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Strategic Decision-Making for Production Facilities Development in the TKP Structure

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ABSTRACT

Indonesia's energy sector faces increasing oil and gas demand, with the West Java region experiencing significant supply-demand gaps that require strategic development of new production facilities to ensure energy security. This study [A1] [A2] aims to select the best scenario for the production facility development plan of TKP Structure, which was carried out using the FVT-AHP method by considering key internal factors and aligning with the external environment obtained by PESTEL and SWOT analysis. A series of primary and secondary data collection has been conducted to obtain valid data for in-depth analysis using both qualitative and quantitative approaches. The goal of the comprehensive analysis was to determine a priority ranking of alternatives based on criteria and sub-criteria that reflected the fundamental objectives and values of the decision maker, the interests of key stakeholders, and the contribution of SMEs involved in the project. The VFT Framework is applied to generate four feasible alternatives and a set of criteria has been established to evaluate the alternatives, specifically focusing on cost, quality, time to implementation, and compliance with eight sub-criteria associated with it. The Analytic Hierarchy Process (AHP) model was created to solve the multi-criteria decision-making process by establishing a priority ranking of criteria and alternatives. The results show that the proposed scenario for the development plan of TKP's production facilities based on priority ranking is to upgrade the PDT Gathering Station. Sensitivity analysis confirms that the priority ranking of the alternatives remains stable despite variations in the criteria.

KEYWORDS *VFT, AHP, Decision-making, TKP Structure*

INTRODUCTION

The demand for oil and gas in Indonesia is increasing in line with economic growth that drives energy demand. Based on the National Energy General Plan for 2050, it is estimated that there will be an increase in oil and gas demand (Do et al., 2018). Oil demand is estimated to increase from 1.66 million BOPD to 3.97 million BOPD, representing an increase of 139%, while gas demand increases sharply from the current 6 MMSCFD and is estimated to reach 26 MMSCFD by 2050, representing an increase of 298% (Cafaro & Grossmann, 2014).

The development of gas fields plays an important role in supporting the energy transition and accelerating emission reductions to achieve the NZE target dominated by renewable energy (Mendes et al., 2017). Indonesia's gas reserve potential is relatively large, ensuring access to energy security, especially natural gas, which is able to provide more environmentally friendly energy than other fossil fuels such as coal and petroleum (Francoso & Belderrain, 2022). Equally important, the Carbon Capture, Utilization, and Storage (CCUS) program also plays an important role in supporting national oil and gas production targets, especially in the use of CO2 to increase oil recovery or carbon storage to reduce emissions (Cherepovitsyn et al., 2022).

Overall gas demand in Indonesia is expected to grow at 1.9% per year from 2023 to 2035 and ramp up to 2.4% per year in the period from 2035 to 2050. As demand conversion takes hold, gas will become the primary fuel to meet incremental power demand before new renewable technology becomes mainstream. Growth is mainly in the power and industrial sectors (Goel & Grossmann, 2017).

West Java and Central Java are key regions in terms of energy demand. Central Java and East Java combined have a gas demand of approximately 623 MMSCFD in 2024. It is estimated that demand can still be met until the end of 2030 with gas supply from fields in East Java, particularly from the Madura Strait field, Cepu development, and Jambaran-Tiung Biru (Infiniti Research, 2024). The gas demand in Central Java, especially for power generation, can be supplied from East Java through the Gresik–Semarang gas transmission pipeline commissioned in 2023. However, the suboptimal gas absorption in Central Java and relatively low market growth in East Java have led to a potential gas surplus. As a result, the excess gas will be diverted to West Java to address gas shortages driven by significant industrial growth through the second phase of the CISEM project, which will connect the gas network from Batang to Cirebon, aiming to be completed by 2026 (Handayani et al., 2023).

West Java, in particular, serves as the economic center and the main demand hub of the country, with a consumption of 1,120 MMSCFD, accounting for 34% of Indonesia's overall demand, as shown in Figure I.5. The region is home to major power projects and industrial zones, making it a crucial driver of the nation's industrial and economic growth. Regionally, West Java contributes approximately one-third of Indonesia's total industrial demand, followed by the East Java Region, which accounts for 22%. Given its strategic significance, West Java plays a pivotal role in the country's energy and industrial landscape (Kunz et al., 2016; Mendes et al., 2017).

Based on the forecast that West Java's gas demand will experience significant growth, the main sectors that are driving the growth of gas demand in West Java are gas-to-power and industrial growth in the area (Le & Nhieu, 2020).

West Java's gas demand is fulfilled through production in the region itself and supply from South Sumatra through the transmission of the PGN SSWJ gas pipeline. In 2024, the supply of pipeline gas from the local area of West Java is 231 MMSCFD, and there is an additional supply of 425 MMSCFD delivered from South Sumatra, so that the total supply of pipeline gas is 655 MMSCFD. However, the supply from the two regions remains insufficient to meet the demand of 1,126 MMSCFD. As a result, there is a shortfall of 470 MMSCFD in total piped gas supply in 2024 that requires 299 MMSCFD of domestic LNG to fill the gap. The supply of piped gas from PERTAMINA in Java and South Sumatra (the Corridor and PERTAMINA South Sumatra blocks) into the West Java region is declining. This gap is projected to widen from 2030 and will continue to increase as gas demand grows, as shown in the figure (Mardani et al., 2023).

To address the decline in piped gas production and meet the rising gas demand, new exploration and development projects, particularly in the West Java region, are required to anticipate the gas shortage. Meanwhile, additional gas supplies from gas fields in the East Java Region will be delivered through the gas transmission pipeline of the CISEM phase 2 project until the end of this decade. PEP Zona 7, a leading oil and gas company in West Java, plays a vital role in providing energy security for industries and society while contributing profits for the government and stakeholders.

In 2024, the company produced approximately 9,700 BOPD of oil and 230 MMSCFD of gross gas. The produced oil is delivered to Refinery Unit VI for subsequent processing into fuel products, while the produced gas is processed before being transported and distributed mainly through the Pertagas pipeline network to meet industrial demand in the West Java region, supplying approximately 30 industrial companies. Only a small portion of the gas is distributed directly to consumers through pipelines owned by the company. The company is currently facing a decrease in gas reserves from the existing structure, increasing energy demand, a high supply-demand gap, and gas producer competition, which presents a challenge for PT PEP in the Zone 7 Working Area.

Several successful findings from gas exploration have encouraged the company to accelerate the development and commercialization of oil and gas production, so that rapid, effective, and efficient field development efforts are needed through innovative ways to meet energy needs and maintain profits in order to ensure business continuity.

This situation encouraged the company to maximize efforts in accelerating the development and commercialization of several successful exploration findings, aiming to increase oil and gas reserves and production. One of the successful exploration discoveries of hydrocarbons is the Tambun Kelapa Structure (TKP), located in the Zone 7 working area. Hydrocarbon resources were proven through the drilling of the TKP-001 well in 2001; however, there are no production facilities, and it needs to be developed.

To address this challenge, research is required to determine the best scenario for field development of the TKP Structure, particularly for gas production facilities and pipeline systems, through innovative methods to meet energy needs and maintain a competitive advantage that ensures business continuity. The urgency of this research lies in the critical need to identify optimal scenarios for the development of new gas fields at the TKP site in order to reduce the supply gap in West Java and ensure national energy sustainability. With West Java's gas demand projected to grow significantly while existing production from mature fields continues to decline, immediate action is required to develop untapped resources like the TKP Structure to prevent energy shortages that could impact industrial operations and economic growth in Indonesia's most economically important region.

The novelty of this research is the application of an integrated Value-Focused Thinking (VFT) and Analytic Hierarchy Process (AHP) multi-criteria approach to evaluate gas production facility development scenarios at the TKP Structure, which has not been previously studied in the context of oil and gas field development in West Java. This research uniquely combines stakeholder value identification through VFT with quantitative decision-making through AHP to address complex strategic decisions in Indonesia's energy sector.

The research questions in this study are: (1) What are the external and internal key factors that influence the Tambun Kelapa Structure surface production facilities development plan in an effort to increase gas supply to fulfill consumer demand? (2) What are the criteria and alternative solutions for developing gas production facilities of the TKP Structure? (3) What is the best solution that can be applied for the development of gas production facilities in the TKP Structure, considering multi-criteria? The research objective is to propose an optimal solution for developing gas production facilities in the TKP Structure based on the best alternative while considering multi-criteria, to meet consumer demand and decision-makers' objectives. The benefits of this research include providing strategic guidance for energy companies in field development decision-making, contributing to Indonesia's energy security through optimized resource development, and offering a methodological framework applicable to similar oil and gas development projects in Southeast Asia.

METHOD

In this study, the conceptual framework, as illustrated in Figure II.5, consists of two main parts. The first stage involves analyzing internal and external factors to determine key factors based on current business environment conditions that may affect the firm's strategy for future competitive advantage, and the second stage focuses on developing a strategy that leads to the best solution in accordance with the objectives of this project to determine the best scenario for developing the surface facilities.

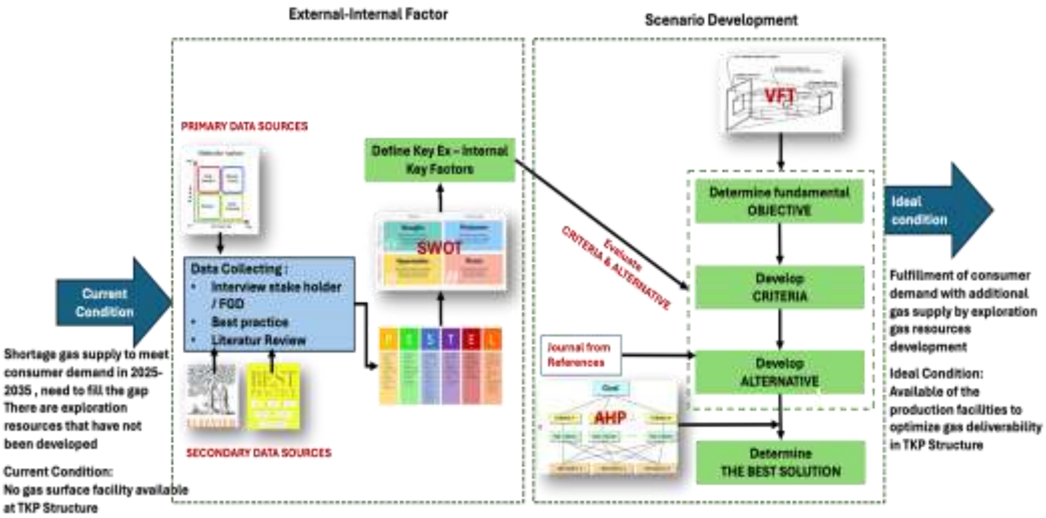

Figure 1. Conceptual Framework for TKP Gas Development (Author, 2025)

The research design for solving the business issues in this study integrates qualitative and quantitative approaches to answer the research questions. The data collected and analyzed consisted of primary and secondary data. The research adopted a scenario-based approach for improving the surface facilities development plan for the TKP structure to fulfill gas consumer demand, overcoming various business issues.

The qualitative approach was utilized to gain a deep understanding of the external business environment from PESTEL analysis that influences the gas market in West Java and to understand internal capability and key improvement factors to overcome challenges with alternative business solutions identified from SWOT analysis. Aligned with this condition, the qualitative method was used to identify values and define objectives for the TKP development plan, which requires primary data sources from stakeholders and secondary data sources for the Value-Focused Thinking (VFT) analysis.

The quantitative method is essential for measuring attributes associated with a set of alternatives and criteria, extending into computational techniques using the Analytic Hierarchy

Process (AHP) method for quantitative comparison and ranking of the most feasible solution for implementation.

The research design utilized to answer the research questions in this study is described in Figure III.1. These steps in the research design are useful for guiding the process of answering the research questions posed in the previous section. External and internal conditions were evaluated through PESTEL and SWOT analyses to identify key improvement factors that can be applied for the optimal solution to the TKP surface facility development plan that was identified in the research questions.

A set of values and objectives is translated into measurable criteria and sub-criteria, guiding the identification of viable alternative solutions through VFT analysis to address the research question concerning the definition of criteria and the generation of alternatives processed using AHP analysis. This ultimately leads to obtaining a top-priority ranking of alternatives that can be implemented for the best solution in TKP development, culminating in a final prioritized list of alternatives with documented rationale. The steps of the research are structured as shown in Figure III.1 and can be described as follows:

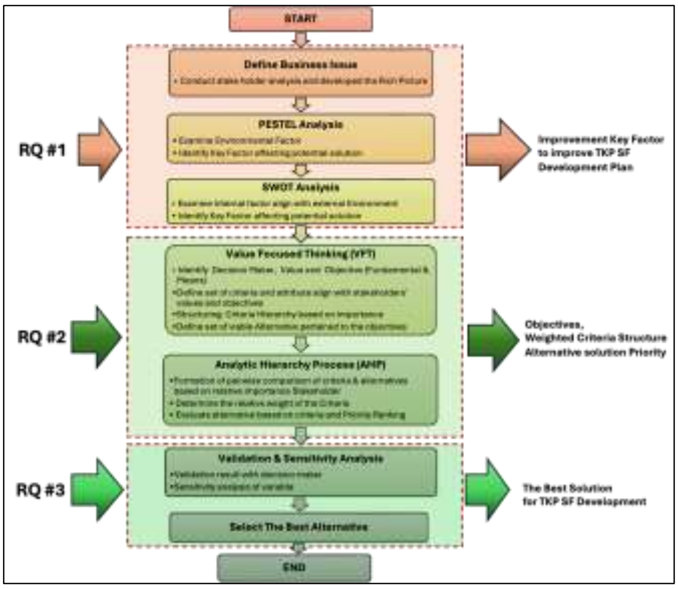

Figure 2. Research Design (Author, 2025)

The data collection method flowchart is illustrated in Figure III.2. In determining external and internal key factors to answer RQ#1, primary data sources are acquired through semi-structured interviews with internal stakeholders, complemented by secondary data from business plans (*RJPP*), which were subsequently analyzed using SWOT analysis. The PESTEL analysis is conducted similarly but relies mainly on secondary data sources.

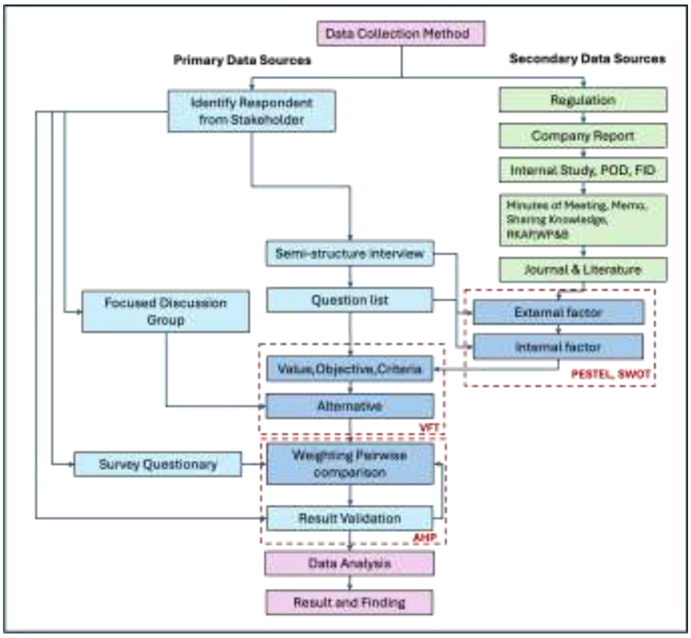

Figure 3. The PESTEL analysis

Data analysis method proposed integration of SWOT, PESTLE, and VFT with AHP combines qualitative insights with quantitative in multi decision-making, to make it a more effective approach for analyzing and determining the best solution in gas development TKP Field. SWOT and PESTLE analyses provide a comprehensive understanding of both internal and external factors by identifying thread and opportunities. Moreover, Value-Focused Thinking (VFT) ensures that the decision-making process is aligned with the organization values and strategic objectives. The Analytic Hierarchy Process (AHP) has a powerful computational framework that prioritizes criteria and evaluates alternatives systematically that overcome the subjectivity in qualitative methods, resulting in more objective solution. The Flow chart of data analysis comprised in 6 step, as shown in Figure 4.

Figure 4. Data Analysis Method (Author, 2025)

To obtain the best alternative solution and address RQ#3, the AHP method is employed as a computational tool to rank criteria and alternatives that align with the goal objective, as illustrated in Figure III.3. The objective, criteria, and alternatives have been identified. However, further evaluation is required based on PESTEL, SWOT and VFT analysis.

RESULT AND DISCUSSION

Business Environmental Analysis

The environmental business analysis is carried out to identify the external and internal key factors relevant to the Company's business conditions, thus, affecting alternative solutions in the development of gas production facilities at the TKP. This was utilized the PESTEL and SWOT frameworks to analyze external and internal analysis.

External Environment.

The PESTEL framework is used to identify factor in Political, Economic, Social, Technology, Environmental and Legal aspect related in determining the best solution for surface production system development plan of TKP Structure. The analysis is performed according to secondary data on some literature review that can be explain bellow:

Table 1. Summary of PESTEL Analysis (Author, 2025)

Aspect	Summary External Factor
Political	• National Lifting Target of 1 million Bopd and 12 BSCFD by 2030. • SKK Migas strategy to accelerate resources to production and commercialization. • Prioritizing natural gas to support energy transition • National natural gas transmission and distribution Network potentially to increase competition.
Economic	• GDP Growth in West Java Province • Growth of industrial estate in West Java. • Increasing the Gas supply-demand gap • Specific gas price policy and allocation.
Social	• Local workforce availability • Densely populated area • Complexity of land acquisition • Potential social conflict
Technology	• The advance gas processing technology (Mini LNG and Modular equipment) • Sophisticated digitalization and automation technology. • High technology of CCS/US.
Environment	• Decarbonization Program. • ESG Standards requirement. • Natural disaster • Environmental Risk
Legal	Complexity of Regulation and permit compliance

Internal Environment

Understanding the internal environment is enabling the company to achieve a competitive advantage. The resource-based view concept can be employed to comprehend how resources are key to superior firm performance. Resources can be categorized into tangible and intangible resources. (Rottherman, 2021). the Pertamina EP has the following resources including tangible assets and intangible assets:

a. **Tangible Resources:** The tangible assets of pertamina EP are: **1)** Pertamina EP operates the largest working area in Indonesia, which covers 113,613.90 km² and spans from Aceh to Papua and is divided into 5 Assets. 2) PEP has also been supported by the synergy of the subsidiary company's policy, which gives an advantage in supply chain management as well as material / equipment and services transferred from the other company's subsidiary in the sub-holding (Annual Report, 2024). **3)** PEP Zona 7 has numerous drilled wells and established infrastructure of production facilities, primarily consisting of an oil and gas gathering station and a gas pipeline network which is directly connected to open-access gas transmission and consumers. **4)** Pertamina EP has a strong financial capability to support business development and operational activities. **5)** PEP has a diverse workforce with varying skills, competencies, and educational disciplines to perform exploration, development, and operational activities.

b. Intangible Asset

As one of Indonesia's largest and most reputable state-owned enterprises in the energy sector, Pertamina has successfully implemented strong corporate governance, social responsibility, excellent HSSE, and various sustainability programs in its operations. This success is recognized by its good ESG rating and numerous awards and certifications from national and reputable international institutions. In 2024, the Company also received various awards, including: **1)** 6 (six) GOLD PROPER awards, 14 Green PROPER awards, and 1 (one) Blue PROPER award. **2)** CSR & Sustainable Village Development Awards at the CSR & Sustainable Village Development Awards event. **3)** Zero Accident Award, Prevention and Management of HIV AIDS, Prevention and Management of Covid-19 at the OHS Award Awarding Ceremony**. 4)** Best & Inspiring CSR, Platinum Social Impact Category at the 2023 E2S Proving League event ASEAN Best Practice for Energy Management (EM) in Buildings & Industries Award-Special Submission ASEAN Center for Energy at the 2023 Asean Energy Awards. **5)** Global Corporate Sustainability Award at the Global Corporate

SWOT Analysis

The SWOT analysis is conducted to assess internal strengths and weaknesses, and external opportunities and threats to provide a comprehensive view of what the Pertamina EP is capable of and which challenges or opportunities the environment presents in the surface facilities development of TKP. The SWOT analysis is summarized in the Table IV.2: To find out the factors that affect the development of production facilities and piping system gas at the crime scene, a survey was conducted with the SME list in Table IV.2, the results were also validated by interviews with internal stakeholders who will manage the assets.

Figure 5. Summary of SWOT Analysis (Author, 2025)

Based on the results of the questionnaire survey with the question " In your opinion, how significant is the influence of the following EXTERNAL factors on the development of the Tambun Kelapa gas production facility?" The generated survey rating can be carried out to find out the level of influence of each of these factors as shown in the Figure IV.2. The results of the survey can be seen in Appendix A.

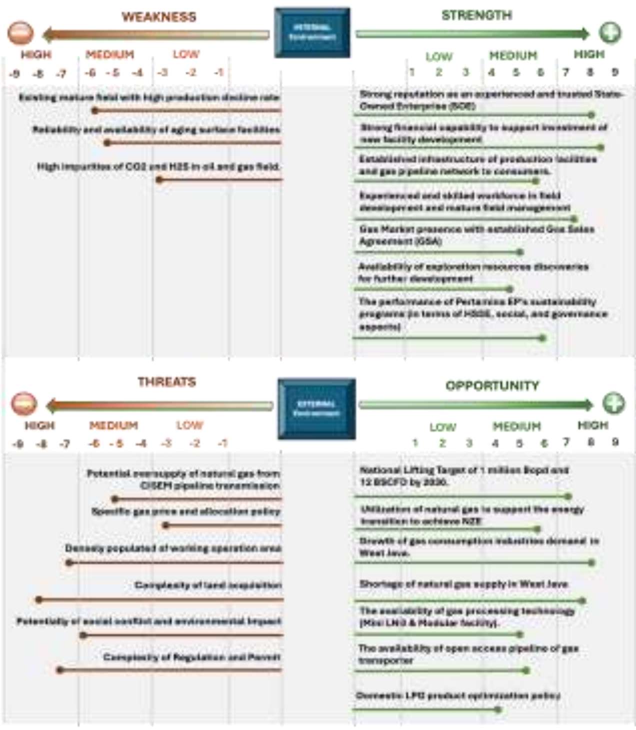

Figure 6. SWOT Analysis Rating (Author analysis based on survey, 2025)

Summary of Internal and External Business Environment.

The external environment is very supportive of gas development. However, there are threats that need to be anticipated in the development of oil and gas projects in Indonesia, especially in West Java (Zakaria et al., 2024). In terms of opportunities, increased gas consumption, the occurrence of gas supply shortages in the region and government support in achieving targets in setting national production lifting targets are the main factors and are strong drivers underlying the development and commercialization of the TKP structure. The use of natural gas in the energy transition towards Net Zero Emissions (NZE), the availability of access to pipelines to consumers, the availability of modular gas processing technology and Mini LNG/CNG are supporting factors as enablers for the development of production facilities and pipeline systems at TKP structures (Wang & Li, 2023).

Various external threats also need to be carefully managed. Pertamina's work area which is located in a densely populated area, the complexity of land acquisition and complex and lengthy licensing process are the main threats that can cause delays or project failures. The potential for social conflict, environmental impact, gas supply from the CISEM pipeline network are escalating into a serious threat if not properly anticipated. The potential for gas oversupply from the CISEM phase 2 pipeline operation can increase competition because it affects the priority allocation of supply to consumers and the potential for gas oversupply. In addition, the policy of setting certain gas prices of USD 6/MMBTU has the potential to reduce the economics of gas development projects, therefore, investment cost efficiency is required. However, the high demand for gas opens up opportunities for an increase in gas prices (Tavallali & Karimi, 2017).

Internally, Pertamina EP has adequate capabilities to develop gas fields by having all the main and supporting factors covering the resources needed. Pertamina EP has a good reputation and experience in realizing gas development, financial ability for investment, and a skilled and capable workforce (Tang et al., 2015). The availability of existing production facilities and pipeline infrastructure, the existence of exploration resources discovery, GSA's commercial portfolio, social HSSE performance and good corporate governance are internal supporting factors for the success of gas development at the TKP structure and in the business sustainability. The existing mature fields and ageing surface production facilities significantly contribute to high production decline rates. The impurities in the oil and gas lead to incremental processing costs. Pertamina EP is primarily operating these typical fields across its working area. Several successful efforts have been made to address rapid declines and rejuvenate these fields, focusing on both subsurface and surface facilities aspects (Silva et al., 2024).

Decision Makers Identification

Decision makers are identified based on their power and interest mapping. The stakeholder analysis has been identified based on their role, power and interest in accordance with some typical projects that have been done previously, presented in the Stake Holder Mapping on the Table IV.3. In this thesis, the author will involve stakeholders who are in the quadrant I (Key Players) of the matrix of power and interests. These stakeholders have a high level of power and importance over the project, and are directly involved in every stage of work, from initiation, execution to project operationalization (work together). Their involvement not only reflects responsibility in decision-making, but also has a deep understanding of the technical, administrative, and regulatory context of the project. Therefore, the selection of stakeholders from this quadrant is seen as relevant in identifying the right expectations, challenges, and strategies to support the successful development of the Tambun Kelapa gas production facility within the framework of this study.

There are 5 key stake holder who have in-deep interviewed to understand their point of view, expectation and objective of this TKP Project that guided by question These findings will subsequently be synthesized to formulate the fundamental objectives and value structures of the project by applying the Value-Focused Thinking (VFT) Method (Saakyan, 2025).

Value Focused Thinking Framework

Value-focused thinking (VFT) is a structured decision-making methodology that emphasizes the importance of values in guiding decision processes and reflecting decision makers' objectives. In the application, identifying the objective is a crucial step to gaining a comprehensive understanding of the values that are considered important in the context of decision-making (Shahinkar et al., 2018). One of the method commonly used to identify objectives is to utilize a wish list or expectations from stakeholders, which is then analyzed and extracted into two categories of objectives: the objectives and the means objectives (Sadeghi et al., 2024).

Means and Fundamental Objectives

"The value assessment comprised several separate task: listing the objectives, distinguishing between means and fundamental objectives, identifying measure for the objectives and prioritizing them. (Keeney, 1996). Based on the expectations of key stakeholders extracted from the interview results, these objectives are categorized as means or ends objectives and logically structured all relevant means objectives by examining the reason for each and within the decision context. It has been compiled of four means to achieve the fundamental objective that comprised of optimize project cost, optimize project quality, optimize time to onstream, optimize Compliance. Furthermore, fundamental objective is determined through linking means-end objective relationship. The fundamental objective can be formulated as "The development of the most effective production facilities and pipeline system to optimize the natural gas deliverability of the resources exploration discovery in the TKP structure". This fundamental objective is articulated within the decision context of the determining scenario developing production facilities and pipeline system of the exploration gas discovery in TKP Structures and gas commercialization to meet consumer demand, contributing to Pertamina EP's business sustainability. The hierarchy of fundamental – means objective is presented in the Figure 7.

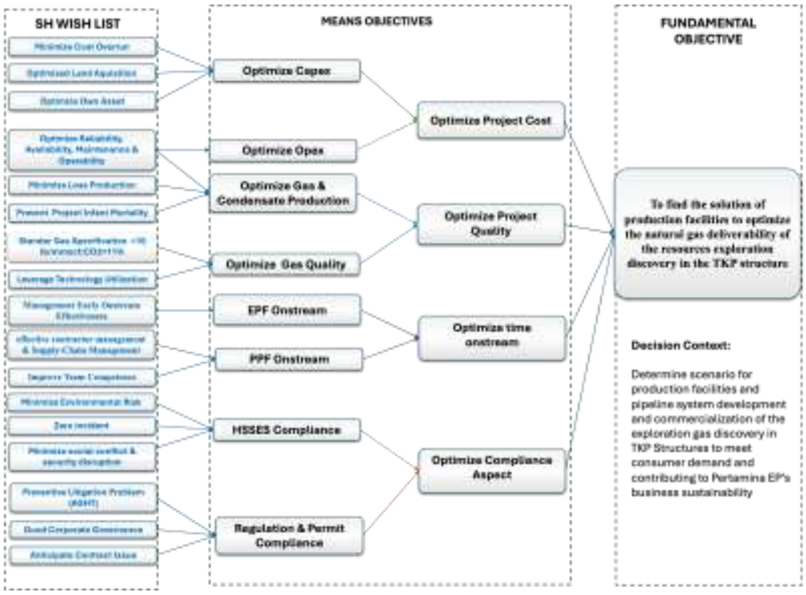

Figure 7. The Hierarchy of Fundamental - Means Objectives (VFT) (Author, 2025)

Creating Alternatives

"The objectives in the fundamental objectives hierarchy list all aspects of consequences that are important in a decision situation. Hence, thinking about how to better achieve these objectives can suggest an alternative." (Keney 1996). The search for suitable alternatives involves creating options that best achieve the values specified for the decision situation, both the qualitative objectives and the quantitative statements of values (e.g., priorities) should be systematically probed to initiate creative thought.

The Focus Group Discussion (FGD) was carried on with Subject Matter Experts (SMEs), identifying all possible alternatives based on specified criteria or values in to figured out solution opportunities in achieving the fundamental objectives. These alternatives were generated using the Value-Focused Thinking (VFT) framework by articulating specific means objectives and values set by decision-makers to achieve the fundamental objectives (Novani. S, 2024), that is find solution of production facilities to optimize gas deliverability to consumers, as illustrated in Figure IV.2. The alternatives are as follows:

1. Alternative 1: Development of a New TKP Gathering Station with Onsite Gas Sales
2. Alternative 2: Development of a New TKP Gathering Station with Pipeline System
3. Alternative 3: Upgrading the Tambun Gathering Station (GS TBN)
4. Alternative 4: Upgrading the Pondok Tengah Gathering Station (GS PDT

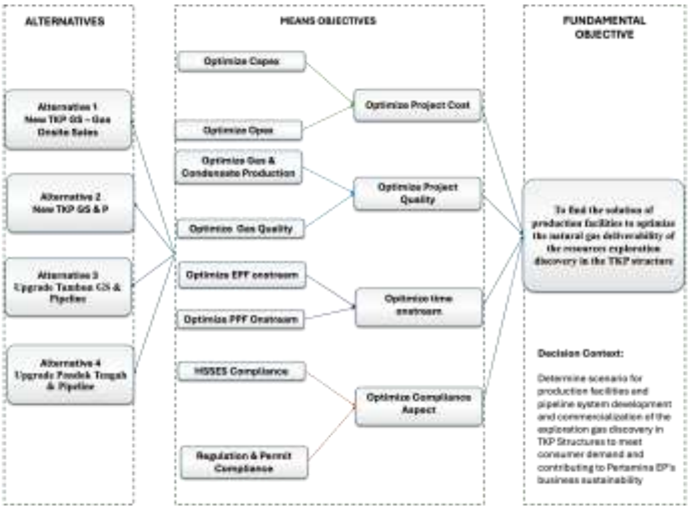

Figure 8. VFT Framework for Creating Alternatives Based on Fundamental – Means Objectives (Author, 2025)

An overview of the location of the TKP well and the possibly new gathering station location associated with piping system ROW to tie-in the nearest existing production facilities which can be utilized is presented in Figure 9.

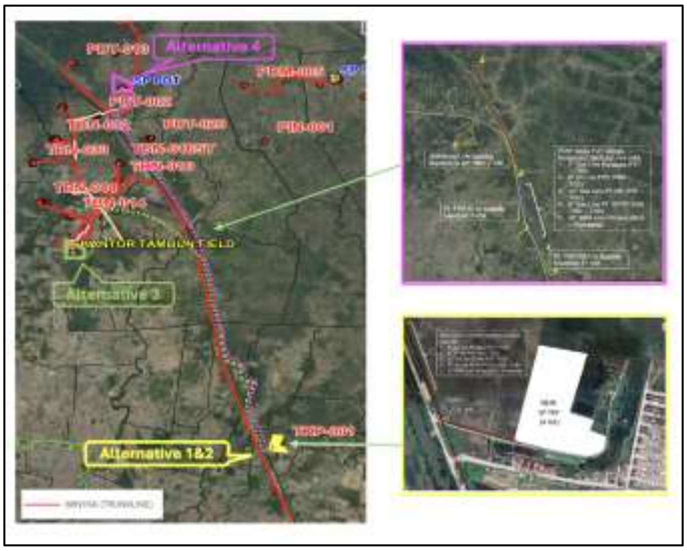

Figure 9. Situational Maps of TKP Wells location and Production Facilities Alternatives (Author, 2025)

The pictures shows that the development of production facilities at TKP mainly consists of two scopes of work:

1. Development of a Gathering Station (GS) to process production fluids from TKP wells, involving process of separation of natural gas, condensate, and produced water, as well as the removal of gas impurities, particularly CO_2 and gas-water content.
2. Development of a fluid transportation system from wells to the gathering station and further to the sales point. This covering the transportation of natural gas through pipeline systems (Flowline from wells to GS and Trunkline from GS to sales point), while liquids which

consist of condensate and water may be delivered either through pipeline systems or via trucking methods.

From these two primary scenarios, several segments of pipeline ROW have been identified for transportation of production fluids from the wells to the gathering stations and subsequently to the sales point. The production flow process for these four feasible development alternatives from TKP wells to the sales point integrates through the existing facility and the planned TKP GS production facilities is depicted in Figure IV.6.

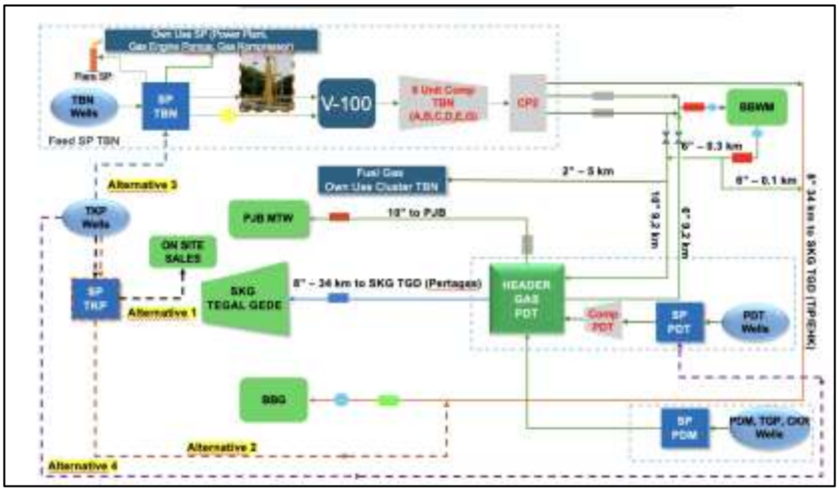

Figure 10. Flow Diagram of the Gas Flow and Facility Development Alternatives for TKP Wells (Author, 2025)

The description of the production facilities process for each alternative is outlined below:

Table 2. Description of alternative result of FGD

Alternative	Description
Alternative 1 (New TKP Gathering Station & Gas Onsite)	• Build new production facilities at TKP-001 area for subsequent processing of production fluid, i.e, gas, condensate and water separation and removal of CO_2 and water content; sales gas onsite; liquid delivered to Tambun gathering station (GS) by trucking for subsequent processing as describe in the Figure IV.7. • Require land acquisition for The new production facilities at TKP area around 45,000 m^2 and the GSA of new gas buyer
Alternative 2 (New TKP Gathering Station & Pipeline system)	• Build new production facilities at TKP-001 area for subsequent processing of production fluid, i.e, gas, condensate and water separation and removal of CO_2 and water content; processed gas is delivered to existing customers through Pertagas open access pipeline and PT TIP pipelines; condensate delivered through tie-in existing pipeline TBN-Tegal Gede; water delivered to Tambun GS by trucking as described in the Figure IV.8. • Require land acquisition for the new production facilities at TKP Area and ROW of gas and oil pipeline, totally around 51,000 m^2.
Alternative 3 (Upgrading Tambun GS)	• Upgrading the existing production facilities in Tambun GS to install additional separator, gas scrubber and metering equipment. Fluid production from TKP is being processes in Tambun GS for separation of gas, condensate and water; processed gas is mixed with Tambun gas production and sent to LPG Plan for extraction of C3-C4 fraction, then lean gas will be delivered to existing consumer through the open access Pertagas pipeline (Figure IV.9)

	• Build new pipeline to deliver TKP's well production fluid to Tambun GS. • Require land acquisition for the new fluid pipeline of with total length 17.6 km or 105,600 m^2
Alternative 4 (Upgrading Pondok Tengah GS)	• Upgrading the existing production facilities in Pondok Tengah GS to install additional separator and metering equipment. Fluid production from TKP is being processes in Tambun GS for separation of gas, condensate and water; output gas is delivered along with PDT gas production, then sent to LPG Plan for extraction of C_3-C_4 fraction, then lean gas will be delivered to existing consumer through the open access Pertagas pipeline. (Figure IV.10) • Build new pipeline to deliver TKP's well production fluid to Pondok Tengah GS • Require land acquisition for the new fluid pipeline with total length 18.6 km or 112,800 m^2

The determination of alternatives has also been aligned with external factors that may influence the viability of each alternative, such as accelerated production timelines driven by growing demand, the availability of Mini CNG technology, and Modular technology. In addition, internal factors have been considered to maximize the utilization of existing infrastructure and the commercialization portfolio as key enablers.

Criteria and Sub-Criteria

To measure the fundamental objectives performance, the means objectives will be identified into measurable criteria. Thus, set of hierarchy of criteria needs to be constructed considering the key factor from external and internal environment which is summarized in section IV.2. A set of measurable criteria and sub criteria is summarized in the Table IV.6.

Table 3. Identified The Objectives into Evaluation Criteria & Sub-Criteria (Author, 2025)

Objectives	Sub-Criteria	Criteria
Optimizing Project Cost	• Capital Expenditure (Capex), Costs related to the construction of new production facilities and the upgrading of existing surface facilities, including land acquisition, permitting, and procurement of materials and services. • Operational Expenditure (Opex), Costs associated with the operation and maintenance of production facilities, covering production activities, equipment maintenance, and service expenses.	Cost
Optimize Project Quality	• Cumulative production, of gas, condensate and its additional added value product from extraction processing (LPG) until end of PSC • Gas quality, as result of process in gathering station to meet sales gas specification which measure in discharge Pressure, CO2 and water content.	Quality
Optimize schedule onstream	• Early Production Facility onstream time, encompass cycle time of Pre-Project, Project execution, Commissioning and Start-up process of the rental EPF.	Time Onstream

Objectives	Sub-Criteria	Criteria
	• Permanent Production Facility onstream time, encompass cycle time of Pre-Project, Project execution, Commissioning and Start-up process of Permanent Production Facilities.	
Optimize Compliance Aspect	• HSSES (Health, Safety, Security, Environment and Social) aspects compliance, that carried out from the pre-construction, construction, operation and post-operation stages to minimize the impact on people, assets, community and the environment that may risk on the sustainability of development projects. • Regulation and permit compliance This includes the implementation of good governance practices, based on number of regulation and permitting aspects compliance to prevent risks, threats, disruptions, obstacles, and litigation problem that may affect the sustainability of the development project	Compliance

Analytical Hierarchy Process Implementation

A set of structure criteria and sub-criteria will be utilized to evaluate the proposed alternatives based on level of preferences of decision maker by conducting Pairwise comparison This section aims to select the most effective production facilities to optimize the natural gas deliverability from the resources exploration discovery in the TKP structure. The Analytical Hierarchy Process (AHP) model is constructed for the decision-making process. There are four criteria and eight sub-criteria associated in it, as a synthesis of the results of decision maker regarding the various values expected in this project, which will be used to assess the decision-making process for the four design alternatives.

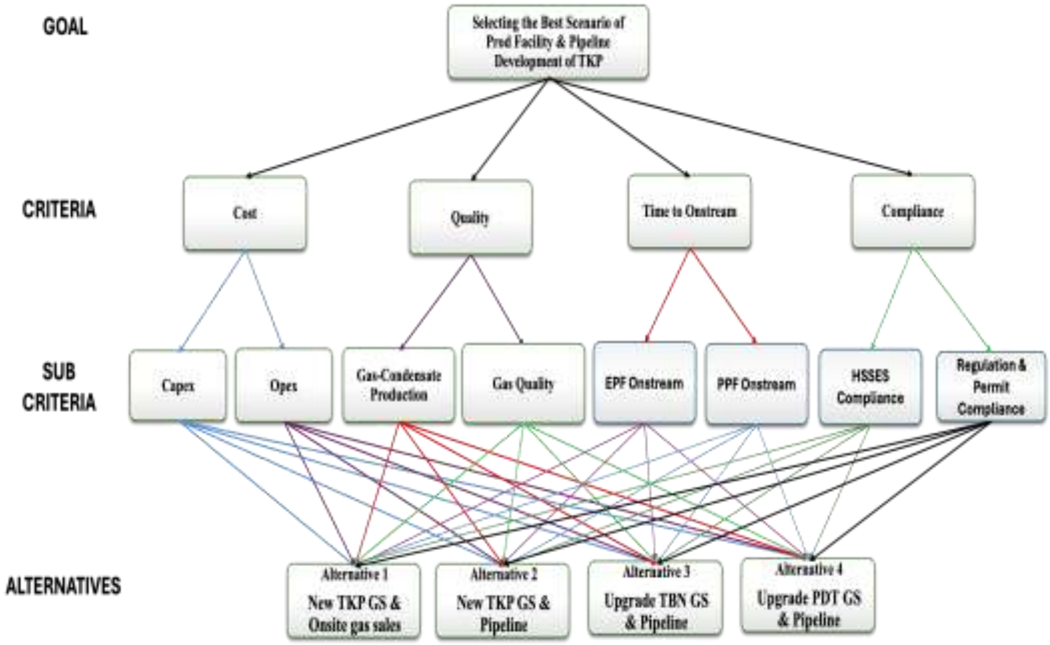

Figure 11. The Structure Decision Hierarchy Process of TKP

The pairwise comparison is carried out to weighted of criteria and sub-criteria on the hierarchy structure model. At this stage, pairwise comparation point value of the criterion Cost, Quality, Time to Onstream, and Compliance, along with their associated sub-criteria, are obtained from questionnaire survey that carried out on the respondent.

These criteria and sub criteria are used to measure alternatives in achieving goals in the decision-making process. Alternative evaluation on each criterion and sub-criterion was carried out by applying quantitative analysis conducted by SMEs with refer to best practices as listed in the bellow table.

Table 4. Identified The Objectives into Evaluation Criteria & Sub-Criteria (Author, 2025)

Alternatives	Cost	Quality	Time To Onstream	Compliance
Cost	1.00	1.00	0.18	0.19
Quality	1.00	1.00	0.25	0.50
Time To Onstream	5.63	3.94	1.00	0.54
Compliance	5.23	2.00	2.00	1.00

Calculating the relative weight of all criteria is appropriate for understanding on which criteria and sub-criteria contribute more or less to the decision alternatives. The relative weight of criteria and alternatives is performed by inputting all data from the pairwise comparison matrices at both the criteria and alternative levels, into the AHP model developed in the Super Decisions software for synthesize calculation.

This figure shows the more to less influential criteria on selecting the best scenario of production facilities development of TKP Structure are the compliance, time to onstream, quality and cost with corresponding relative weighted factors 0.426, 0.386, 0.122, and 0.084, respectively. On the sub-criteria level the top three aspects with high contribution are HSSES, Regulation & Permit compliance and Early Production Facility onstream time that corresponding to the weight factor of 0.284; 0.245; 0.142, as indicated from the second row of sub criteria normalized weight factors.

In conclusion, the quality is the most significant impact criterion that the decision maker needs to mitigate how the changes in the initial setting problem can reflect in the results to make a more confident decision in selecting the best scenario of production facilities development of TKP Structures. In this study, sensitivity analysis is performed by adjusting the weight of a criterion to 0 while keeping the others proportionally constant, and observing how the alternatives priorities change as the weight of the criterion changes. Applying the same way to criteria of cost, quality, time and compliance, we can create a plot to observes how much impacting alternatives priority

CONCLUSION

This study utilized the VFT-AHP method to select the optimal production facility development scenario for the TKP Structure, integrating a comprehensive analysis of key internal and external factors identified through PESTEL and SWOT frameworks. Data were gathered via semi-structured interviews, surveys, and literature reviews to ensure a robust qualitative and quantitative approach, prioritizing alternatives based on criteria that reflect stakeholder values and the project's fundamental objectives. A sensitivity analysis was conducted to identify the key criteria influencing the priority rankings, thereby strengthening the decision-making process and providing a model applicable to similar future cases.

The analysis identified significant external drivers, including government support for national oil targets and rising gas demand, alongside challenges such as regulatory complexity and land acquisition issues. Internally, PEP's strong reputation, financial capability, and skilled workforce were recognized as key enablers. The evaluation criteria—Compliance, Time to Onstream, Quality, and Cost—were weighted accordingly, leading to the conclusion that upgrading the Pondok Tengah Gathering Station and constructing a pipeline from TKP Well (Alternative 4) is the best scenario, achieving the highest priority ranking of 30.76%, a result consistently supported by sensitivity analysis.

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