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Developing a Value-Focused Thinking and Analytic Hierarchy Process-Based Strategic Decision-Making Framework for Managing High Salt Content Crude Oil in Refinery Operations

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ABSTRACT
The government's policy to maximize domestic crude oil absorption has placed a Refinery in Indonesia in a complex strategic position, particularly due to the increasing requirement to process high-salt-content crude oil. This condition introduces significant risks to equipment reliability, process stability, and operational efficiency, requiring more robust and structured decision-making capabilities. This study aims to identify key barriers in strategic decision-making, develop an improved framework, and evaluate its effectiveness in addressing the high-salt crude challenge. A mixed-methods sequential exploratory approach is applied, combining qualitative analysis — including SWOT, Five-Why, interviews, focus group discussions, and Value Focused Thinking (VFT) — with quantitative evaluation using the Analytic Hierarchy Process (AHP). VFT is used to define decision objectives and generate strategic alternatives, while AHP structures decision criteria, assigns weights, and prioritizes alternatives. The results show that the key barriers to decision-making are predominantly systemic, including governance inconsistency and lack of integrated evaluation criteria. The developed VFT–AHP-based framework introduces four main decision criteria, namely Operational Excellence, Process Stability, Economic Performance, and Strategic Feasibility, and evaluates four strategic alternatives. The AHP results indicate that new desalter installation is the highest-ranked alternative (32.9%). Sensitivity analysis demonstrates that the ranking is robust under ±20% variation in criteria weights, confirming model stability. Furthermore, the proposed framework improves decision clarity, consistency, and transparency by transforming a fragmented and binary decision process into a structured multi-criteria evaluation system. Management validation confirms that the framework is practical to implement and enhances accountability and defensibility under regulatory and audit scrutiny.

INTRODUCTION

The Indonesian government, through Minister of Energy and Mineral Resources Regulation No. 42/2018 and its update in Regulation No. 18/2021, mandates the prioritization of domestic crude oil utilization to meet national energy needs (Nurhidayah et al., 2024; Purwosaputra et al., 2022; Rimbono et al., 2025; Sambodo et al., 2026; Siagian & Kasuma, 2025; Suharsono et al., 2022). These regulations require refineries in Indonesia and other licensed processing entities to prioritize domestic crude supply, while contractors (KKKS) must offer their crude to domestic refineries before exporting (Karonga, 2025; Nurcahyono & Prawiraatmadja, 2025; Rosyidah et al., 2023). This policy aims to reduce import dependency and enhance domestic value creation. As a result, all refinery units are required to maximize

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the absorption of domestic crude oil. However, differences in refinery configurations, technology, age, and operational flexibility lead to varying levels of readiness and capability in processing crude oil with diverse quality characteristics (Luo et al., 2022; Olaizola et al., 2022; Pouran Manjily et al., 2024; Sharma et al., 2025).

Indonesian crude oil exhibits significant variability in composition across different regions, influenced by geological conditions and basin characteristics. For example, studies of South Sumatra oil wells highlight substantial differences in crude quality between sub-petroleum wells, a trend also observed nationwide (USGS, 2016). This variability poses challenges, particularly for older refineries with conventional configurations and limited tolerance for low-quality crude. As noted by Ari A. Ahmed (2021), chloride salts can hydrolyze at high temperatures to form hydrochloric acid, accelerating corrosion in refinery units, while fouling reduces heat transfer efficiency and may lead to shutdowns. Additionally, processing lower-quality crude can reduce yields of high-value products such as gasoline and diesel, while increasing lower-value residues, thereby affecting refinery profitability.

The implementation of the government's policy to require the absorption of all domestic crude oil puts refineries in Indonesia under significant strategic pressure (Karonga, 2025). In particular, PT. XYZ faces multidimensional challenges because it has to process domestic crude from the Southern Sumatra region (Sumbagsel), which has low-quality characteristics, especially high salt content (Hammoud et al., 2023). This condition is directly contrary to the refinery's operational design, which was built around conventional technology and has inherent infrastructure limitations (Wasim & Djukic, 2022). The direct impact manifests as an increase in the intensity of leaks in the processing units, particularly in the overhead system and associated piping, due to corrosion from hydrochloric acid (HCl) formed during the heating process of crude oil with high salt content (Al-Moubaraki & Obot, 2021; Ahmed, 2021; Vakili et al., 2023; Shatab et al., 2023).

From a governance perspective, the decision-making process for new crude oil or changes in characteristics has been defined in the Organizational Work Procedures (TKO) and follows several stages of evaluation and approval. In this framework, every proposed change must go through a structured technical review. Under normal conditions, crude that exceeds predefined limits should not be processed. However, in practice, the need to maintain crude supply, achieve production targets, and comply with government policy often puts the refinery in a difficult position where such crude is still considered for processing. This creates a dilemma between meeting external regulatory requirements and following internal operational standards for safety and reliability. Processing off-spec crude introduces operational and equipment risks, while rejecting it may lead to non-compliance with policy directives and affect refinery performance.

While existing studies by Ahmed (2021) provide strong technical justification for controlling the risks of high-salt crude oil, they do not explicitly explain that these risks must be systematically integrated into refinery decision-making. This gap highlights the importance of a structured decision-making framework that integrates technical, operational, reliability, and strategic considerations in crude oil selection for refinery operations. To address this, Value Focused Thinking (VFT) and the Analytic Hierarchy Process (AHP) are combined in a framework tailored to refinery and corporate decision-making contexts. An exploratory mixed-methods approach is used to integrate qualitative and quantitative perspectives. VFT ensures alignment of objectives and criteria with organizational values, while AHP supports systematic and measurable evaluation of alternatives. This framework provides a structured and accountable basis to enhance the organization's ability to manage high-salt crude under complex regulatory and operational constraints.

The main issue addressed in this research is how management can formulate an optimal strategy to balance compliance with government policies, operational sustainability, mechanical integrity, and refinery profitability. Accordingly, the research objectives are defined to provide a structured direction and ensure alignment with the identified problem: identifying key factors that contribute to delays and weaknesses in the strategic decision-making process at the refinery; developing an improved decision-making framework for managing high-salt crude oil to enhance responsiveness, consistency, and alignment with operational requirements; and evaluating the effectiveness of the proposed framework by comparing it with the existing decision-making approach in addressing high-salt crude challenges.

METHOD

Research Design

This study uses research design as the main direction for answering the research questions clearly. The researcher applies an exploratory design together with a mixed-methods approach, as it can combine qualitative and quantitative analysis within a single study. In the qualitative stage, the study focuses more on exploring organizational aspects and value orientations that can affect the process of strategic decision-making inside the organization, while the quantitative phase is used to validate and prioritize these findings through a structured decision model. The research begins with identifying business problems and formulating research objectives based on important organizational priorities, such as operational reliability, regulatory compliance, and profitability. The study then continues by collecting various types of data. Primary data were gathered through interviews, questionnaires, and focus group discussions, whereas secondary data were obtained from internal company documents, including SOPs, crude quality reports, and operational records, to support a more in-depth analysis.

The next stages involve problem exploration and model development, where the study analyzes the existing decision-making process, identifies bottlenecks, and evaluates both internal and external factors affecting performance. Using approaches such as SWOT, Five-Why, and VFT, the research defines key objectives, values, and alternative strategies, which are then structured into a decision-making model using the AHP. This model is designed to be systematic, transparent, and aligned with organizational goals. Finally, the research produces practical business solutions and recommendations, including the selection of optimal strategies for managing high-salt crude oil and the development of an implementation roadmap. The entire framework is then validated by management through presentations and feedback sessions to ensure its relevance, feasibility, and alignment with organizational needs, ultimately supporting improved speed and quality in strategic decision-making.

Data Collection Method

The data collection process in this study mainly uses qualitative method by combining primary and secondary sources so researcher can obtain more complete understanding about the research problem. Primary data is collected from semi-structured interviews and focus

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group discussions with selected respondents who have experience and direct involvement in refinery operation and decision-making activities.

Subject matter experts (SMEs) in this study were selected using a purposive approach to ensure the relevance and credibility of the data. The selection was based on three main criteria: direct involvement or prior experience in crude oil management processes, including roles related to crude handling from procurement to processing; sufficient work experience to understand operational and decision-making contexts; and a minimum position level equivalent to supervisor. These criteria ensure that the insights obtained are grounded in practical experience and accurately reflect real decision-making practices within the organization.

Table 1. The panel consists of cross-functional Subject Matter Experts tailored to refinery operations.

Code	Source	Role
R1	General Manager	Focuses on strategic decision-making and operational policy to provide insights on governance, SLA, and business priorities
R2	Process Engineering CDU	Focuses on technical analysis, process optimization, and crude blending evaluation to describe corrosion risks, fouling, and alternative technical mitigations.
R3	Spv. Operational CDU	Focuses on distillation unit operation control and crude feed arrangement to provide information related to operating windows, operational constraints, and the impact of high salt.
R4	Reliability Engineer	Focuses on equipment maintenance, corrosion analysis, and integrity management to provide data on leakage trends, clamps, and maintenance costs.
R5	Refinery Planning & Supply Chain Specialist	Focuses on crude procurement, logistics, blending crude, evaluation crude, blending economic, and planning crude to provide perspectives related to supply flexibility, freight costs, crude policies, crude governance and processing quantity.

Source: Primary data processed, 2026

After that, all data is analyzed to identify key themes that related with operational issues and also strategic insights from the field. On the other side, secondary data were collected from internal and external documents like operational reports, maintenance records, organizational policies, feasibility studies, regulatory frameworks, and industry comparison analysis. All of these documents were reviewed and combined carefully to strengthen the qualitative findings in the research.

To ensure analytical coherence and methodological triangulation, primary and secondary data are systematically integrated into a unified dataset. The triangulation technique is executed by verifying the empirical findings from the semi-structured interviews and focus group discussions against the hard empirical data found in internal operational reports and technical maintenance logs. This combined dataset is then cross-analyzed through multiple analytical frameworks specifically SWOT, 5-Why, VFT, and AHP to map operational realities, trace systemic root causes, extract corporate objectives, and validate strategic alternatives. This multi-layered integration enhances the validity and credibility of the conclusions while supporting the development of a coherent, practical, and context-based decision-making framework aligned with refinery operational conditions and strategic.

Data Analysis Method

The data analysis process integrates both qualitative and quantitative approaches to transform collected data into meaningful insights and support the research objectives. The qualitative phase start with thematic analysis from data collected through document reviews, semi-structured interviews, and focus group discussions. In this process, the researcher do transcription, coding, and systematic grouping to find repeated patterns that related with challenges in strategic decision-making at PT.XYZ. After that, SWOT analysis is used to explore internal strengths and weaknesses together with external opportunities and threats that can affect the decision-making process. Then, VFT is applied to define fundamental objectives and means objectives, which later changed into measurable criteria and sub-criteria for deeper analysis. These steps provide a structured foundation for identifying relevant decision factors, determining priorities, and formulating alternative strategies based on organizational values and operational realities.

The quantitative phase complements the qualitative findings by applying AHP to evaluate and prioritize the identified strategic alternatives. This approach uses pairwise comparisons to assign weights and rankings to each alternative based on predefined criteria, ensuring a systematic and objective evaluation. The consistency of judgments is checked by using CI and CR values, where CR value ≤ 0.10 is considered acceptable and reliable for the analysis process. After that, the final stage of integration combines qualitative understanding with quantitative results to build a more complete and transparent decision-making framework. This integrated model help to increase accountability, align both technical and economic considerations, and support the organization in choosing the most effective mitigation strategy for handling high-salt-content crude oil, while also improving the overall quality of decision-making process.

RESULTS AND DISCUSSION

Analysis

The analysis is focused to gain a more comprehensive understanding about internal and external conditions of the organization while also examining how the mechanisms create delays in decision-making process. This is used as a foundation to develop a more structured decision-making process framework.

A. SWOT Analysis

SWOT analysis is used to identify factors that make the decision-making process unclear, particularly in crude oil management at PT. XYZ. From a SWOT questionnaire administered to cross-functional respondents within the company, the study collects group perceptions about the internal and external conditions of the organization that can affect strategic decision-making in crude management work.

In the analysis step, every final SWOT keyword is developed by combining closed-ended questionnaires using a Likert scale with open-ended responses from respondents, in order to make the results more complete and understandable. The researcher uses both types of responses to make the findings clearer and to verify the consistency of information collected during the study.

1. Strength

The survey results indicate that PT.XYZ has quite strong internal strengths in supporting strategic decision-making for crude management activities. This condition can be seen from the intensity level and perceptions from SMEs toward the question guidelines, where the Likert scale scores are more than 4.0.

Table 2. Internal Strength Analysis

Code	Keyword	Guideline Question	Avg Score	Open Ended Respons
S1	Organizational Experience	SQ1 – Experience handling various crude quality	4,6	Quality & Availabilty Information, Management Support, measurable risk matriks
S2	Cross Fuctional Coordination	SQ2 – Organizational Sructure for cross coordination SQ6 – Internal forums for support decision	4,45	Two way coordination, meeting effectiveness
S3	Established SOPs	SQ3 – Existing SOPs support faster response	4,1	General Manager directives, formal leadership guidance
S4	Strong Technical Capability	SQ4 – Technical Capability to provide fast recomendation	4,4	Staff Competence & Experience, Data Accuracy

Source: Primary data processed, 2026

These findings show that delay in decision-making not mostly come from weak organization competency, no experience, or low technical capability. The real problem is more related to limitation in how the organization use and maximize those strengths in effective way at strategic decision-making level.

2. Weakness

The Weakness category gives more critical indication in explaining strategic decision-making problems at PT.XYZ. The SMEs explained several major obstacles in the decision-making process, including hierarchical culture, fragmented technical and economic data, and different risk perceptions between functions. These conditions indicate that there are systemic internal barriers which can affect the effectiveness of strategic decision-making in the organization.

Table 3. Internal Weakness Analysis

Code	Keyword	Guideline Question	Avg Score	Open Ended Respons
W1	Unintegrated Technical-Economic Data	WQ3 – Economic and Technical data not integrated	4,2	Conflict interest, Low quality Information, margin vs risk trade off
W2	Divergent Risk Perception	WQ4 – Different risk perceptions across functions	4,2	Different focus and value orientation among departmens
W3	Governance Inconsistency	WQ6 – Frequent Management rotation causes inconsistency priorities WQ1 – Layered approval delays decisions WQ5 – Hierarchical organizational limits authority	4,1	Absence a pioneer for decision making, avoiding responsibility, fear of legal risk, cascade information level not synchronized
W4	Fragmented Technical Data	WQ2 – Technical Data often unavailable or incomplete	4	Low information readiness and quality

		SQ5 – Accessibility of technical field information	3,7	

Source: Primary data processed, 2026

The weaknesses identified in this study are mostly structural and institutional, not caused by individual factors. Because of that, the main challenge is not related to technical capabilities, but more connected with the governance design and the structure of decision-making process at PT.XYZ.

3. Opportunities

The opportunity part give positive view and hope from SMEs about chance to make decision-making more effective at PT.XYZ. The result show that current situation in strategic decision-making is not seen as permanent structure problem, but more like issue that still can be fix and improve by doing targeted redesign in organizational process.

Table 4. External Opportunities Analysis

Code	Keyword	Guideline Question	Avg. Score	Open Ended Respons
O1	Data Digitalization	OQ1 – Digitalization crude quality & operational data	4,8	Realtime laboratory result, corrosion data
O2	Integrated Decision Dashboard	OQ2 – Integrated dashboard for technical, economic, and risk data	4,8	Integrated CAM Evaluation, strengthening collaboration & governance
O3	Predictive Analytics	OQ3 – Predictive or early warning systems	4,5	Damage mechanism, Risk prediction
O4	Unified Communication Platform	OQ4 – Integrated cross fuctional communication platform	4,7	Digital communication, easy access
O5	Refinery Modernization Program	OQ5 – Refinery modernization and technology improvement	4,4	Sampling improvement, unit reliability
O6	Industry Benchmarking	OQ6 – Benchmarking other refinery or industry best practice	4,5	Collaboration with external stakeholder, capability management risk, input legal team

Source: Primary data processed, 2026

From the perspective of strategic improvement, these findings indicate that PT.XYZ does not need major or radical changes in the plan for improving the decision-making process. The SMEs believe that strengthening the integrated decision support system is already enough to improve the effectiveness of decision-making in the organization.

4. Threats

The respondents say that external pressure is seen like big challenge and also threat that can risk the operation of PT.XYZ. This situation can act like catalyst that make internal weakness become more stronger impact, for example it reduce organization flexibility and create inefficiency inside internal system. Because of that, the speed and also effectiveness of strategic decision making can be negative affected and not running well.

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Table 5. External Threats Analysis

Code	Keyword	Guideline Question	Avg. Score	Open Ended Respons
T1	Domestic Crude Policy Pressure	TQ1 – Full domestic crude absorption policy	4,4	Government directive, lifting targets
T2	Audit & Criminalization Risk	TQ2 – Audit pressure and criminalization risk	4,6	Legal & stakeholder pressure
T3	Crude Quality Variability	TQ3 – Variability of domestic crude quality	4,5	Impurities, damage mechanism risk
T4	Supply & Planning Uncertainty	TQ4 – Domestic crude supply uncertainty	4,4	Fluctuating government policies

Source: Primary data processed, 2026

In general, SWOT analysis show that decision-making process in PT.XYZ especially for crude oil with high salt content is not only depend on one factor but come from mix of strong technical capability, internal structure limitation, chance for improvement, and also more strict regulatory pressure. All this factor is working together and give impact to how fast and how clear the strategic decision can be taken in crude management activity. From this combined analysis, next section present a consolidated SWOT summary that collect and explain the main strategic factors which influence clarity and speed of decision-making in the company.

Figure 1. SWOT Analysis for Decision Making Process (Author, 2026)

B. 5-Why Analysis

Based on SWOT analysis result, the research then continue using 5-Why method for dig more deep into root cause of problem in strategic decision-making. The 5-Why approach is used step by step to follow cause and effect chain until it can find the basic systemic reason behind the issue. So, the problem statement for 5-Why is taken from internal weakness and external threat that already found in SWOT analysis. The problem is defined like this: strategic decision-making in crude quality management at PT.XYZ often become slow and not clear especially when crude variability is high and regulatory pressure also increasing.

Table 6. 5-Why Analysis of Strategic Decision Making Issues in Crude Management

Level	Why Question	Identified Cause	SWOT Findings
Why-1	Why are Strategic Decisions often delayed and unclear?	Technical, economic, and risk evaluations are conducted separately, leading to prolonged discussions and repeated clarifications before decisions are finalized.	W1 – Unintegrated Technical–Economic Data W4 – Fragmented Technical Data
Why-2	Why are technical, economic, and risk evaluations conducted separately?	Each function applies different evaluation perspectives, focus and priorities when assessing crude acceptance and mitigation options.	W2 – Divergent Risk Perception
Why-3	Why do divergent risk perspectives persist across functions?	There is no standardized, data-based decision framework that integrates technical limits, economic impacts, risk indicators, and regulatory constraints into a single evaluation model.	W1 – Unintegrated Technical–Economic Data O2 – Integrated Decision Dashboard O3 – Predictive Analytics
Why-4	Why has no standardized and integrated decision framework been implemented?	Decision governance is inconsistent, with unclear decision ownership, authority, escalation rules, and acceptable risk boundaries.	W3 – Governance Inconsistency
Why-5	Why is decision governance inconsistent and risk-averse?	The existing decision-making system was not designed to operate under high regulatory pressure and high crude quality uncertainty, leading to defensive and risk-averse decision behavior.	T1 – Domestic Crude Policy Pressure T2 – Audit & Criminalization Risk T3 – Crude Quality Variability T4 – Supply & Logistics Uncertainty

Source: Primary data processed, 2026

Systematically, 5-Whys analysis try to move from surface problem into more deep root cause problem. From result analysis, main causes for delay and unclear strategic decision-making in crude management at PT.XYZ is like there is no integrated data-driven decision system, governance not consistent and decision ownership still not clear, regulatory and legal pressure very high so organization become more risk avoid behavior, and also data between technical and economic side still very fragmented and not well connected.

The evaluation result also same direction with Weakness and Threats from SWOT analysis. This root cause finding give strong basic reason why company need integrated decision support framework for improve how decision-making process work.

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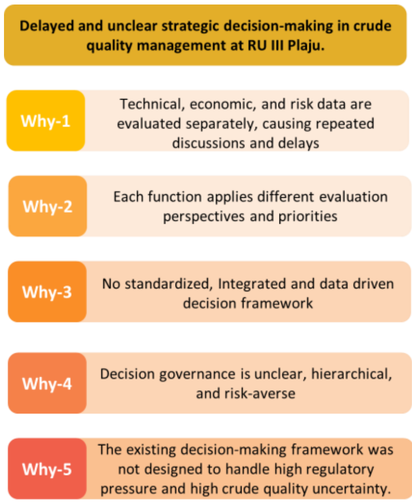

Figure 2. 5-Why Analysis – Root Cause Identification (Author, 2026)

Business Solution

The main challange identified for PT.XYZ from the analysis is the systemic issue of constraints within the existing strategic decision-making process for the management of changes in crude oil characteristics, rather than technical or people capabilities.

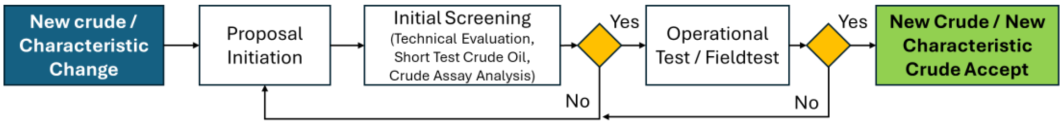

Figure 3. Current Acceptance Framework of New Crude Oil / Crude Oil with New Characteristics (Author,2026)

The current crude oil acceptance and evaluation process is designed to focus more on validating the technical aspects of crude oil processing. Under stable operating conditions, this approach can work effectively to maintain technical feasibility and operational safety in the company. But when geopolitical uncertainty and frequent policy changes happen, the company need to respond and adapt faster. The current framework still cannot fully support this situation because it does not clearly integrate economic considerations, risk factors, regulatory limitations, and governance aspects, even though these elements become more important when domestic crude oil variability is getting higher.

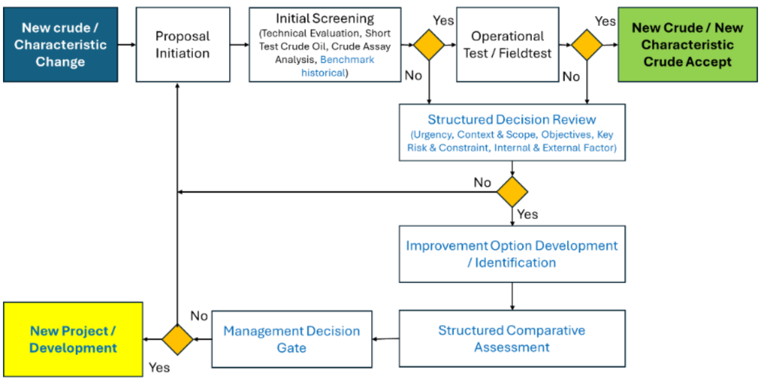

Figure 4. Proposal New Framework for Processing of New Crude Oil / Crude Oil with New Characteristics (Author,2026)

The new decision framework is made in purpose to handle and reduce the root causes that already identified, not to replace the existing technical evaluation system. The main goal of this design is to close the gap between technical validation process and strategic decision-making process that often not well connected. This solution introduce structured, value-based, and multi-criteria framework that help management to compare and evaluate alternatives in more systematic way under operational, economic, and strategic limitation conditions.

In this study, VFT approach is used for develop decision solution by putting organizational values and objectives as the main center in decision process. VFT is a normative method in decision analysis that focus on idea that good decision quality depend more on clarity of goals, not only depend on available alternatives or system limitation (Keeney, 1996). This approach usually used in complex strategic situation where many interests exist, also many conflict between objectives, and there is trade-off between technical, risk, and economic consideration.

AHP was developed by Saaty as a multi-criteria decision-making method that combines qualitative and quantitative considerations through hierarchical structures and paired comparisons (Saaty, 2008). The capability of AHP to check consistency make this method suitable for strategic decisions that involve many stakeholders and possible bias in giving evaluations.

The combination of VFT and AHP create a complementary approach for decision-making process. VFT is used to make sure that the objectives and criteria structure already represent organizational values and interests as a whole, while AHP is applied to evaluate different alternatives more objectively and measurably based on the structure that has been developed before. This integrative approach is recommended in the multi-criteria decision analysis literature for complex and cross-functional strategic problems (Belton & Stewart, 2002)

1. Identifies Fundamental and Means Objectives

VFT-based group discussions were carried out with cross-functional SMEs to identify and reach agreement on decision-making objectives and organizational values that become the basis for policy choices in high-salt crude management. In VFT, goals are separated into two main levels, namely fundamental objectives that reflect the main reasons for decisions and means objectives that act as a means to achieve these main goals (Parnell & Loerch, 2007).

Table 7. Summary FGD Results

Topic Discussion	Guideline Question	FGD Final Results with SME's
Identify Fundamental Obejctives	What are the main decision-making goals regarding high salt crude?	All SMEs agree that the main objective of decision-making is to ensure safe and stable unit sustainability (sustained operability), while still considering crude processing economic performance and flexibility.
	Which is fundamental?	Sustained operability is defined as the fundamental objective.
	Which is supportive ?	Safety aspects, process stability, reliability, crude flexibility, and economic performance are positioned as supporting (means) objectives.
Determination of Values and Priorities	How do we measure each goal?	Objectives are measured using technical, operational, and economic indicators that reflect process stability, equipment risk, and financial impact.

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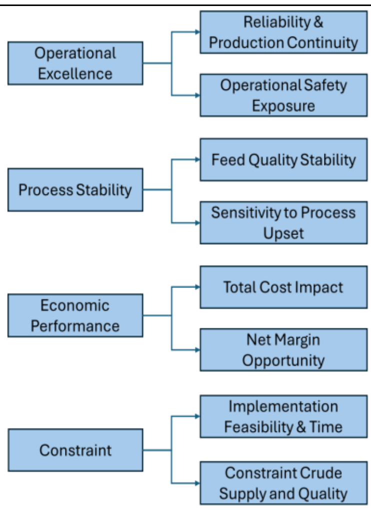
	What are the units and directions of preference for each criterion?	Decision preferences consistently favor conditions that are more stable, safer, and more economical at a controlled level of risk.
	Is data available?	Supporting data are available across all functions; however, they remain dispersed and have not yet been integrated into a single decision-making framework.
Identify Alternative Solutions	What are the realistic alternatives to overcome the problem of high salt?	Four main alternatives are considered realistic: installation of a new desalter, optimization of the existing desalter for the entire CDU, enhanced blending management, and segregation of crude intake.
	What are the advantages and disadventages of each alternative?	Each alternative involves trade-offs between technical effectiveness, cost, implementation time, and operational flexibility, with high reliance on external factors creating decision dilemmas.
Validation and Consistency	Is the hierarchy of values complete and does not overlap?	The value hierarchy is assessed as complete and non-overlapping.
	are all criteria measurable?	All criteria can be assessed through data and expert judgment.
	is there anything that needs to be added?	No additional criteria are required; the structure is considered sufficiently applicable.

Source: Primary data processed, 2026

Table 8. Value Focused Thinking Process for the management of crude oil with high salt content

Alternative	Decision Context	Design Criteria	Fundamental Objective
Installation of New Desalter Unit Optimization of Existing Desalter for All CDU Enhanced Blending Management Crude Intake Segregation Strategy	Decision analysis for selecting the most appropriate strategy to manage high-salt crude under operational, economic, and organizational constraints		To ensure the sustainable, safe, and stable operation of refinery units at PT.XYZ under high-salt content crude conditions, while explicitly considering economic performance and operational aspects and flexibility.

Source: Primary data processed, 2026

Based on VFT mapping result, sustain operability become main fundamental objective, it meaning refinery system must keep safe, stable, and reliable operation within technical limit that already defined. The means objectives that found come from different priority area, but all of them still connected and support the sustain operability target in overall operation.

After that, these means objectives then break down into decision criteria and measurable sub-criteria which later used for AHP evaluation process. These criteria and sub-criteria are created from cross-functional discussion result and also reflect important value elements in high-salt crude oil management context. The criteria structure is designed more comprehensive so it can represent complexity between organization objective and alternative evaluation, but still try to keep consistency and reliability in decision making process.

The development of criteria and sub criteria parameters is make because there is need to connect conceptual value with real operational side that can be measured in actual practice field. Each criteria is expected to represent main objective of organization, while sub criteria act like measurable indicator that help quantitative evaluation using AHP method. In this study, VFT approach is used for change abstract organizational goals into more practical evaluation criteria inside multi criteria decision making framework.

Table 9. Final Decision Criteria and Sub-Criteria

Criteria	Sub-Criteria	Description
Operational Excellence	Reliability and Production Continuity	Alternative capabilities in minimizing unplanned shutdowns, maintaining operational continuity, and reducing loss of operating hours due to disruption of high-salt crude processing.
	Operational Safety Exposure	The level of exposure to safety risks during the refinery's daily operations arising from fluctuations in crude quality and processing complexity.
Process Stability	Feed Quality Stability	Alternative ability to control the variability of salt and BS&W in the crude feed to the CDU so that the process parameters remain within controlled limits.
	Sensitivity to Process Upset	The level of tendency of the process to experience upset, operational deviation, or instability when there is a change in crude quality.
Economic Performance	Total Cost Impact	The impact of total costs includes CAPEX, OPEX, maintenance costs, and potential loss of production opportunities due to operational disruptions or crude restrictions.
	Net Margin Opportunity	The potential to increase margins through the use of discounts on high-salt crude and its impact on high-value products such as avtur and solvents.
Strategic Feasibility	Implementation Feasibility and Time Constraint	Limits on feasibility and speed of alternative implementation taking into account organizational limitations, approval cycles, operational readiness, and applicable regulations.
	Constraint from Crude Supply Availability and Quality	Constraints stemming from the availability of crude supply, variability in crude quality, as well as external pressures related to crude acceptance obligations and flexibility.

Source: Primary data processed, 2026

2. Generate Alternative Strategy

Based on the discussion results, several potential initiatives were identified to handle the challenges related with high-salt crude management. Following the VFT approach, the generation of alternatives was conducted broadly to capture a wide range of realistic operational and strategic options. These initiatives include technical solutions such as installing a new desalter unit, optimizing existing desalter facilities, and upgrading equipment materials, as well as operational strategies like enhanced blending management, crude intake segregation per CDU, chemical treatment optimization, upstream crude pre-treatment, and selective crude handling. Each alternative offers different benefits, such as improving process stability, reducing corrosion risk, increasing operational reliability, and enhancing economic performance. However, each also comes with its own constraints, including high capital expenditure, dependency on external parties, operational limitations, and sensitivity to crude variability.

To ensure relevance and feasibility within the research scope, the identified alternatives were further screened and classified into two main categories. Primary alternatives consist of strategic options that have a direct and significant impact on achieving key operational and organizational objectives without depending on external parties, while also being distinct enough for meaningful comparison in a multi-criteria evaluation. These initiatives include installation of a new desalter, optimization of the existing desalter units, improvement of blending management, and segregation of crude intake. Meanwhile, complementary initiatives are positioned as supporting actions that can increase the effectiveness of the main strategies, although they tend to overlap with other initiatives or depend strongly on external factors. This category includes chemical treatment optimization, upstream crude treatment, equipment material upgrades, and selective crude handling. This classification helps focus the analysis on the most impactful strategies while still acknowledging the role of supporting initiatives in improving overall refinery performance.

3. Decision Hierarchy – AHP

The construction of the hierarchy follows the fundamental principle of AHP, in which a complex decision problem is decomposed into multiple levels to facilitate pairwise comparison and priority synthesis (Saaty, 1990).

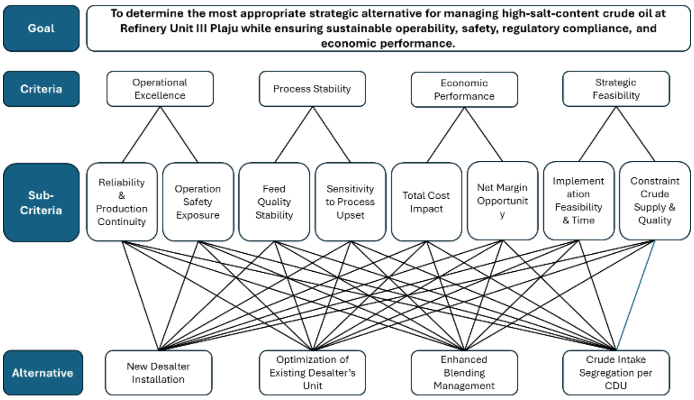


Figure 1. AHP Hierarchy Structure (Author, 2026)

4. Pairwise Comparation of AHP Model

Pairwise comparison is use for decide the relative importance weight from every element in decision hierarchy system. This process change qualitative opinion from Subject Matter Experts into more objective number priority scale. With pairwise comparison, the complex problem in strategic decision-making for high-salt crude oil at PT.XYZ become more simple because only compare two element at same hierarchy level step by step.

In AHP method, the evaluation is based on Saaty importance intensity scale for measure how strong one criterion, sub-criterion, or alternative is more dominant than others. The result from this process become main foundation to combine business priority that show balance between operational reliability, process stability, economic efficiency, and also company strategic survival.

For evaluation purposes, data collection was conducted using structured questionnaires in which respondents (SMEs) assessed alternative strategies through pairwise comparisons. Each SME determined the most dominant option based on their knowledge, experience, skills, and professional competencies. These judgments were systematically organized into pairwise comparison matrices covering key evaluation aspects such as operational excellence, process stability, economic performance, and strategic feasibility, along with their respective sub-criteria and strategic alternatives. To obtain a unified assessment, all individual responses were aggregated using the geometric mean method, ensuring that differing expert perspectives were proportionally represented in the final evaluation results.

The aggregated data were then processed into a comprehensive pairwise comparison matrix to calculate eigenvector values, which represent the relative priority weights of each criterion and alternative. In addition, consistency testing was performed using the CI and CR to ensure the reliability of the judgments provided by the SMEs. This process ensures that the final prioritization results are not only systematic and transparent but also methodologically robust, providing a reliable basis for selecting the most appropriate strategy.

Table 10. Weighted for Criteria, Sub Criteria and Alternatives

CRITERIA			SUB-CRITERIA		
	Weight	CR		Weight	Global Weight
Operational Excellence	0,2860	0,0055	Reliability & Production Continuity	0,4134	0,1182
	0,2860		Operation Safety Exposure	0,5866	0,1678
Process Stability	0,2246		Feed Quality Stability	0,3153	0,0708
	0,2246		Sensitivity to Process Upset	0,6847	0,1538
Economic Performance	0,2740		Total Cost Impact	0,2972	0,0814
	0,2740		Net Margin Opportunity	0,7028	0,1925
Strategic Feasibility	0,2154		Implementation Feasibility & Time	0,2318	0,0499
	0,2154		Constraint Crude Supply & Quality	0,7682	0,1655

SUB-CRITERIA	ALTERNATIVES								
	I		II		III		IV		CR
	New Desalter Installation		Optimization of Existing Desalter's		Enhanced Blending Management		Crude Intake Segregation per CDU		
	Weight	Global Weight	Weight	Global Weight	Weight	Global Weight	Weight	Global Weight	
Reliability & Production Continuity	0,3242	0,0383	0,2348	0,0278	0,2582	0,0305	0,1828	0,0216	0,0096
Operation Safety Exposure	0,3509	0,0589	0,2239	0,0376	0,2619	0,0439	0,1632	0,0274	0,0191
Feed Quality Stability	0,3875	0,0274	0,2144	0,0152	0,2141	0,0152	0,1840	0,0130	0,0487
Sensitivity to Process Upset	0,2302	0,0354	0,1639	0,0252	0,3249	0,0500	0,2810	0,0432	0,0108
Total Cost Impact	0,1911	0,0156	0,2097	0,0171	0,3559	0,0290	0,2433	0,0198	0,0216
Net Margin Opportunity	0,4004	0,0771	0,1650	0,0318	0,2362	0,0455	0,1984	0,0382	0,0354
Implementation Feasibility & Time	0,1313	0,0066	0,1925	0,0096	0,4054	0,0202	0,2707	0,0135	0,0562
Constraint Crude Supply & Quality	0,4215	0,0697	0,1983	0,0328	0,2398	0,0397	0,1405	0,0232	0,0120
Priority Weight	0,3290		0,1970		0,2740		0,2000		

Source: Primary data processed, 2026

Based on the analysis results, a ranking priority weight was obtained for four strategic alternatives in processing high-salt crude oil at PT.XYZ. The alternatives are ordered based on their priority scores as follows: new desalter installation with weight 0.3290 as the highest priority, followed by enhanced blending management with weight 0.2740. Next is crude intake segregation per CDU units with weight 0.2000, and the lowest priority is optimization of existing desalter units with weight 0.1970.

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The interpretation of each decision alternative reveals distinct strategic implications and operational trade-offs for the refinery's positioning. Operational alternatives such as enhanced blending management (ranked second at 0.2740) offer a faster and more flexible short-term operational solution to obtain salt content specifications. However, this blending option often has the potential to sacrifice profit margins, increase freight costs, and is heavily limited by crude oil selection and tankage availability. Similarly, the alternative of crude intake segregation per CDU units (0.2000) isolates the processing risks but limits the refinery's flexibility and capacity to maximize valuable product yields like gasoline, avtur, and diesel. Lastly, the alternative of optimizing existing desalters (0.1970), while requiring lower immediate expenditures, is highly constrained by original design limits and unable to process crude oil with high salt content optimally across all operating blocks.

From a technical perspective, prioritizing the New Desalter Installation (0.3290) reflects a long-term commitment to maintaining stable and reliable refinery operations. Salt content in crude oil can be hydrolized at high temperatures in the pre-heating process, producing HCl that leads to corrosion in the CDU overhead system. A new desalter fundamental solution to reducing salt content before the crude enters CDU, helping to minimize corrosion, prevent equipment damage, and reduce the frequent need for temporary leak repairs such as clamps.

From an economic standpoint, although this option requires significant investment (High CAPEX) and time to implement, it offers greater flexibility in processing different types of crude. This allows the refinery to take advantage of more affordable high-salt domestic crude, ultimately creating opportunities to reduce procurement costs without compromising operational performance.

5. Sensitivity Analysis

Sensitivity analysis is a basic way of approaching the multi-criteria decision making (MCDM) method that determines how stable the best solution is chosen when a number of parameters change. (Sitompul et al, 2024).

In this study, the researcher performed a sensitivity analysis to assess the robustness of the AHP-based decision-making model when faced with potential future uncertainties. The analysis primarily emphasizes economic performance as the selected sensitivity variable, since this aspect is considered highly vulnerable to external changes. Economic performance was chosen due to the fact that margin pressure, capital constraints, and cost fluctuations can vary significantly and may shift decision priorities, particularly when there are changes in oil prices, subsidy policies, or corporate budget allocations, even though technical risks tend to remain relatively stable. The procedure was conducted by modifying the global weights of selected sub-criteria by ±20%, while ensuring that normalization was maintained so that the total global weight consistently equaled one. Through this approach, the study evaluates how sensitive the decision outcomes are to changes in weighting within the AHP model.

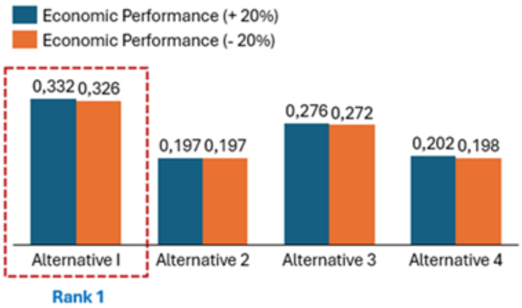

Figure 6. Sensitivity Analysis Result (Author, 2026)

The analysis results show that the alternative rankings do not change from the tested sensitivity analysis scenarios. This indicates that the proposed framework is strong and stable with low sensitivity to variations in criterion weights within a reasonable range.

6. Final Evaluation New Decision Framework

To verify that the chosen alternative and the newly developed decision-making framework are consistent with the company's strategic direction, the researcher conducted an interview with a senior manager as part of a management review process. The findings from the interview indicate that the proposed framework, which integrates VFT and AHP, remains relevant and practical for operational conditions at PT. XYZ. It is viewed as a useful tool to support the company in determining optimal mitigation strategies, particularly in decision-making contexts that involve multiple stakeholders, diverse constraints, and various sources of uncertainty.

Table 11. Validation of the Developed Decision Framework (VFT-AHP Approach)

Identified Weakness	Current Framework	Developed Framework	Management Review
Absence of integrated, data-driven decision framework	Technical, economic, risk, and regulatory data are evaluated separately	All decision dimensions consolidated through VFT objectives and AHP evaluation matrix	Integrated decision view, clarity, structured discussion
Fragmented technical and economic data	Data presented in different formats, causing repeated clarification	Inputs each function standardized into criteria and sub-criteria hierarchy	Systematic evaluation, single reference, reduced ambiguity
Divergent risk perception across functions	Different functions apply different priorities and risk interpretations	Risk priorities aligned through AHP weighting and comparison	Risk alignment, cross-functional consistency
Inconsistent decision governance	Unclear decision ownership, authority, escalation, and risk acceptance boundaries	Decision supported by documented criteria, weights, ranking, and documented decision rationale aligned with defined decision roles	Decision ownership clarity, governance strengthening, accountability, decision traceability, audit readiness
High regulatory and legal pressure	Strong compliance and audit scrutiny increase perceived decision risk, leading to conservative and delayed decision	Regulatory compliance and legal risk are explicitly incorporated as fundamental decision objectives, enabling defensible and transparent decision justification	Audit defensibility, professional justification, compliance readiness
Decision-making system not designed for high uncertainty	Existing workflow assumes moderate risk and stable conditions	Structured and quantitative comparison of multiple mitigation	Adaptive decision-making, strategic flexibility, long-term orientation

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	causing decision logic dominated by binary accept / reject outcomes	and improvement alternatives, replacing binary accept/reject logic.

Source: Primary data processed, 2026

From a managerial standpoint, this framework is regarded as effective because it simplifies complex, multidimensional considerations into structured evaluations of alternatives using quantitative weighting. By applying clearly defined criteria and systematic weighting, it enables different options to be compared in a more coherent and decision-oriented manner, rather than being treated as isolated technical discussions. In addition, the framework is seen as enhancing clarity, consistency, and governance across various functional areas within an organization. It allows decision-makers to better understand the rationale behind prioritizing certain alternatives over others in line with established strategic objectives. Through improved transparency, traceability, and auditability, this approach contributes to strengthening the overall quality and accountability of organizational decision-making processes, effectively transforming fragmented considerations and preventing decisions from being dominated by purely subjective technical evaluations or short-term financial focus.

On a conceptual level, this model strengthens the governance framework by integrating technical, economic, and policy considerations into a cohesive objective structure based on VFT, explicitly incorporating regulatory compliance and audit readiness as fundamental decision objectives alongside refinery profitability. On an operational implementation level, the framework serves as a formal decision-support mechanism that clearly separates the analytical, cross-functional evaluation roles of technical teams (Engineering, Reliability, Planning, and HSSE) from the final decision-making authority of top management. This structural separation enhances decision ownership, ensuring that by providing a documented, mathematically weighted rationale aligned with defined decision roles, the organization establishes absolute audit defensibility and professional justification under regulatory and audit scrutiny, effectively mitigating concerns about legal risks and defensive managerial behaviors in the face of complex national energy mandates.

Implementation Plan & Justification

This implementation plan is structured to support the effective adoption of the proposed framework within the organization. Its main objective is to ensure that the value-based, multi-criteria decision-making approach moves beyond a theoretical concept and becomes practically applicable in both organizational governance and everyday operational activities within the company.

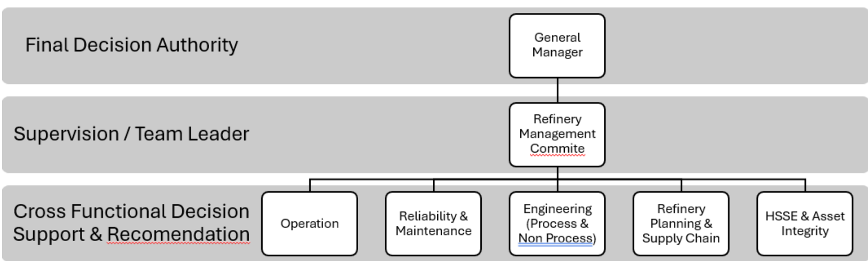

Figure 7. Organization Chart of Implementation Team (Author, 2026)

The proposed implementation involves the application of a structured decision-making process in the new crude oil processing plan or in cases where there are changes in characteristics, particularly when initial screening or operational testing fails to meet the established acceptance criteria, ensuring the company remains compliant with government policies.

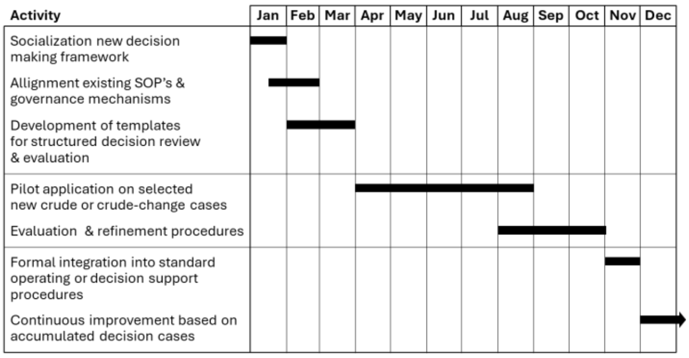

Figure 8. Schedule of Implementation (Author, 2026)

The implementation of the new framework is carried out by integrating it into the existing decision-making flow without replacing the existing operational processes. The proposed approach is designed to ensure that day-to-day operations continue without interruption while minimizing the risk of organizational instability throughout the implementation phase. It functions primarily as a support tool for decision-making, whereas the ultimate decision-making power remains with management in order to preserve accountability, uphold good governance principles, and ensure compliance with legal considerations. In addition, this framework is intended to enhance the transparency and coherence of strategic decisions by introducing a more systematic and evidence-based evaluation process. By applying this structure, organizations may be able to reduce delays in decision cycles and strengthen the consistency between technical assessments and the broader strategic objectives of the company.

CONCLUSION

The management of high-salinity crude oil reveals a critical gap between technical evaluation and strategic decision-making, which must simultaneously address operational constraints and regulatory requirements. This misalignment underscores the need to strengthen decision processes to improve transparency, governance, and operational consistency. The observed delays and inconsistencies are not merely procedural, but indicative of systemic deficiencies, including fragmented data structures, divergent risk interpretations, weak cross-functional coordination, and escalating regulatory pressures.

To address these challenges, a value-based decision-making framework is proposed, integrating technical, economic, risk, and regulatory dimensions. Value-Focused Thinking (VFT) is employed to structure organizational objectives, while the Analytic Hierarchy Process (AHP) is applied to prioritize these objectives and evaluate strategic alternatives. The results show that New Desalter Installation ranks highest (32.9%), followed by Enhanced Blending Management (27.4%), Crude Intake Segregation per CDU (20.0%), and Optimization of Existing Desalters (19.7%). Sensitivity analysis confirms the robustness of this ranking under ±20% variation in criteria weights, demonstrating model stability.

The integrated VFT–AHP framework advances decision-making by replacing fragmented and binary evaluations with a systematic multi-criteria approach. Theoretically, it contributes to decision science by demonstrating how VFT and AHP can function as an integrated problem-structuring methodology for complex energy management decisions under significant external trade-offs. Practically, the framework enhances governance by improving

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clarity, consistency, and transparency, while establishing a clear separation between cross-functional analytical roles and managerial decision authority. This structure strengthens accountability, audit defensibility, and regulatory compliance. To further institutionalize its application, formal legal and compliance validation is required to ensure robustness in documentation, justification, and audit readiness.

However, the analysis is constrained by limited access to confidential operational data and reliance on expert judgment, which may introduce subjectivity. Future improvements should focus on expanding data availability through digitalization and integrated real-time dashboards, as well as incorporating predictive analytics or early warning systems to enhance objectivity, responsiveness, and reliability in continuous decision-making environments.

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