

Design of a Strategic Decision-Making Framework Based on Multi-Criteria Decision Analysis (MCDA) to Address Geopolitical Risks in Oil and Gas Shipping Operations at PT XYZ

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ABSTRACT

Oil and gas shipping operations are increasingly exposed to geopolitical risks because they depend on strategic maritime chokepoints and operate across jurisdictions affected by conflicts, sanctions, security threats, and regulatory changes. This study aimed to develop a strategic decision-making framework based on Multi-Criteria Decision Analysis (MCDA) to translate geopolitical risks into measurable operational decisions for PT XYZ. The research employed a qualitative explanatory case study supported by descriptive quantitative analysis. Data were collected through semi-structured interviews, internal document analysis, and public secondary sources and were validated through source and method triangulation. Security Risk Assessment was conducted using threat, vulnerability, consequence, likelihood, and impact parameters, followed by scenario analysis, safety and legal compliance screening, direct weighting, and MCDA-based alternative ranking. The results showed that crew safety and ship and cargo safety were the highest-priority criteria. The Continue as Planned option failed to meet the safety threshold, whereas the Re-Routing and Delay/Hold Position options achieved the highest scores of 4.20 and 4.16, respectively. Sensitivity testing indicated that these rankings could shift depending on management priorities. The study concluded that integrating security risk assessment, scenario analysis, and MCDA supported more structured, transparent, and accountable strategic decision-making under geopolitical uncertainty while strengthening organizational preparedness, resilience, and continuity of energy supply.

INTRODUCTION

Oil and gas shipments are critical components of the global energy supply chain. These activities involve the transportation of crude oil, petroleum products, and liquefied natural gas using tankers and liquefied natural gas carriers across transnational shipping lanes. Consequently, they operate within complex environments involving multiple jurisdictions and are heavily influenced by international political, security, economic, and regulatory conditions. Dependence on maritime routes means that energy supply continuity is determined not only by vessel and port readiness but also by the stability of the regions traversed during transportation. A significant portion of global energy trade depends on several strategic maritime chokepoints, including the Strait of Hormuz, the Strait of Malacca, Bab el-Mandeb, and the Suez Canal, which connect energy-producing regions with global consumption centers.

Dependence on specific routes and chokepoints means that political and security disruptions in one location can directly affect energy transportation, shipping costs, supply availability, and the economic stability of importing countries (Sirvent Zaragoza, 2016). A maritime route gains geopolitical significance when it becomes part of competition for influence, access control, and power projection among states (Dittmer, 2021). Due to high vessel traffic concentration, disruptions at one chokepoint can propagate throughout the

shipping network through route diversions, vessel congestion, delivery delays, increased transit times, and reduced transportation capacity (Wan et al., 2023; Wang et al., 2024).

Furthermore, when maritime access is associated with energy, trade, and national strategic interests, chokepoints can become instruments of pressure, access restriction, or power projection, causing maritime transportation issues to develop into broader strategic conflicts (Lavengood, 2024). Recent cases have demonstrated that geopolitical risks to shipping are not limited to armed conflicts but may also emerge from strategic competition, increased military activities, policy changes, and diplomatic tensions.

The Bab el-Mandeb region is vulnerable to increasing maritime security threats due to its proximity to conflict zones, the presence of armed actors, and involvement by external forces (Alexandre, 2021; Farah, 2024). Tensions in the Taiwan Strait increase security uncertainty through military activities and potential miscalculations among actors (You & Hao, 2018), while geopolitical dynamics in Southeast Asia may alter trade patterns and regional transportation route configurations (Coşar & Thomas, 2021). The Russia–Ukraine conflict demonstrates how regional conflicts can reshape shipping networks through access restrictions, route diversions, and increased insurance costs (Cong & Wang, 2024). Such tensions also drive structural changes in supply chains through supplier diversification, regionalization, and the utilization of alternative routes, including Arctic routes, which require consideration of infrastructure readiness, navigational safety, and emerging geopolitical risks (Bosone & Stamato, 2023; Guo et al., 2022).

From a supply chain management perspective, geopolitical disruptions in shipping lanes generate systemic impacts, including transportation delays, increased logistics costs, schedule uncertainty, changes in transportation capacity, and supply shortage risks. These conditions increase the need for rerouting, additional security measures, and adjustments to distribution planning (Dawar & Bai, 2024).

At the organizational level, such disruptions reduce supply chain cost efficiency and affect financial performance through increased transportation costs, delays, and operational uncertainty (Fausiah et al., 2026). These vulnerabilities are associated with the characteristics of modern supply chains, which are highly interconnected, dependent across sectors, and operated with limited capacity reserves. Consequently, increasing network complexity and interdependence expose organizations to external disruptions that are difficult to predict (Christopher & Peck, 2004). Disruptions in one part of the network may generate ripple effects affecting suppliers, transportation providers, ports, and customers across different locations (Ivanov & Dolgui, 2020).

These conditions reinforce the importance of supply chain resilience, which includes not only the ability to recover operations after disruptions but also the ability to anticipate, respond, adapt, and maintain critical functions during crises through preparedness, flexibility, information visibility, and coordination among stakeholders (Hohenstein et al., 2015). In addition to resilience, organizations require dynamic capabilities to adapt resources and operational processes to changing environments, including the ability to identify changes, determine strategic responses, and reconfigure resources. In shipping operations, these capabilities are reflected through route adjustments, schedule modifications, security resource mobilization, alternative supplier or port utilization, and strengthened coordination with relevant stakeholders (Herburger et al., 2024). Therefore, adaptability is a critical factor in maintaining operational continuity amid geopolitical uncertainty.

The impacts of geopolitical risks at the macro level must be translated into organizational operational contexts. PT XYZ, as a national oil and gas shipping company, is exposed to geopolitical dynamics because some of its operations involve international shipping lanes and strategic chokepoints. Disruptions to shipping routes may affect crew safety, ship and cargo security, delivery schedule reliability, operational costs, regulatory compliance, and

energy supply continuity. Therefore, organizations must not only identify emerging geopolitical threats but also determine appropriate responses based on risk levels and operational conditions.

Statements regarding exposure levels and decision-making patterns require support from internal operational data to ensure that research problems are based on empirical gaps rather than assumptions.

In practice, companies may need to make rapid decisions during conflict escalation, navigation restrictions, increased vessel threats, or regulatory changes. Possible alternatives include continuing operations, enhancing security measures, delaying departures, changing ports, rerouting vessels, transferring risks, or activating business continuity plans. Each alternative has different consequences related to safety, security, cost, time, supply continuity, legal compliance, and corporate reputation. Therefore, decision selection requires a structured and accountable decision-making framework.

The transformation of geopolitical threats into operational and security risks requires a structured framework. ISO 31000:2018 positions risk management as an integral component of organizational governance, planning, and decision-making. In the oil and gas industry, API Standard 780 provides a systematic security risk assessment methodology through the identification of assets, threats, vulnerabilities, and consequences, while the International Ship and Port Facility Security (ISPS) Code establishes security requirements for ships and port facilities. These frameworks serve complementary functions: ISO 31000 provides general risk management principles, API Standard 780 supports security risk assessment processes, and the ISPS Code regulates maritime security obligations. A structured maritime security risk assessment enables organizations to determine risk levels consistently and identify mitigation measures appropriate to operational conditions (Perković et al., 2024).

However, the results of security risk assessments do not automatically produce strategic decisions. Risk assessments identify threats, vulnerabilities, consequences, and control effectiveness, whereas management must select among alternative actions with different advantages, limitations, costs, and consequences. The gap between risk assessment outcomes and strategic decision selection requires a decision-support framework. This need becomes more significant because strategic decisions are often made under conditions of uncertainty, limited information, restricted time, analytical constraints, and cognitive limitations.

The bounded rationality perspective explains that organizational decisions are not always based on perfect optimization because decision-makers operate with incomplete information and various limitations. Strategic decision-making processes are influenced by cognitive constraints, environmental uncertainty, stakeholder interests, and organizational dynamics (Eisenhardt & Zbaracki, 1992).

Under these conditions, decisions based solely on individual intuition or experience may result in inconsistent judgments across situations and organizational units. Dean and Sharfman (1996) emphasized the importance of procedural rationality, in which decisions are supported by information searches, alternative evaluations, relevant data utilization, and systematic assessment procedures because such processes provide stronger accountability than intuition-based decisions.

For energy shipping companies, this approach is essential because operational decisions involve human safety, asset security, legal compliance, reputation protection, and energy supply continuity. Decision complexity in oil and gas shipping operations continues to increase because management must simultaneously consider multiple criteria, including crew safety, ship and cargo security, threat exposure levels, supply continuity, operational costs, transit time, legal compliance, corporate reputation, alternative routes and port availability, emergency response readiness, and risk appetite and tolerance limits.

Some of these criteria involve trade-offs: the lowest-cost alternative may not provide acceptable safety and security levels, whereas the safest alternative may require additional costs, longer transit times, and contractual consequences. This trade-off characteristic indicates that single-criterion decision-making approaches are insufficient for addressing geopolitical risks in energy shipping operations.

A method is therefore required to integrate quantitative and qualitative criteria, make management preferences explicit, and demonstrate exchanges among competing objectives. In this context, Multi-Criteria Decision Analysis (MCDA) can serve as a systematic decision-support approach. Belton and Stewart (2002) explained that MCDA includes formal approaches that explicitly consider multiple criteria to support individual or group decision-making processes.

Unlike optimization methods that seek an objectively predetermined optimal solution, MCDA is positioned as decision aiding, meaning that it supports decision-makers' reasoning processes rather than replacing their judgment (Roy, 1996). This approach is supported by value theory and multi-attribute utility theory, which enable decision-makers to express preferences and evaluate competing objectives in measurable forms (Keeney & Raiffa, 1993).

Thus, MCDA not only generates alternative rankings but also assists in structuring problems, defining objectives, identifying alternatives, establishing criteria, evaluating performance, and understanding the consequences of each decision. MCDA is particularly suitable for energy shipping contexts because it provides transparent and traceable decision-making processes, creating an audit trail that strengthens accountability to stakeholders. The relevance of MCDA in maritime decision-making has been supported by Dourmouis (2025), who noted that shipping decisions generally involve combinations of technical, economic, operational, safety, security, and environmental considerations that cannot be represented by a single indicator.

Nevertheless, MCDA has limitations that must be carefully managed to maintain credibility. Weighting and alternative evaluations involve subjective judgments, and this subjectivity is inherent in decision-support processes; therefore, it must be managed rather than ignored (Roy, 1996). Expert assessments may also be affected by cognitive and motivational biases that influence outcomes (Montibeller & von Winterfeldt, 2015). Furthermore, the reliability of MCDA depends on data quality, may become complex when numerous criteria and alternatives are involved, and may produce different rankings depending on the selected aggregation methods (Triantaphyllou, 2000). Therefore, selecting an appropriate MCDA method requires careful justification (Guitouni & Martel, 1998). This study addressed these limitations through competency-based expert selection, bias mitigation procedures, consistency testing, such as the consistency ratio in paired comparison approaches (Saaty, 1980), and sensitivity analysis to evaluate the robustness of results under different weighting scenarios.

Effective MCDA implementation requires careful problem structuring because analytical accuracy is strongly influenced by how objectives, alternatives, criteria, stakeholders, and decision constraints are formulated. Poor problem structuring may result in overlapping criteria, incomplete alternatives, or rankings that do not accurately represent the actual decision problem (Marttunen et al., 2017).

The concept of value-focused thinking complements MCDA by positioning organizational values and objectives as the foundation of decision formulation. The decision-making process should begin not with available alternatives but with identifying desired outcomes and values that must be protected (Keeney, 1996). In oil and gas shipping operations, these values include human safety, ship and cargo security, energy supply continuity, regulatory compliance, reputation protection, and operational sustainability. These values then guide the development of decision criteria and evaluation of alternatives.

With these characteristics, MCDA functions as a bridge that translates risk assessment results into strategic decisions. The output of the API 780-based security risk assessment, including consequence, threat, and vulnerability evaluations, provides the basis for criteria formulation and weighting, while geopolitical scenario analysis establishes the operational context in which alternatives are evaluated. Through the MCDA decision matrix, alternatives such as continuing operations, rerouting, delaying departures, changing ports, increasing security measures, transferring risks, and activating business continuity plans can be systematically ranked according to prevailing risk conditions. Therefore, MCDA does not merely function as a scoring tool but serves as a mechanism connecting threat intelligence, risk assessment, and strategic response options within a coherent and accountable decision-making process.

Problem Formulation

Based on the description in the background, the research problem is formulated in the following five questions:

1. What forms of geopolitical risk are most relevant to the security aspect of oil and gas shipping operations at PT XYZ?
2. Analyzing how these geopolitical risks are transformed into exposure to oil and gas security risks?
3. What criteria does PT XYZ's management use in choosing strategic decision options, and what is the relative weight between these criteria?
4. How can the formulation of Multi-Criteria Decision Analysis (MCDA) support the company's strategic decision-making?

Research Objectives

According to the four problem formulations, this research aims to:

1. Analyze the characteristics and relevance of geopolitical risks that affect the security aspects of oil and gas shipping operations at PT XYZ.
2. Analyze the mechanism of transforming geopolitical risk into exposure to operational security risks.
3. Formulate strategic decision-making criteria and determine the level of relative importance between criteria.
4. Establish a decision-making framework based on Multi-Criteria Decision Analysis (MCDA) to strengthen the evaluation process and strategic decision-making.

Research Benefits

- 1 This research provides a basis for management in building *strategic risk-based decision-making* in oil and gas shipping operations. The resulting framework can help management understand the *trade-offs* between crew safety, asset security, continuity of supply, surcharges, legal compliance, corporate reputation, and corporate risk tolerance limits.
- 2 Practically, this research can help PT XYZ and oil and gas shipping companies in developing mitigation priorities, strengthening *security intelligence*, assessing high-risk routes, developing *contingency plans*, and aligning security processes with international standards. The results of the study can also support decision-making related to route selection, fleet allocation, crew protection, insurance premium management, and cross-functional coordination during geopolitical escalations.
- 3 Socially, this research contributes to the understanding that securing the energy supply chain is part of the public interest. Oil and gas shipping disruptions not only impact companies, but also have the potential to affect energy availability, prices, and economic stability of the community.
- 4 Technically, this research produces a design of indicators, risk matrices, and mitigation models that can be used as tools in *security risk assessment*, *scenario planning*, and *business continuity planning* in oil and gas shipping operations.

METHOD

3.1 Research Approach

This study employed a qualitative approach supported by descriptive quantitative analysis. The qualitative approach was used to examine the processes, considerations, and mechanisms underlying management's strategic decision-making in addressing geopolitical risks in oil and gas shipping operations. Descriptive quantitative analysis was used to provide measurable assessments of security risk levels, Security Risk Assessment scores, decision criteria weights, estimated operational impacts, additional transit time, additional costs, potential delays, and risks to supply continuity.

This approach was selected because geopolitical risks have complex, dynamic, and cross-jurisdictional characteristics and are strongly influenced by contextual factors. These risks were not only examined as external challenges but were also translated into security risk exposures that could affect vessels, crews, cargo, ports, shipping routes, costs, schedules, insurance, and the sustainability of the oil and gas supply chain.

3.2 Type/Type of Research

This type of research is an explanatory case study. The case study was chosen because the research focuses on PT XYZ as an oil and gas shipping company that has exposure to global geopolitical dynamics, international shipping lanes, *Chokepoint* strategic ports, maritime security risks, and disruptions to energy supply chains. The explanatory nature is used because this study not only describes geopolitical risks, but also explains how these risks are transmitted into security risks and how the results of risk assessments are used as the basis for strategic management decision-making.

3.3 Research Methods and Strategies

The research method was carried out through triangulation of primary data and secondary data. Primary data was obtained through interviews with resource persons related to HSE, security, emergency response & crisis management, and enterprise risk management. Secondary data was obtained through the study of internal and external documents relevant to geopolitical risks, securing oil and gas shipping operations, maritime security and risk management.

The research strategy is carried out by integrating *Security Risk Assessment*, scenario analysis, decision-making criteria, *Multi-criteria decision analysis* (MCDA), and decision-making matrix. *Security risk assessment* used to assess *threat*, *vulnerability*, *consequence*, *likelihood*, and *Impact*. Scenario analysis is used to test various possible geopolitical escalations. MCDAs are used to help with the weighting of decision criteria, while decision-making matrices are used to compare alternative strategic management decisions.

The interview instrument will be directed to several main themes as follows:

Table 3.1 Interview question framework and data mining focus

Interview Theme	Data Mining Focus
Identify geopolitical risks	Forms of geopolitical risk that are considered relevant to oil and gas shipping operations, such as armed conflict, tensions between countries, sanctions, blockade, port restrictions, <i>chokepoint</i> disturbances, piracy, sabotage, or attacks on ships.
Geopolitical Intelligence	Information sources, monitoring mechanisms, monitoring frequency, and how companies obtain information related to the development of geopolitical risks that have the potential to affect shipping routes, ships, crews, cargo, and ports.

Interview Theme	Data Mining Focus
Translation of geopolitical risks into security risks	The way companies translate geopolitical information into exposure to operational security risks to ships, crews, cargo, shipping routes, ports, operating schedules, costs, insurance, and continuity of supply.
Mapping of affected assets and business processes	Assets, routes, ports, ships, crews, cargo, shipping schedules, contracts, insurance, and business processes are most affected in the event of an escalation of geopolitical risks.
<i>Security risk assessment</i>	The security risk assessment process is based on <i>threats</i> , consequences, likelihood, and impact in oil and gas shipping operations.
Determination of risk rating	The way the company determines the level of risk, risk category, risk priority, and the basis for determining risks as insignificant, low, moderate, significant, catastrophic.
<i>Risk appetite and risk tolerance</i>	The limits of risk that can be accepted by companies in oil and gas shipping operations and how <i>risk appetite</i> and <i>risk tolerance</i> are used in strategic management decision-making.
Scenario analysis	The use of risk scenarios such as <i>chokepoint</i> closures, attacks on ships, port access restrictions, sanctions, increased war risk premiums, re-routing, or shipping delays.
Strategic decision-making criteria	The criteria used by management in choosing decision options, such as crew safety, ship and cargo security, continuity of supply, additional travel time, additional costs, legal compliance, reputation, insurance, readiness of alternative routes, and business continuity plan.
Management decision options	The basis for management's consideration in choosing the option of continue as planned, continue with enhanced security, re-routing, delay shipment, change loading/discharge port, transfer risk through insurance, activate contingency plan, or activate business continuity plan.
<i>Decision matrix</i> and MCDA	The use of <i>the decision matrix</i> and MCDA as a tool to weight decision criteria and comparison of alternative decisions in a transparent, structured, and accountable manner.

RESULTS AND DISCUSSION

Results of the implementation of *security risk assessment*

Based on the results of the study, the *security risk assessment* process for PT XYZ's oil and gas shipping operations was carried out through five stages, namely asset characterization, threat assessment, vulnerability assessment, risk evaluation, and risk control. These stages are

used to identify critical assets, map threat exposures, evaluate the effectiveness of existing safeguards, and determine additional mitigation needs.

Overall, ship operations ranging from terminal *loading* departures, *anchorage*, and *drifting* in the Strait of Hormuz, transit at *the Hormuz chokepoint* and Arabian Gulf, *vessel loading* at Aramco terminals, to navigation on *shipping lines* face major threats in the form of missile and drone attacks, conflicts between countries, sea mines, intimidation of armed vessels, and limited maneuverability which has the potential to cause crew casualties, damage or loss of ship, collision or grounding, environmental pollution, as well as financial and legal impacts. The existing *risk level* is in the Significant to Catastrophic category. Necessary mitigations include delays in departure or transit when threats are active, real-time monitoring of intelligence and *maritime security advisory*, coordination with maritime and port authorities, increased navigation supervision and *Ship Security Level*, extinguishing system readiness, damage control, emergency communication and procedures, safe lane verification, and *port substitution* or *rescheduling* when needed. War *risk insurance* and P&I protections must also be ensured to remain in effect. Once all controls have been implemented and the safety conditions and shipping lanes have been verified, the *residual risk* may be downgraded to Moderate; however, if operations remain carried out while the threat is still active, the risk remains in the Significant to Catastrophic category.

Geopolitical Risk Scenario Analysis

Scenario analysis is used to understand how geopolitical conditions may develop and affect PT XYZ's operations. This approach is important because geopolitical risks are dynamic, non-linear, and often evolve through initial signals before becoming actual disruptions. Scenario analysis helps management test organizational readiness, identify triggers, establish early warning indicators, and compare alternative responses before a crisis occurs.

The analysis of geopolitical scenarios was prepared using the intuitive *logics* (Schoemaker, 1995) and Global Business Network (Wack, 1985; Schwartz, 1991; van der Heijden, 1996) where the scenario is not a single forecast, but rather a coherent set of alternative future scenarios, which are constructed by identifying basic trends and key uncertainties to address common mistakes in decision-making such as *overconfidence* and *tunnel vision*, by identifying the driving factors and critical uncertainties of geopolitical risks in shipping operations, and then stringing them together into multiple scenarios plausible, consistent, and different alternatives.

The scenarios are derived from the results of Security Risk Assessment, maritime security advisory, and resource validation, so that each scenario becomes a testing context for alternative decisions within the framework of the MCDA. This scenario is exploratory to test the resilience of decisions. The following are geopolitical risk scenarios relevant to geopolitical operations

The scenario shows that the management response should be tailored to *Severity*, *Urgency*, and *Reversibility*. The scenario of an attack on the ship has *Severity* and requires a quick response. The scenario of an increase in insurance premiums requires a cost analysis and *Risk transfer*. Sanctions scenario requires *Legal Clearance* before operational decisions are made. Thus, scenario analysis helps management avoid a single response to all risk conditions.

The main value of the scenario is not in the ability to predict the future with certainty, but in the ability of the organization to prepare for a response to different possible futures. For PT XYZ, scenario analysis increases management readiness by building decision choices before the crisis develops. The strategic implication is an increase in the speed and quality of decision-making because management does not start the analysis from scratch when an escalation occurs.

Management Strategic Decision Making Criteria

Strategic decision-making in oil and gas shipping operations affected by geopolitical risks requires clear, measurable, and relevant criteria. Results such as *continue as planned*, *re-routing*, *delay shipment*, *port substitution*, *security enhancement*, *risk transfer*, *convoy/escort*, or activation *contingency plan* cannot be based on just one factor. Each alternative has *trade-off*. The selection of criteria is based on the *value-focused thinking* (Keeney, 1992), where criteria are derived from the company's strategic objectives in managing geopolitical risks, and then filtered using criteria properties that are essential, measurable, and non-redundant. Substantively, the criteria are sourced from the Security Risk Assessment framework, shipping risk literature, and source validation, so that the eight include all dimensions of strategic decision consequences: safety, asset security, financial, operational, compliance, continuity, and reputation. Based on the results of the study,

The safety of the crew is the highest priority criterion because it concerns the protection of human lives. The safety of ships and cargo is the next priority because they are high-value assets and have the potential to cause environmental and economic impacts in the event of an incident.

Additional travel time and operational costs are required to assess the economic consequences of the decision option. However, cost should not be the only dominant criterion in high-threat situations. Insurance needs to be considered because *coverage*, *exclusion*, and *war risk premiums* can determine the feasibility of the operation. Legal compliance is the limit of non-negotiable decisions. If a route or port poses a risk of sanctions or violations of the law, then even an operationally attractive option cannot be chosen without legal clearance. Reputation is also an important criterion because shipping decisions in conflict conditions can affect stakeholders' perceptions of company responsibilities.

Decision matrix and MCDA analysis

The decision analysis in this study was carried out in two consecutive stages and cannot be reversed. The first stage is screening using non-compensatory rules, namely safety screenings and legal compliance screenings. The second stage is the ranking of alternatives that pass the filter using *Multi-Criteria Decision Analysis* with direct weighting. This separation is important because the *weighted sum model* is compensatory — a low score on one criterion can be covered by a high score on another. For criteria concerning the protection of life and compliance with the law, the compensatory nature is unacceptable, so they are treated as conditions that must be met first, not as criteria that can be exchanged.

Based on the results of *security risk assessment* and scenario analysis, this study identifies several alternative decisions that can be applied by PT XYZ management in dealing with geopolitical risk exposure in oil and gas shipping operations. These alternatives include *continue operation*, *continue operation with security enhancement*, *delay shipment* or *hold position* or *re-routing*. Risk transfer through insurance, the use of *convoys* or *escorts* when available and in accordance with legal provisions, as well as the activation of *contingency plans* or *business continuity plans*.

These alternatives are then compared through a *decision matrix* with the *Multi-Criteria Decision Analysis* (MCDA) approach. This analysis integrates the results of security risk assessments, threat development scenarios, company risk acceptance limits, and operational considerations into a single evaluation structure. Through this process, each alternative is assessed based on their respective capabilities in protecting the crew, maintaining the safety of the ship and cargo, maintaining continuity of supply, meeting legal requirements, and controlling the consequences of time and cost.

The results of the analysis show that the most feasible decision is not always an alternative with the least additional cost or time. In high-threat conditions, safety, security, and legal compliance are the main considerations that limit the feasibility of an alternative. Thus,

the decision matrix is used to transparently show *the trade-offs* between alternatives and help management distinguish which alternatives are feasible, feasible with additional mitigation, or unacceptable.

Results of weighting criteria

Weighting is carried out to determine the level of relative importance of each criterion to PT XYZ's strategic decision-making objectives. Based on the results of the identification and grouping of criteria, the aspects used in the alternative evaluation include crew safety, ship and cargo safety, supply continuity, additional time, additional operational costs, legal compliance, company reputation, readiness of alternative operations, readiness of *contingency plan* or *business continuity plan*, as well as conformity with *the company's* risk appetite and risk tolerance.

The weighting results show that crew safety as well as ship and cargo safety are placed as criteria with the highest level of importance. The determination is based on the magnitude of the consequences that can arise in the event of a security failure, especially casualties, asset damage, loss of cargo, environmental pollution, and termination of operations.

Cost and time criteria are still taken into account as they affect the operational and commercial feasibility of an alternative. However, neither aspect is placed as a consideration that can replace or compensate for failures in the aspects of safety and legal compliance. Low-cost alternatives can still be declared unfeasible if they are not able to reduce the risk to the crew and assets within the company's tolerance limits.

Basis for weight determination

1. Relevance to the company's strategic goals

The results of the analysis show that the magnitude of the weight of each criterion is determined based on its relationship with the company's main objectives in maintaining human safety, asset security, continuity of operations, legal compliance, and the sustainability of the energy supply chain.

The safety of the crew and the safety of the ship and cargo gain greater weight because failures in both aspects can have immediate and far-reaching impacts. These impacts are not only in the form of casualties and physical damage, but can also develop into supply disruptions, financial losses, legal consequences, insurance claims, and a decline in the company's reputation.

In contrast, criteria whose impact is more limited or can still be recovered through operational actions acquire a relatively lower weight. Nonetheless, all criteria are retained in the model as each provides the information necessary in comparing alternative decisions.

2. Magnitude of risk and consequences

The results of the assessment show that the level of importance of criteria is also influenced by the magnitude of the consequences if the risk cannot be controlled. Criteria relating to possible casualties, ship damage, loss of cargo, pollution, sanctions violations, and supply interruptions are positioned as key considerations.

This determination leads to alternative decisions that are able to reduce exposure to major consequences to obtain better judgment. In contrast, alternatives that provide only time and cost benefits, but still maintain a high level of threat or vulnerability, obtain lower ratings. These results show that the rating process not only assesses alternative efficiencies, but also considers alternative capabilities in preventing unacceptable consequences for companies.

3. Operational characteristics and levels of exposure

The results of the analysis of shipping activities showed that the level of risk exposure was different at each stage of the operation. Ships located in terminals, berths, narrow shipping lanes, or *strategic chokepoints* have different maneuver limitations and exposure times than ships in open water.

These differences are used in assessing the relevance of the criteria in each scenario. In transit scenarios through conflict areas, for example, safety, security, readiness of alternative routes, and response speed become more dominant. Meanwhile, in the scenario of delayed departure or port replacement, additional time, cost, contractual compliance, and continuity of supply become more prominent.

Thus, the results of weighting and alternative assessments are not treated separately from operational conditions. Interpretation of the results still takes into account the ship's location, stage of operation, threat intensity, security system readiness, and availability of alternatives.

5. Data quality and sufficiency

The results showed that the level of confidence in the assessment of each criterion was influenced by the quality and adequacy of the available data. Safety, security, travel time, and operational cost criteria are relatively easier to trace through company procedures, operating data, risk assessment results, and supporting documents.

Meanwhile, some aspects such as the development of geopolitical threats, changes in the intentions of actors, possible port restrictions, and reputational impacts have a higher level of uncertainty. The uncertainty is not used to increase or decrease the strategic weight of a criterion. In contrast, data limitations are recorded as the confidence level of the assessment and are checked through triangulation, expert validation, and sensitivity analysis.

This approach is used so that weights still represent the strategic importance of the criteria, while the quality of the data is treated as a factor that affects the reliability of the score and the interpretation of the results.

6. Results of Resource and Member Evaluation

The determination of weights and alternative scores was confirmed through the assessment of resource persons who understood shipping operations, maritime safety, risk management, legal compliance, risk financing, and business continuity. The assessment is used to ensure that the MCDA's structure not only reflects conceptual considerations, but also describes the operational conditions and management priorities of PT XYZ.

The results of the resource person's assessment were used to evaluate the completeness of the criteria, the fairness of the weight, the relevance of the alternative decision, and the suitability of the assessment scale. Differences of opinion between resource persons were analyzed based on their respective fields of competence. Considerations from the security and operations functions are mainly used to evaluate safety and operational feasibility, while the legal, risk management, finance, insurance, and business continuity functions provide assessments of compliance, risk tolerance, cost, insurance protection, and recovery readiness.

The input of the resource persons is then compared with the results of the interview, internal documents, and external sources. The results of the comparison are used to correct weights and scores before alternative rankings are set. Where there were substantive differences in judgment, the study used sensitivity analysis to test whether the change in weight affected the alternative order of decisions.

Weighting Basics

MCDA – Direct Weighting is one of the *Multi-Criteria Decision Analysis* methods where each decision criterion is weighted directly based on subjective judgment or *expert judgment*. The criteria are determined based on the fundamental objectives of strategic decision-making in managing geopolitical risks and then derived from the results of the security risk assessment after the candidate criteria are collected, the criteria are filtered using the properties of the criterion set. Keeney and Raiffa (1976) and Belton and Stewart (2002), who established that the criteria should ideally be essential, operationally measurable, non-overlapping to avoid *double counting*, minimal in number, and understandable and preference-independent. The goal is to express the relative priority of each criterion to be used in the alternative evaluation of the decision with the following information:

1. Weight scale : 0 – 1
2. Conditions : total whole weights of criteria = 1 or 100%
3. Assessment resources : management, an in-house team of experts, or a combination of both.

The subjectivity of expert assessment is not eliminated because it is impossible in the MCDA, but is managed through the selection of resource persons based on competency criteria, consistency test procedures, and sensitivity analysis, so that the weighting results can be accounted for methodologically.

Multi-Criteria Decision Analysis (MCDA) Calculation

In this study, *Multi-Criteria Decision Analysis (MCDA)* is used as a systematic method to assess alternative decisions in oil and gas shipping based on various risk and operational criteria. The rating scale uses a score of 1 to 5, where:

- 1) Score 1: Alternatives strongly do not support the criteria or show high risk;
- 2) Score 5: Alternatives strongly support the criteria or show minimal risk.

The interpretation of the score varies according to the type of criteria:

1. Safety, Security, Threat Level, Risk Rating: a high score indicates an alternative capable of reducing risk exposure to ships, crew, cargo, and operations.
2. Time and Cost: a high score indicates additional time or relatively lower cost, making the alternative more efficient.
3. Legal Compliance, Alternative Operational Readiness, and Business Continuity Plan (BCP): high scores indicate the feasibility of better implementation and the company's readiness in the face of operational disruptions.

The formula for calculating the *Total Weighted Score* is:

$$\text{Total Skor Tertimbang} = \sum (\text{Bobot Kriteria} \times \text{Skor Alternatif})$$

Calculation of the weighted score value of the Continued as Planned option

Based on the matrix, the alternative with the highest weighted value is re-routing with a score of 4.20. This option can be an option if alternative routes are available and can significantly reduce risk exposure. However, in the context of the Strait of Hormuz, re-routing has limitations because *the chokepoint* is the main route in and out of the Arabian Gulf. Therefore, re-routing should be tested based on the ship's position, shipping destination, draft limitations, additional travel time, additional fuel costs, insurance support, and legal compliance.

The second alternative is delayed departure or hold position with a score of 4.16 This option is relevant if the escalation is considered temporary and there are indications that the security situation can improve in a certain time. Delays or hold positions can prevent ships from the most critical phase of conflict, especially if the ship is still in a loading terminal, anchorage, or a relatively safer area. However, this option still has consequences for schedules, costs, and potential delivery delays.

The third alternative is to continue operation with security enhancement with a score of 3.92. This option is only worth considering if the threat level decreases, there are no actual attacks on the same route, maritime authorities do not issue shipping restrictions, insurance still provides adequate coverage, and *residual risk* can be lowered to within *risk tolerance*. If *the existing risk* is still high, security enhancement alone is not enough to be the basis for the decision to continue operations.

The fourth alternative is to continue operation as planned with a score of 2.92. This option obtained the lowest score because it did not provide an adequate risk reduction to crew safety, ship and cargo security, threat level, and risk rating. Although this option is most advantageous in terms of time and short-term costs, it is not in line with the principle of *risk-based decision-making* when geopolitical risk is still high.

Determination of Tolerance Value (*threshold*)

The determination of the risk category threshold in this study follows the principle of grouping MCDA scores into priority categories as commonly used in the multi-criteria analysis literature. The specific limit value was set by the researcher by referring to *PT XYZ's risk appetite* and *risk tolerance*, not taken from a source's standard number. As the main filter, safety is applied at the criterion level, i.e. alternatives with a safety or security score below 3 are declared unfeasible, while the total score is only used to rank alternatives that have passed the filter.

Threshold setting basis

Integration of risk appetite and risk tolerance of the company

The determination of thresholds in strategic management decision-making must be in line with *the company's risk appetite* and *risk tolerance*. *Risk appetite* describes the level of risk that the organization is willing to accept as a whole, while *risk tolerance* shows the maximum limit of risk that can be borne in each operational aspect.

In the context of PT XYZ's oil and gas shipments, the safety of the crew and ship has the highest priority. Therefore, any decision option that lowers the total MCDA score below 3.4 is automatically categorized as high risk, indicating that the risk is unacceptable without additional mitigation measures. Thus, this threshold helps management set mitigation priorities according to the company's risk policy and ensure that strategic decisions are in line with the organization's risk profile.

Multi-Criteria Analysis

The total MCDA score is obtained from a combination of criterion weights and alternative assessment of decisions. Each criterion has a weight that reflects its strategic relevance to safety, continuity of supply, cargo security, cost, and compliance. Alternative results are scored against each criterion.

The results of this calculation provide an initial interpretation of the risk category (*insignificant, low, moderate, significant, catastrophic*) before the decision is formally ratified. MCDAs are used to structure comparisons between alternatives and ensure measurable, transparent, and accountable assessments, while also considering complex multi-criteria interactions

Qualitative Validation

Although the total score provides a quantitative basis, the initial recommendations must be validated qualitatively. This process involves:

1. Interviews with relevant stakeholders, such as HSSE, Security, shipping operations, and Emergency Response & Crisis Management.
2. Expert judgment *considerations, including operational experience, route conditions, crew readiness, and possible geopolitical disruptions.*
3. Adjustment of recommendations according to the actual operational context and strategic priorities of the company.

This stage ensures that the decisions taken are not only based on MCDA scores, but also take into account pragmatic aspects and real business contexts, so that PT XYZ's management's strategic decision-making is more effective in maintaining supply chain continuity, crew safety, and cargo security.

In the context of PT XYZ's strategic management decision-making, each decision option was evaluated using a total MCDA score that reflected a combination of weighting criteria and alternative assessments of aspects of crew safety, cargo security, continuity of supply, cost, time, legal compliance, reputation, and operational readiness.

This risk classification is divided into three main categories that guide initial recommendations before qualitative validation and final decisions are made by management:

1. High Risk - Not Recommended: a total score of ≤ 3.4 of these options poses a high risk to safety, cargo, continuity of supply, or *compliance*.
2. Moderate Risk - Worthy of Note: a total score of 3.41 – 4.0 options can be executed, but additional mitigation or *enhanced security is required*.
3. Low Risk - Strong Recommendation: total score > 4.0

Initial Decision and Recommendation Options

To support management's strategic decision-making, each decision option is evaluated using the MCDA's total score, which reflects the weight of the criteria and assessments of various critical factors such as crew safety, cargo security, continuity of supply, cost, time, legal compliance, and operational readiness. This total value is used to determine the risk category of each option and provides a basis for management to establish initial recommendations before qualitative validation is carried out.

The following table presents an initial decision-making matrix, which relates each option's total score to the corresponding initial recommendations. A low-scoring option indicates a high risk and is usually not recommended, while a high-scoring option indicates a more acceptable risk and is a strong recommendation, with a note that operational conditions and the readiness of the route or port have been checked.

This matrix aims to assist management systematically in comparing alternative decisions and determining the most appropriate mitigation measures or operational actions.

Table 4.10 Initial decision options and recommendations

Decision Options	Total Value	Initial Recommendations
Continue as Planned	2,92	Not recommended — fall before rating
Continue Operation + Security Enhancement	3,92	Worthy of note; Need additional mitigation
Delay Departure / Hold Position	4,16	Strong recommendations; Excels when cost–time/route priority is limited
Re-routing	4,20	Strong recommendations; Excels when alternative routes are available & safe

Sensitivity test

Because the score difference between the top two alternatives was only 0.04, a sensitivity test was conducted to test the rigidity of the rankings against changes in the weight of the criteria. The test was conducted on five weighting scenarios that reflected different management priorities, against three alternatives that passed the safety screening (*Continue as Planned* has been dropped).

The results of the sensitivity test show that the first rank is not completely rigid. Re-Routing ranked first in four of the five scenarios, but when the priority shifted to cost and time (S3), Delay/Hold Position ranked first. These findings confirm that Re-Routing and Delay/Hold Position are practically equivalent, and the selection between them depends on the priority of criteria set by management in the actual situation.

Data triangulation results

Triangulation was applied to test the credibility of the study's three main findings, namely scenario risk level, criterion weighting, and alternative decision ranking, by cross-confirming between documents, cross-functional resource person assessments, MCDA calculations, and theoretical lenses. Convergence between sources is treated as a reinforcement

of findings, while divergences are explored and explained (Denzin, 1978; Patton, 1999; Carter et al., 2014).

Risk level of the Strait of Hormuz scenario

The results of the *security risk assessment* of exposure to the US-Iran conflict (Table 4.2) placed *the existing risk* in the Significant category and decreased to *Moderate residual risk* only after mitigation was implemented. These findings were cross-confirmed by maritime security advisors as well as incident reports and *media monitoring* that showed actual threats in the region, and validated by Security function resource persons (NS-03) who assessed the implementation of SRA and risk acceptance thresholds, as well as external maritime/geopolitical security experts (NS-05) who assessed the fairness of the scenario.

Priority and weighting of criteria

The MCDA weighting (Table 4.4) placed shipcrew safety and cargo-ship safety as the highest criteria (0.20 each), followed by time, cost, and compliance (0.12) as well as reputation, alternative routes, and BCP readiness (0.08). This weight is cross-confirmed by the assessment of the HSSE resource person (NS-01) on the safety dimension, Security (NS-03) on *Risk appetite* and *Risk tolerance*, and Business Continuity Management (NS-04) on the criteria for risk acceptance and integration of SRA results with the decision process. This safety priority is also consistent with the principle *value-focused thinking* and the SRA approach that places life protection as the most critical consequence, so that the weight applied is not an individual's preference but a result that converges across functions and across theoretical foundations.

Alternative ranking of results

Weighted score calculation results in a sequence *Re-routing* (4,20) and *delay/hold* Position (4,16) As the top two alternatives, followed by Continue Operations + Security Enhancement (3,92), whereas *continue as planned* (2,92) Died before the rating because his safety score (1) was below the safety filter (score < 3). This ranking is methodologically cross-confirmed. MCDA's quantitative results are in line with the qualitative assessment of the resource persons, Emergency Response & Crisis Management (NS-02) on eligibility *delay/hold* and operational recovery, as well as Security (NS-03) on feasibility *Re-routing*—and by reviewing the Operations/Marine Advisory document regarding the availability of alternative routes.

Rating durability

The sensitivity test (Table 4.11) shows *Re-routing* ranked first in four of the five weighting scenarios; only when the priority is shifted to cost-time (S3), the delay/hold position becomes the first rank. The quantitative results differed by only 0.04 and exchanged positions according to priorities in line with the qualitative assessment of the interviewees that the choice depended on the actual conditions and priorities of management. The difference in S3 is therefore not treated as a contradiction of data, but rather as an affirmation of the nature of the *Quota* decision.

The overall results of the study show that geopolitical risk is a source of strategic risk that has a direct transmission line to operational security risks in oil and gas shipments. These findings expand the understanding of security risk management from an asset-focused approach to a more dynamic approach, *route-based*, *scenario-based*, and *decision-oriented*. Geopolitical risk is not sufficiently understood as an external threat, but must be translated into risks to ships, crew, cargo, routes, ports, schedules, costs, insurance, legal compliance, reputation, and continuity of supply.

A review of eight previous studies identified in the Chapter II literature shows that studies on geopolitical risk, maritime security, supply chains, and multi-criteria decision-making have so far developed separately and have not been integrated into a single decision-making framework for oil and gas shipping operations.

From perspective *Security Risk Assessment*, this study shows that *parameter threat*, *vulnerability*, *consequence*, *likelihood*, and *Impact* need to be linked to the geopolitical context. *Threat* It comes not only from maritime crime, but also from political conflicts, state actors, non-state actors, sanctions, and maritime restrictions. *Vulnerability* not only related to the physical weakness of the ship, but also the limitation of information, dependence on certain routes, limitations of alternative ports, limitations *Coverage* insurance, and readiness for cross-functional coordination. *Consequence* not only in the form of ship damage, but also disturbance *Supply Chain*, additional fees, breach of compliance, and reputation.

From the perspective *of maritime security*, the findings of the study show that oil and gas vessels are at the crossroads between commercial interests and international security dynamics. Ships carrying energy cargo can be affected by conflicts that do not directly involve the company. This strengthens the need for *maritime domain awareness* and *geopolitical threat intelligence* in oil and gas shipping operations. Management decisions must take into account that threats at sea can change rapidly and have cross-jurisdictional consequences.

From a *strategic decision-making perspective*, this study shows that oil and gas shipping decisions in geopolitical conditions are complex decisions influenced by *bounded rationality*. Management faces limited information, uncertainty in the development of conflicts, time pressures, and *trade-offs* between goals. Therefore, a *decision-support framework* is needed to reduce reliance on intuition and individual experience. Frameworks don't eliminate uncertainty, but they help organizations make more explicit, consistent, and accountable decisions.

MCDA contributes to the multi-criteria decision-making process. Its advantage lies in its ability to accommodate a variety of disparate criteria, such as safety, cost, time, legal, insurance, and reputation. However, this study also confirms that MCDA should be used with caution. Weighting criteria depending on quality *Expert Judgment*, completeness of pairwise comparison, and consistency of assessment. Therefore, the MCDA/AHP results should be treated as analytical support, not an automatic final decision.

The contribution of research to security risk management practices is the preparation of conceptual relationships between geopolitical threat intelligence, *Security Risk Assessment*, scenario analysis, decision criteria, MCDA, and *Decision Matrix*. This contribution is important because many organizations *have a risk assessment*, but it does not always have an explicit mechanism to change the outcome *Risk assessment* be a management decision. This study bridges this gap by placing SRA as an input for *strategic decision-making*.

Thus, the relevance of geopolitical risks to PT XYZ lies in its ability to change the operating environment rapidly. Escalation of conflicts, port restrictions, threats to merchant ships, increased *war risk premiums*, disruption of navigation systems, or changes in the policies of certain countries can change the level of threats to routes and ports. These changes then affect *route risk assessment*, security enhancement *recommendations*, re-routing *decisions*, shipment delay decisions, alternative port selection, and the activation of *contingency plans* or *business continuity plans*.

CONCLUSION

Based on the study results, the main geopolitical risks affecting PT XYZ's oil and gas shipping operations included regional armed conflicts, chokepoint disruptions, and sanctions or embargoes, with the Strait of Hormuz identified as the area with the highest exposure. These risks affected operations through changes in threat levels, asset vulnerabilities, and potential consequences throughout each voyage phase, particularly during loading activities and transit through strategic chokepoints. The research developed an MCDA-based Strategic Security Risk Decision Framework consisting of eight decision criteria, with priority given to crew safety and ship and cargo safety. The implementation of the framework indicated that re-

routing and delay/hold position were the most suitable alternatives, with selection depending on operational conditions and risk scenarios. This framework complemented PT XYZ's existing risk management system by providing a more structured, transparent, and accountable decision-making process while supporting the application of Contingency Theory and Dynamic Capability Theory.

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