one petroleum product to another. This hypothesis could be confirmed or refuted by a complementary quantitative study. In short, this initial exploratory study of the oil supply chain in Morocco will serve as a starting point for future research, particularly to quantify the risks associated with imports from non-oil-producing countries. Future work could be conducted to assess the energy security of non-oil-producing African countries and make a comparison along the lines of studies on South Asian countries [34].

The research perspectives can also focus on a quantitative assessment of current risks (post-Covid-19, geopolitical conflicts, and energy transition), especially for oil-importing countries.

In terms of our future research, we intend to complement this qualitative study with a quantitative one to measure the impact of risk mitigation strategies on petroleum supply chain performance in Morocco and enrich the literature on risk management in the oil supply chain.

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