

Decision Making Analysis in Phase 7 Road to Support A 54 MT Production Plan at PT Kusan Girimulya Wijaya

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ABSTRACT

In response to its plan to increase annual coal production to 54 million tons, PT Kusan Girimulya Wijaya (PT KGW) faces operational and logistical challenges related to transport infrastructure. Historically reliant on Phase #4 as the primary road from pit to port, the introduction of new disposal routes from KGU Pit to KGS Void—featuring 25 fleets and three crossing points—has raised concerns over safety, congestion, and productivity loss. This study aimed to identify and evaluate the optimal infrastructure development alternative to support the increased production target. Using a qualitative approach, data were gathered through interviews, field observations, and document analysis. The research employed Kepner-Tregoe Problem Analysis to diagnose root causes and was followed by Focus Group Discussions (FGDs) utilizing Value Focused Thinking (VFT) to formulate alternative road development options: Construct Phase #4, Construct Phase #7, and Construct Phase #7b. These alternatives were assessed using the Simple Multi-Attribute Rating Technique (SMART), incorporating cost (CAPEX and OPEX), safety, operational efficiency, corporate image, and duration as criteria. Results showed Construct Phase #7b as the optimal choice, offering the lowest cost (\$308 million) and highest benefit value (79.55). The study demonstrates the importance of strategic mine planning and decision-support methodologies in managing production scale-ups while ensuring cost-effectiveness and operational sustainability. Future research is suggested to evaluate the long-term implementation performance and explore digital monitoring solutions to further enhance resilience in mine transport systems.

Keywords: Loss of Production, Focus Group Discussion, Kepner-Tregoe Problem Analysis, Value Focus Thinking, Simple Multi-Attribute Rating Technique, Decision-Making.

INTRODUCTION

PT Kusan Girimulya Wijaya (PT KGW) is a prominent coal mining company operating under a Coal Mining Business Work Agreement (PKP2B) in South Kalimantan, Indonesia. Since its operations commenced in 2006, PT KGW has progressively increased its production capacity from 5 million tons per year to 13 million tons by 2012, and subsequently to 36 million tons in 2017 following a feasibility study. In 2022, an Addendum Andal and RKL-RPL Type A were conducted to expand the production capacity to 46.8 million tons, supported by an environmental feasibility

approval. The company is currently preparing for an ambitious increase to a maximum of 54 million tons per year, necessitating strategic changes to its infrastructure and operational planning.

The transition to this higher production capacity presents complex logistical and safety challenges, especially in relation to coal transport infrastructure. Historically, PT KGW relied on a single primary transportation route, Phase #4, for moving coal from pit to port. However, with the rising production targets and altered disposal patterns—specifically the new disposal activity from KGU Pit to KGS Void involving 25 fleets and three road crossings—there is a growing risk of congestion, productivity losses, and safety hazards. These complications, if not addressed, could result in significant Loss of Production Opportunity (LPO), thus threatening the feasibility of the 54 million ton target (Fitriani, 2023; Hidayat M. A., 2021; Ramadhan, 2022).

To mitigate these risks and enhance operational efficiency, the company initiated a structured decision-making process. This involved the use of qualitative methods including in-depth interviews, field observations, and document analysis to diagnose the problems comprehensively. Focus Group Discussions (FGDs) were conducted with key stakeholders from various divisions—including mining operations, planning, safety, finance, and external consultants—employing the Kepner-Tregoe Problem Analysis method to identify root causes and evaluate potential road infrastructure alternatives (Balasubramaniam, 2019; Boateng, 2012; Duboz et al., 2022; Kraaijvanger et al., 2016; O.Nyumba et al., 2018; Scheelbeek et al., 2020).

The study proceeded with an evaluative phase using the Value Focused Thinking (VFT) approach to derive and frame viable alternative solutions. Three main construction options—Construct Phase #4, Construct Phase #7, and Construct Phase #7b—were identified. These alternatives were assessed using the Simple Multi-Attribute Rating Technique (SMART), which allowed for the comparison of each option across multiple weighted criteria, including cost (CAPEX and OPEX), safety, operational stability, corporate image, and project duration.

Results from the SMART analysis revealed that Construct Phase #7b offers the best balance of low cost (\$308 million), high operational benefit (aggregate score of 79.55), and cost savings (\$15.5 million) compared to other alternatives. This comprehensive analysis underscores the importance of strategic mine plan management in sustaining production growth and highlights the necessity for robust infrastructure and decision-support systems to ensure long-term operational and financial success.

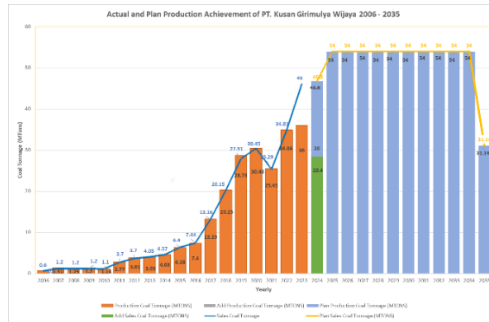


Figure. 1 Actual and Planned Production Achievement Chart of PT. KGW 2006-2035

Source: Company Feasibility Study Data, 2023

This study aimed to identify and evaluate the optimal infrastructure development alternative to support the increased production target. Compared to prior studies such as AlMaian et al. (2016), which applied SMART and Value-Focused Thinking (VFT) for supplier quality management, and Patel (2017), which used SMART in civil engineering planning, this research extends the application of these tools into a high-stakes mining infrastructure decision-making context. Unlike Thompson (2011) who focused on generic haul road construction and maintenance, this study combines root cause analysis (Kepner-Tregoe), VFT, and SMART to evaluate not only technical and economic feasibility but also strategic sustainability dimensions, such as safety and operational continuity, within a real-world production target scenario. Thus, the novelty lies in the integrated methodological application for resolving multi-criteria infrastructure planning in large-scale coal mining operations under escalating production demands.

RESEARCH METHOD

This research employs a qualitative approach to explore phenomena occurring in the field through in-depth interviews, direct observation, and document analysis. The research design is structured based on several research questions and proceeds through a series of stages to gain a comprehensive understanding of the problem.

The first stage is data collection, which involves both primary and secondary data. Primary data is obtained directly from field sources using methods such as surveys, interviews, focus group discussions (FGDs), and observations. Secondary data includes technical and administrative documents. Technical data encompasses road plan maps, production targets, coal reserve calculations, and mining sequences, which are processed using software such as Minescape for 3D modeling and ArcGIS for geospatial mapping and analysis. Administrative data is sourced from internal and external documents such as feasibility studies, environmental impact analyses, government regulations, procedures, and journals. Challenges in this stage

include tracking scattered and frequently updated approval documents, which complicates quality control and data screening.

Once data is collected, a situational assessment is conducted to analyze current internal and external conditions. This involves evaluating time trends, impacts, and priority scales to identify key factors that influence strategic decision-making, while also considering opportunities, challenges, risks, and alternative solutions.

Following the situational analysis, the research identifies the root cause of the problem through brainstorming sessions using the Kepner-Tregoe method. This step aims to isolate the actual source of the issue affecting operational goals.

Finally, after determining the root problem, FGDs are conducted involving department personnel and expert consultants to identify relevant attributes for decision-making. The Value-Focused Thinking method is applied to guide the evaluation and selection of alternative solutions aimed at supporting the business objective of increasing production to 54 million tons at PT KGW.

Table 2. Personnel Experience and Competence in Focus Group Discussion

No.	Division and Department	Experience and Competence
1	Head of Mining or Chief Mining Engineer (KTT)	Experienced in overseeing the overall planning and implementation of projects from upstream to downstream of good mining practices, skilled in aligning core and non-core project objectives with overall business objectives. Or have authority from management as the highest leader responsible at the location to decide technical and non-technical policies.
2	Mining Development and Contracts Division	Provide insight and expertise in managing the development of mining operations, infrastructure, and contracts, evaluating technical requirements for efficient and optimal projects.
3	Strategic Planning and Optimization Department	Competent in data analysis and providing strategic input to optimize operations and improve project outcomes in designing effective long-term strategies and optimizing resources to achieve business or operational goals.
4	Mining Project Plan Section	Proficient in coordinating and ensuring that all technical aspects of the mining plan are represented and considered accurately, the data required to effectively design, manage, and execute the mining project plan. This section covers the various aspects that contribute to the success of a mining project, from project inception to completion of operations.
5	Environment and Reclamation Department	Having expertise in sustainable environmental management, mitigating environmental impacts from operations, and land reclamation after mining activities are completed, including expertise and experience to manage, protect, and restore the environment with government standards and regulations.
6	Mine Operation Production Division	Skilled in providing operational insights, evaluating the feasibility of plans, and managing the resources required for implementation, or being able to optimize production activities in the mine. This covers

No.	Division and Department	Experience and Competence
		the entire process from material extraction to product delivery that meets quality and quantity standards while maintaining safety, efficiency, and sustainability.
7	Finance Department	Knowledgeable in evaluating cost implications of proposed solutions and ensuring alignment with budget constraints.
8	Safety Department	Expertise in identifying potential risks and implementing mitigation strategies to manage safety and risk management related to the project. In this context, it includes the skills and experience to effectively manage, implement and monitor safety policies and practices as well as ensuring workplace safety, minimizing the risk of accidents and creating a safe working environment for all employees.
9	Human Resources Development Department	Experienced in workforce management ensures that the results of Focus Group Discussions (FGD) are aligned with the capabilities and training of team members in recruiting, developing, retaining, and managing employees to support the achievement of organizational goals. This includes the skills and experience needed to carry out HRD functions effectively, from HR management to employee development.
10	External or Consultant	Providing external expertise and unbiased recommendations on complex technical and non- technical issues according to the respective field of consulting services being used.

Source: Company Data, 2024

Alternative solutions obtained from the Focus Group Discussion (FGD) brainstorming process are calculated using the Simple Multi-Attribute Ranking Technique (SMART), which is used to assess various relevant alternatives and has been weighted for each attribute and calculated economically, company benefits, and analyzed for risk based on criteria such as safety, stability of production operations, company image, duration, cost, and company benefits. SMART allows for a structured comparison of several attributes, allowing decision-makers to choose the optimal solution. With the solution selected as the optimal and efficient step for the project, a Potential Problem Analysis (PPA) is carried out to identify incidents and problems that may arise in the future.

After obtaining the best option, the next step is to prepare a follow-up schedule so that the program can be implemented according to plan, effectively and efficiently.

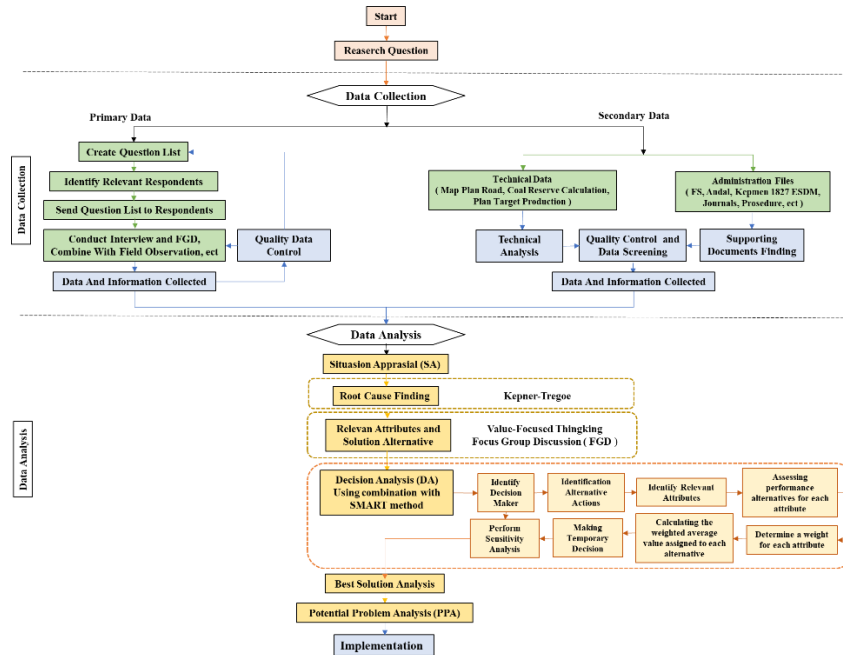


Figure2. Research Design Flowchart

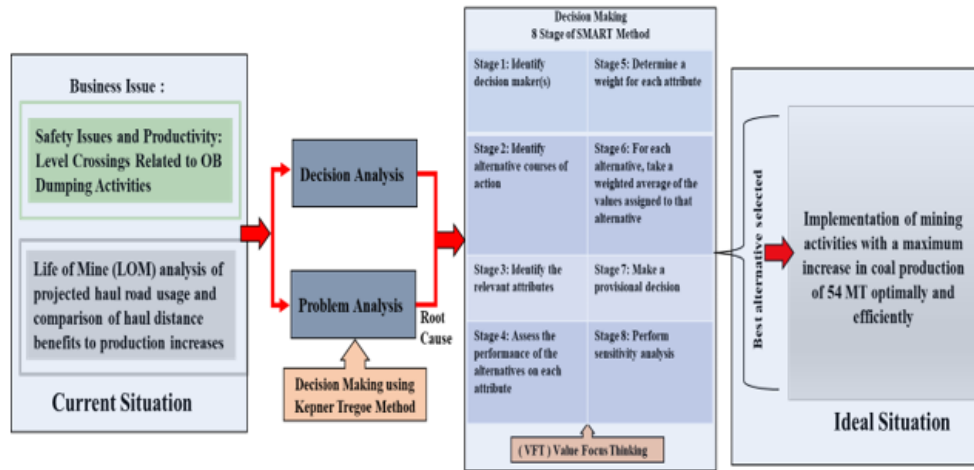


Figure.3 Conceptual Framework of Study at PT. Kusan Girmulya Wijaya

RESULT AND DISCUSSION

Table 3. Situation Appraisal of significant production increase activities to 54 MT per year.

No	Concern	Sub Concern	Action Statement	Timing	Trend	Impact	Process Needed	Priority
1	Production	Production volume increases by 54 MT without strengthening infrastructure.	Prepare a hauling infrastructure development plan that is in accordance with the production volume according to the long-term LOM target submission permitted in the Andal, Feasibility Study (FS).	High	High	High	DA	1
2	Budget	Readiness for increased operational costs with increased production targets	Compile and analyze last year's High operational costs and actual conditions by making long-term total cost projections for Life of Mine (LOM).	High	High	High	DA	2
3	Operational	The load on the main route has increased without the potential for alternative productivity to decrease, which has not been achieved according to plan, so that fleet allocation is not optimal.	Adjusting fleet distribution to alternative routes to reduce congestion on main route.	High	High	High	DA	3
4	Safety Issue	Operational obstacles on the main route with the presence of large fleets causing congestion, the physical condition of the road is challenging there will be disposal activities from the KGU Pit to the empty KGS void, with 3 crossing points and 25 fleets.	Redesigning road layouts and adjusting traffic flow to reduce obstacles, as well as repairing or evaluating main route infrastructure to support smooth hauling operations and reduce high risks.	High	High	High	PA	4
5	Construction	The East Block location includes the Kusan-Girimulya Mine, the actual condition of which is constrained by unsupportive topography and areas that do not interfere with reclaimed areas and limited IPPKH.	Make a detailed plan to overcome construction constraints according to relevant area conditions and have been included in the IPPKH according to the long-term Life of Mine (LOM).	High	Medium	High	PPA	5
6	Extreme Weather	Extreme weather affects road stability.	Develop mitigation strategies for the impacts of severe weather, such as road repairs, when weather conditions are stable.	Medium	Medium	High	PPA	6

Current issues that require a Decision Analysis (DA) process are:

1. Priority 1: Infrastructure strengthening needs to be planned and implemented before production increases to prevent operational problems.
2. Priority 2: Increased operational costs need to be analyzed immediately to control expenses and prevent greater financial problems in the future. With increased production targets, operational costs tend to increase if no efficiency measures are taken. Uncontrolled cost increases can disrupt profitability and even project sustainability. Since there are several budget allocation options and cost control strategies related to the increase in production targets, there is a dilemma regarding the best allocation and strategy, and clear goals need to be set regarding cost efficiency.
3. Priority 3: Suboptimal fleet distribution allocation needs to be addressed immediately to improve efficiency and achieve productivity targets.

Problems that require the Problem Analysis (PA) process are:

4. Priority 4: Potential accidents due to congestion and challenging road conditions

Problems required in the Potential Problem Analysis (PPA) process are:

5. Priority 5: Topographic constraints and land limitations need to be anticipated in the planning stage to avoid delays and additional costs.
6. Priority 6: Mitigation strategies need to be prepared but the impacts are not constant and can be anticipated.

Problem Analysis (PA)

Based on the conditions of target changes and significant production increases, disposal activities will be carried out from KGU Pit to the KGS Void space, with 3 crossing points and 25 fleets, related to safety issues and decreased productivity. Life of Mine (LOM) projections for the use of haul roads and comparison of haul distance benefits. With the many obstacles that exist, it is necessary to find the root of the problem related to the decrease in Overburden (OB) productivity in decision-making to support the 54 MT production plan at PT Kusan Girimulya Wijaya. Based on the Kepner Tregoe Problem Analysis.

Focus Group Discussion (FGD)

This discussion group consisted of the Head of Mining or Chief Mining Engineer (KTT), Mining Development and Contracts Division, Strategic Planning and Optimization Department, Mining Project Plan Section, Environment and Reclamation Department, Mine Operation Production Division, Finance Department, Safety Department, Human Resources Development Department, and External or Consultant. Table 2 Personnel Experience and Competence in Focus Group Discussion.

In this chapter, after getting the root of the problem from the previous discussion, we followed up with a Focus Group Discussion (FGD) to find alternative solutions to the problem as follows:

1. Main Route Obstacles: Reducing obstacles on the main route by redesigning the road layout and adjusting traffic flow.
2. Alternative Routes: Developing and opening alternative routes to distribute operational loads. (There are 3 alternatives: Construct Phase 4, Construct Phase 7, and Construct Phase 7b.)
3. Road Topography: Improving infrastructure on the main route to improve hauling efficiency.
4. Infrastructure Improvement: Preparing a hauling infrastructure development plan that is in accordance with the current production volume.
5. Weather: Developing mitigation strategies to deal with the impact of bad weather.
6. Fleet Capacity: Adjusting the allocation of the hauling fleet to optimize productivity.

Value-Focused Thinking (VFT)

Deciding what is desired and finding a way to achieve it are two key activities in the Value Focused Thinking (VFT) approach (Bortoluzzi et al., 2021; Pacheco et al., 2019; Tshering & Gao, 2020). Choices of road infrastructure are generated to create phase 4, create phase 7, and create phase 7b. The explanation of each of these alternatives is explained in detail in Table.3, as Alternative Solutions, which is used to list various alternative solution options along with a brief description of each solution. The description of the table so that it can be understood together with the members of the discussion group team to see each of these alternatives if they will be applied according to actual conditions in the field when conducting Value Focused Thinking (VFT) before being used in the decision-making process or problem analysis to compare and evaluate possible solutions before determining the best choice.

This scheme can be summarized in the picture. Each description can be seen in Figure 4.

Table 4. Alternative route of solution for case study of increasing coal production to a maximum of 54 MT

No.	Alternative solution	Description
1	Construct Phase 4	The actual condition of the main coal transportation road already exists, but the actual condition is that there are 3 intersection points, and 25 fleets on this main route have challenging physical conditions.
2	Construct Phase 7	Making other alternative roads on the High Wall (HW) side, dividing the hauling distribution that still passes through phase 4 and to phase 7.
3	Construct Phase 7b	The creation of another alternative road on the High Wall (HW) side is a partial diversion of phase 7 in segment C to obtain disposal capacity and divide the hauling distribution that still passes through phase 4 and to phase 7b.

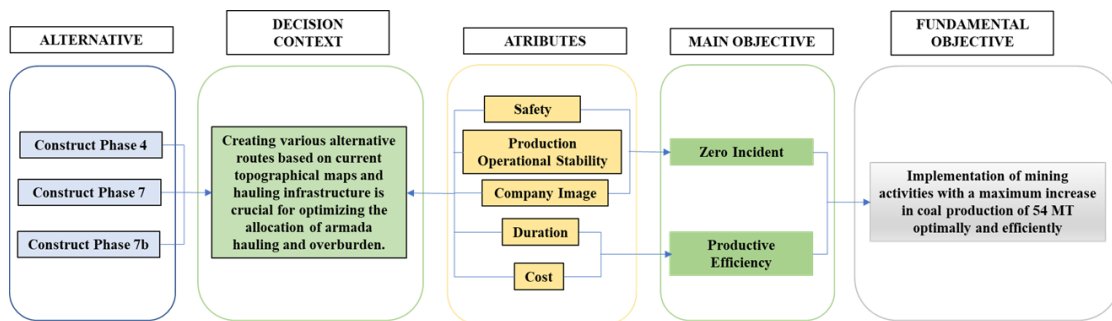


Figure 4. Value-Focused Thinking Scheme for Infrastructure Development Projects

SMART (Simple Multi-Attributes Rating Technique)

The Strategic Planning and Optimization Department, as the main implementer, conducts research on problem analysis, decision-making, and problem-solving in accordance with the area restrictions in the East Block of Girimulya Pit covering the Kusan-Girimulya Void Area. Responsible for determining steps to resolve problems related to production, budget, operations, safety, construction, and extreme weather issues that can be obstacles.

Stage 1: Identification of Decision

The decision maker is the mining head or chief mine engineer, who is responsible for resolving the problem of decreasing hauling and overburden productivity on the main hauling route that began to be detected since the significant increase in production in 2022 in the supervision of project planning and implementation or in focus group discussions (FGD) or has expertise in aligning project objectives with all stages of PT Kusan Girimulya Wijaya Coal's Mining Management Chain.

Stage 2: Identification of Alternative Actions

This structured process to identify alternative actions aims to address the main hauling road, improve the efficiency of hauling load distribution, adjust road infrastructure to support optimal and safe production increases, and ensure that the selected solution is not only effective in the short term but also sustainable and in line with PT Kusan Girimulya Wijaya's long-term goals. The cost calculation of the alternative hauling road options is shown in table 5.

Table 5. Partial Situation Calculation Cost

Option Alternatif Hauling Road	Total Cost CAPEX (USD, Mio)	Coal Haul Vol (Mmt)	Length (km)	Hauling Rate LOM (USD)	Hauling Cost (USD, Mio)	Maint. Rate (ton/km, USD)	Maint. Cost (USD, Mio)	Total Cost OPEX (USD, Mio)
Construct Phase #7b (1-A-B-G-F Km20)								
- Hauling Cost #7b (A-B-G-F Km20)	6.03	190	8.92	0.08	131	0.01	20.963	152
- Hauling Cost #4		163.3	10.18	0.08	129	0.01	20.563	150
- TOTAL		353.3			260		41.526	302
Construct Phase #7 (1-A-B-C-F Km20)								
- Hauling Cost #7 (A-B-C-F Km20)	3.78	190	9.42	0.08	139	0.01	22.138	161
- Hauling Cost #4		163.3	10.18	0.08	129	0.01	20.563	150
- TOTAL		353.3			268		42.701	310
Construct Phase #4 (1-A-D-E-F Km20)								
- Hauling Cost #4 (A-D-E-F Km20)	0	353.3	10.18	0.08	279	0.01	44.487	323
- TOTAL		353.3			279		44.487	323
Cost Saving Phase #7 To Phase # 4			0.76		11.20		1.79	12.99
Cost Saving Phase #7b To Phase # 4			1.26		18.57		2.96	21.53

Stage 3: Identify Relevant Attributes

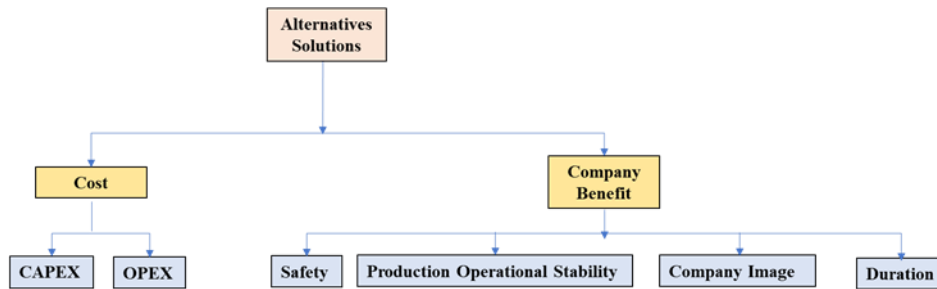


Figure 5. Value Tree of Decision Making

In this follow-up focus group discussion (FGD), which carries the idea of Value-Focus Thinking, the alternative solution decisions obtained can be divided into two criteria, namely cost and company benefits. The cost costs are divided into two sub-sub-criteria, namely CAPEX and OPEX. In contrast, company benefits are divided into four sub-criteria: safety, stability of production operations, company image, duration.

Stage 4: Assessing the performance of alternatives on each attribute

The initial step for this measurement is to first create a score scale for each option that shows an explanation of the scoring concept of each benefit criterion.

1. The first sub-criterion is cost. With limited costs, of course it is necessary to prioritize projects that have the greatest positive impact on the company so that it can develop according to the target of increasing production and sustainability.

Cost is divided into two sub-criteria:

- a) Infrastructure Investment Cost CAPEX (Capital Expenditure):

This includes the initial costs required to build new facilities or infrastructure, such as haul roads, stockpiles, ports, and other supporting facilities. This cost is included in capital expenditure because it is a large expenditure that has long-term benefits. Project Development Cost: This cost is included in the planning, design, and construction of new projects. This involves spending on land acquisition, feasibility studies, permits, and other technical costs related to project development.

- b) Maintenance Cost OPEX (Operational Expenditure):

Included in operational costs, this cost includes maintaining infrastructure and equipment to keep it functioning properly, including road repairs, maintenance of machinery, and other equipment used in daily operations. Daily Operating Cost: ongoing costs related to daily operations, such as fuel, labor wages, transportation costs, and other energy costs required to keep operations running.

2. Safety is the third sub-criterion that must be considered because it is directly related to the safety of life and property. In increasing the production capacity to the proposed 54 MT, the best position that can produce optimal production is the selection of transportation routes that must support this objective by considering the very high potential risk of accidents, so that safety should not be underestimated.
3. The fourth sub-criterion is the stability and efficiency of production operations. One of the efforts to maintain stability and efficiency of production operations is by reducing congestion on main routes by redistributing the fleet and developing alternative routes, this can increase transport speed and reduce travel time, ensuring transport stability even though production volume increases to 54 MT.
4. The fifth sub-criterion is the company's image. PT Kusan Girimulya Wijaya builds its image in general in a way that is not easy; they must convince their customers that their company has positive values that can be appreciated by the community and awards from the government.
5. The sixth sub-criterion is duration. The duration of an alternative project is also a factor to consider, because the faster the alternative construction project for the hauling road is carried out, the faster the preparation of achievements that can be produced coal.

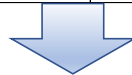
The FGD process involves determining the criteria for alternative options, measuring their performance, and calculating their effectiveness, involving all relevant parties and the decision-making team. The focus group consists of representatives from various departments, including the mine manager, mine development, strategic planning, the sector mine plan project, operations management, finance, safety, HR, and external consultants. The initial step for this measurement is to first create a scoring scale for each option that shows an explanation of the assessment concept for each benefit criterion. The scoring scale for the identification of the status of each sub-criteria is shown in table 6 and table 7 below.

Table 6. Criteria Value Weight Provisions.

No.	Criteria	Requirement	Score Value Range (0-100)	Parameter
1	Safety	Has the highest level of safety because it successfully eliminates risky activities (3 crossing points and 25 fleets). Safety risks are completely eliminated.	75-100	Low
		Provides a significant level of safety, but there are still some residual risks to be aware of and some risks that can be managed.	50-74	Medium
		Reduces some safety risks but cannot eliminate major risks such as collisions, decreased productivity, or property loss.	25-49	High
		The safety level is very low because there is no action to eliminate risky activities (3 crossing points and 25 fleets). Potential to cause accidents.	0-24	Very High
2	Production Operational Stability	Having high flexibility in distributing coal hauling, shortening hauling distance, increasing disposal capacity, and reducing major risks.	75-100	Flexible
		Able to distribute coal hauling evenly and shorten hauling distance, but cannot increase disposal capacity.	50-74	Medium Flexible
		It has significant limitations, such as relying on only one main route without optimal coal hauling distribution or additional disposal capacity.	25-49	Medium Limited
		There is no significant operational flexibility or efficiency capability, thus not supporting stable operations at high production volumes.	0-24	Limited
3	Company Image	Maintaining the company's image by avoiding negative issues, working on schedule, adhering to high standards, and resolving operational constraints. The company's commitment is clearly visible in achieving the targets that have been set.	75-100	Positif
		Contributing to the positive image of the company, but there are still some challenges, such as not getting a permit to release land for the redistribution area, so it is necessary to move the hauling road to another location to increase disposal capacity.	50-74	Medium Positif
		Demonstrating less than optimal commitment contributes to the decline in the company's image, such as significant schedule delays due to lack of planning efficiency and significant schedule delays, decreased productivity, and potential failure to achieve production targets that have been submitted for permits to the government, thus creating the impression that the company is not serious and planning is not optimal, which affects public and government trust.	25-49	Medium Negatif
		It is very dangerous for the company's image, shows indifference to risk, safety, the environment, and government programs, and shows no commitment to the production targets that have been submitted according to the permit to the government, which can cause a loss of public and investor trust or even the revocation of the company's permit.	0-24	Negatif
4	Duration	The fastest construction duration because it does not require the construction of new infrastructure, allowing the project to immediately start production and generate income.	75-100	Short
		The duration of the work takes 1 year, which is considered moderate and allows the production target to be achieved in a relatively short time and can support production acceleration within a realistic time frame.	50-74	Medium
		The duration of the work is longer, around 1.5 years, due to the re-preparation, which takes more time, but is still acceptable and tolerable in medium-term planning.	25-49	Long
		The duration of the work is very long, far exceeding the expected time tolerance, so that it can delay the achievement of the company's production and income targets.	0-24	Very Long

Table 7. Identification of Sub-Criteria Status on Each Option

No.	Criteria	Score Value Range (0-100)	Parameter	Construct Phase #7b	Construct Phase #7	Construct Phase #4
1	Safety	75-100	Low	100	100	
		50-74	Medium			
		25-49	High			
		0-24	Very High			10
2	Production Operational Stability	75-100	Flexible	100		
		50-74	Medium Flexible		74	
		25-49	Medium Limited			25
		0-24	Limited			
3	Company Image	75-100	Positif			
		50-74	Medium Positif	74	65	
		25-49	Medium Negatif			25
		0-24	Negatif			
4	Duration	75-100	Short			100
		50-74	Medium		50	
		25-49	Long	30		
		0-24	Very Long			



No.	Criteria	Score Value Range (0-100)	Parameter	Construct Phase #7b	Construct Phase #7	Construct Phase #4
1	Safety	75-100	Low	Low	Low	
		50-74	Medium			
		25-49	High			
		0-24	Very High			Very High
2	Production Operational Stability	75-100	Flexible	Flexible		
		50-74	Medium Flexible		Medium Flexible	
		25-49	Medium Limited			Medium Limited
		0-24	Limited			
3	Company Image	75-100	Positif			
		50-74	Medium Positif	Medium Positif	Medium Positif	
		25-49	Medium Negatif			Medium Negatif
		0-24	Negatif			
4	Duration	75-100	Short			Short
		50-74	Medium		Medium	
		25-49	Long	Long		
		0-24	Very Long			

Stage 5: Determine a weight for each attribute

Determine the sub-criteria as a benchmark for the company benefits of each alternative choice. In this case, the last four sub-criteria are used and then weighted to calculate the aggregate total for the 4 sub-criteria aspects, namely safety, stability or efficiency of production operations, company image, and the length of the weighting assessment based on Table.

Table 8. Table of Original Weighting the Attribute for the 4 sub-criteria aspects

No.	Criteria	Requirement	Original Wights Score Value Range (0-100)	Prioritas	Strategic Objectives
1	Safety	Safety is a top priority because it has a direct impact on worker safety is a crucial factor in the mining industry because Zero Incident (main objective) not only maintains the company's reputation but also reduces the potential for additional costs due to work accidents. support operational continuity. Government regulations and international standards also place safety as a top priority in project decision-making.	100	1 (highest priority)	Operational Sustainability
2	Production Operational Stability	Operational stability of production is ranked second in priority, closely related to the achievement of production targets for operational stability, ensuring the smoothness of the production process so that the production target (54 MT) can be achieved optimally. Operational instability can result in downtime, decreased productivity, and increased operational costs.	90	2 (very important)	
3	Company Image	The third priority of corporate reputation is that it is very important to attract investors and maintain a competitive position in the market. Because success in the safety and stability aspects contributes directly to improving the company's image. Although important, it indirectly supports the sustainability of the project, the impact is more long-term than the safety and production operational stability aspects.	75	3 (important but lower than safety and stability)	Sustainable Reputation
4	Duration	Duration is more flexible than other factors and can often be negotiated or rearranged without major impacts on safety or operational stability but still affects efficiency. Project duration affects the speed at which a company achieves production targets.	70	4 (important but more flexible)	

After that, the 4 attributes must be normalized using the formula:

$$Normalized\ Weight = \frac{Original\ Weight}{Total\ Original\ Weigh}$$

Table 9. Weight Process

Attributes	Original Wights	Normalize Weight
Safety	100	0.30
Production Operational Stability	90	0.27
Company Image	75	0.22
Duration	70	0.21
Total	335	

Stage 6: Calculating the weighted average of the values assigned to each alternative

After obtaining the normalized weights for each attribute, the next step is to calculate the aggregate value of each alternative. The method is to multiply the normalized weight value by the initial value and then add up the results of the multiplication of the 4 attributes.

Table 10. Recapitulation of the weighted value aggregate.

Strategic Objectives	Operational Sustainability		Sustainable Reputation		Aggregate of Weighted Value
	Safety	Production Operational Stability	Company Image	Duration	
Option Alternatif Hauling Road	0.30	0.27	0.22	0.21	
Construct Phase #7b	29.85	26.87	16.57	6.27	79.55
Construct Phase #7	29.85	19.88	14.55	10.45	74.73
Construct Phase #4	2.99	6.72	5.60	20.90	36.19

SMART RESULT		
Rank	Alternatives	Weighted Value
1	Construct Phase #7b	79.55
2	Construct Phase #7	74.73
3	Construct Phase #4	36.19

Stage 7: Making a temporary decision

Construct Phase 7b has the lowest total investment cost (CAPEX) and maintenance cost (OPEX) and the largest benefit; the gold bubble for Construct Phase 7b is located on the far left on the X-axis, indicating an operating cost of 308 million USD and has the highest aggregate benefit value result of 79.55. With the same revenue, this lowest cost yields the greatest benefit, as indicated by its largest bubble size among the three. Construct Phase 7b is the best overall choice with the optimal combination of costs saving, cost, and additional benefits.

Table 11. Provision Total New Cost, Total Original Cost, Total Cos Saving and Aggregated Benefit

No	Option Alternatif Hauling Road	Total New Cost (USD, Mio)	Total Original Cost (USD, Mio)	Infrastructure Investment Costs CAPEX (USD, Mio)	Cost-saving Maint OPEX (USD, Mio)	Total Cost-saving = ((Cost-saving Maint OPEX-Cost CAPEX)) (USD, Mio)	Aggregated Benefit
1	Construct Phase 7b	292.	308.	6.03	21.53	15.50	79.55
2	Construct Phase 7	305.	314.	3.78	12.99	9.21	74.73
3	Construct Phase 4	323.	323.	-	-	-	36.19

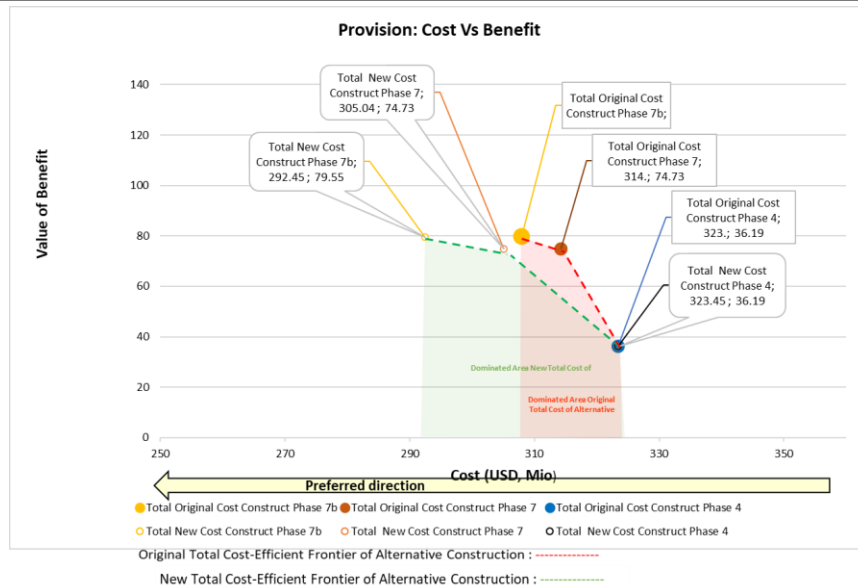


Figure 6. Provision: Cost vs. Benefit

Table12. Provisional Decision Total Original Cost VS Benefit

Provisional decision : Total Original Cost VS Benefit					
Option Alternatif Hauling Road	Construct Phase# 7b		Construct Phase# 7		
(Total Original Cost (USD, Mio)	\$ 307.948	79.55	\$ 314.242	74.73	
Construct Phase# 4	\$ 323.448	\$ 15.50	43.36	\$ 9.21	38.54
	36.19	0.36		0.24	
Construct Phase# 7	\$ 314.242	\$ 6.29	4.82	\$ -	-
	74.73	1.31		\$ -	

With this approach, decision-making is carried out to ensure cost efficiency while still considering the benefits obtained from each construction phase.

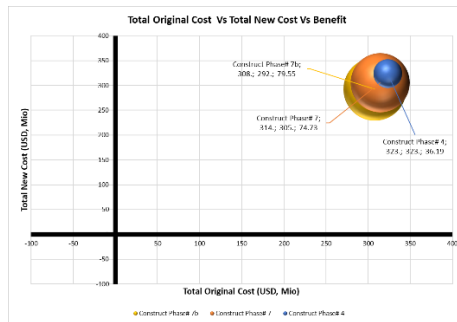


Figure 7. Provision: Total Original Cost , Total New Cost vs. Benefit

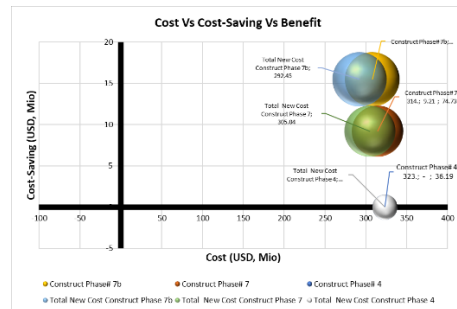


Figure 8. Provision: Cost vs. Costs-Saving vs. Benefits

Stage 8: Perform sensitivity analysis

The dotted vertical line labeled "Current Weight" shows the current or original weight of the combined criteria of safety, stability, and production operational efficiency. At this point, we can see the score of each option with the existing weight.

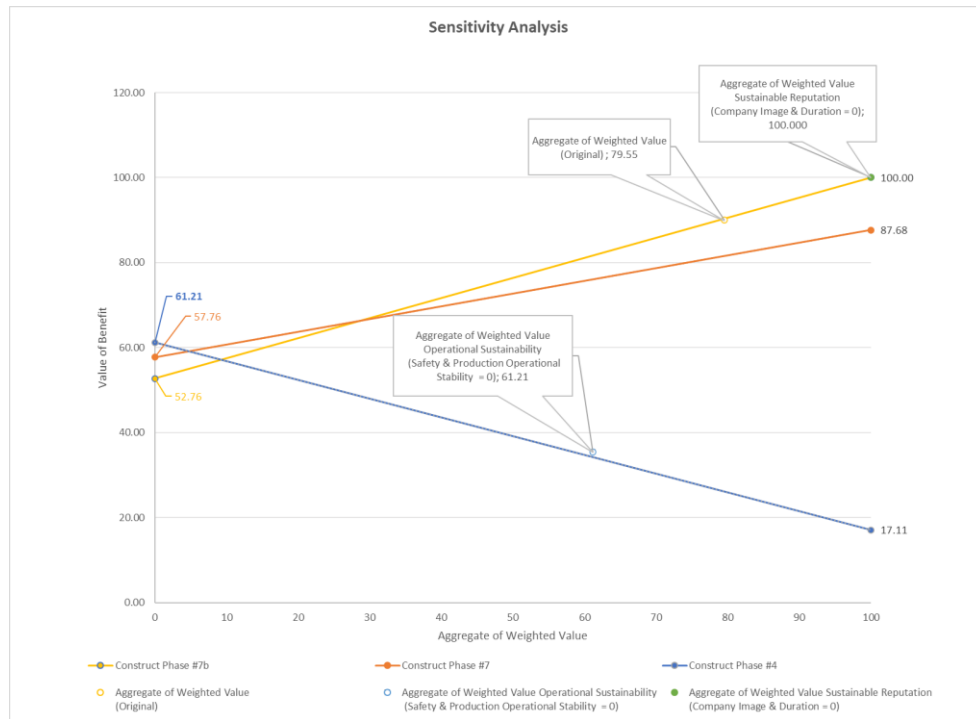


Figure 9. Graph of sensitivity analysis results

Tabel 13. Sensitivity analysis by giving variations in weight to each company benefit criterion in the sub-criteria.

No	Attributes	Aggregate of Weighted Value Operational Sustainability (Safety & Production Operational Stability = 0)	Aggregate of Weighted Value (Original)	Aggregate of Weighted Value Sustainable Reputation (Company Image & Duration = 0)
1	Construct Phase #7b	52.76	79.55	100.00
2	Construct Phase #7	57.76	74.73	87.68
3	Construct Phase #4	61.21	36.19	17.11

Construct Phase #7b has the highest score (around 79.55), followed by Construct Phase #7 with a score of 74.73, and finally Construct Phase #4 with a score of 36.19. This means that, based on the current weight, Construct Phase #7b is the best choice.

Potential Problem Analysis (PPA)

This Potential Problem Analysis (PPA) proactively identifies five major potential problems of the Construct Phase #7b project (weather, equipment, logistics, labor, and design), along with their impacts, causes, preventive measures, and contingency plans, with the aim of minimizing risks and ensuring smooth project progress (Guo et al., 2022; Ridlo & Ghiffari, 2022).

1. Extreme weather disturbances (floods) This problem is related to natural factors that are difficult to predict accurately. Prevention focuses on mitigating the impact of flooding through good Construct Phase #7b drainage and weather monitoring. Contingencies are prepared to minimize the impact of delays.

2. Construction equipment failure This problem is related to asset maintenance during Construct Phase #7b. Prevention focuses on regular maintenance. Contingencies are prepared to deal with sudden damage so that work does not stop.
3. Raw material logistics problems are related to the Construct Phase #7b supply chain. Prevention focuses on good communication with suppliers and inventory management. Contingencies are prepared to address delays or shortages of logistics supplies, such as base course or other supporting materials, by seeking other vendor options as Construct Phase #7b logistics suppliers.
4. Labor conflict is related to human resources. Prevention focuses on communication and problem solving if there are obstacles in operations or other non-technical obstacles during Construct Phase #7b. Contingencies are prepared to address labor shortages due to conflict.
5. Design error (design revision) with design planning and implementation always reviewed every progress of Construct Phase #7b. Prevention focuses on better verification and communication when monitoring the implementation of the design in the field on a daily, weekly, and monthly basis. Contingencies are prepared to minimize the impact of design revisions on schedule and costs during Construct Phase #7b.

Business Solution

Based on the SMART analysis applied in this study, PT Kusan Girimulya Wijaya, in its preparation efforts to achieve the target and increase production of 54 MT in the East Block Location, including the Kusan-Girimulya Mining Area, the attributes of safety, stability, and operational efficiency of production greatly affect the aggregate value of each alternative.

Then the assessment is carried out on alternative options based on the level of urgency and potential impact on the sustainability of the company PT Kusan Girimulya Wijaya to achieve the coal production target of 54 MT, three alternative options have been determined as described in the Identify the Alternatives Courses of Action Alternative sub-chapter.

Alternative Option Construct Phase #7b has the lowest cost of \$308 Mio among the three options and produces the highest benefit value of 79.55. And it has the highest cost savings of \$15.50 Mio compared to other choices, the combination of cost savings, low costs, and high benefits makes it the best choice.

Alternative Option Construct Phase #7 has a slightly higher cost than the Construct Phase 7b option of \$314 Mio and produces slightly lower benefits of 74.73. And has a cost savings of \$9.21 Mio Despite the cost savings, the higher cost and lower benefits compared to the construction phase #7b alternative place it in second place.

Based on this study, the results of this sensitivity analysis indicate that the best choice is highly dependent on the priority given to the safety criteria, the stability of production operations is the most important consideration, which is the company's strategic objective, which is called operational sustainability. Compared to corporate image and duration, which are the company's strategic objectives, which are called reputation sustainability. If safety and stability of

production operations, which is called operational sustainability, are very important, Construction Phase #7b is the best choice. If corporate image and duration, which is called reputation sustainability, are more important, Construction Phase #4 can be considered (although with significant trade-offs on safety and stability aspects). Construction Phase #7 offers a compromise between the two groups of criteria.

This analysis is very important to make the right and informed decision.

Implementation Plan

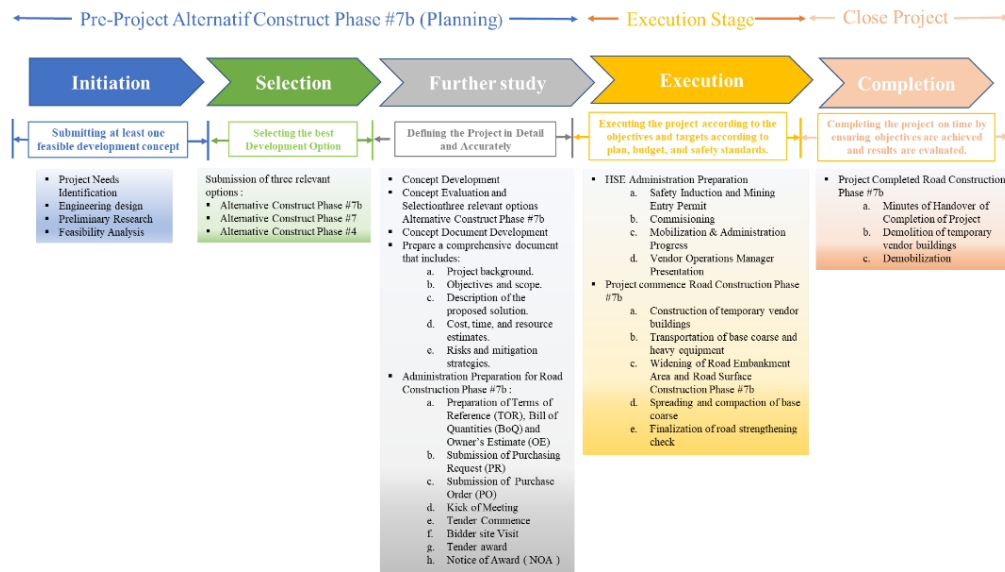


Figure 10. Investment Management Stage of the Company for the Alternative Construct Phase #7b

A structured approach to mine plan management, Alternative Construct Phase #7b, is proposed, which includes identifying annual, monthly, weekly, and daily project work plans. This will ensure that the company has clear guidelines for the implementation of the Alternative Construct Phase #7b mine plan. The implementation plan should also focus on monitoring and evaluating the Alternative Construct Phase #7b project mine plan to ensure compliance and effectiveness are running according to plan and on time.

CONCLUSION

PT Kusan Girimulya Wijaya, located in South Kalimantan, Indonesia, faced logistical challenges in supporting a significant production increase to 54 million tons, previously relying solely on Phase #4 road access for coal transport. With new disposal routes from KGU Pit to KGS Void involving 25 fleets and multiple crossing points, concerns emerged around safety, productivity decline, and unplanned Loss of Production Opportunity (LPO) due to incomplete supporting infrastructure. A focus group discussion using Kepner-Tregoe analysis identified root causes, followed by alternative solution evaluations through Value Focused Thinking (VFT) and

SMART analysis. Among three proposed options, Construct Phase #7b was selected as the most cost-efficient and beneficial, offering the lowest cost (\$308 Mio) and highest benefit value (79.55). The study underscores the importance of strategic mine plan management to avoid operational inefficiencies and productivity setbacks. Future research should assess the long-term sustainability and operational impact of Construct Phase #7b, including its effects on safety, environmental outcomes, and cost-efficiency. Further exploration of real-time monitoring and predictive maintenance technologies, as well as benchmarking against similar mining operations, is recommended to enhance mine transport system resilience.

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