DECISION MAKING ANALYSIS OF MAINTENANCE STRATEGY TO RESPOND CHF 6 AND CHF 7 OPERATIONS

Check for updates

[1*]Gito Wijaya, [2]Pri Hermawan

[1,2]*Master of Business Administration, School of Business and Management,*
  Institut Teknologi Bandung - Indonesia

e-mail:
[1*]gito_wijaya@sbm-itb.ac.id *(corresponding author)*
[2]prihermawan@sbm-itb.ac.id

ABSTRACT

PT Black Energy has infrastructure on both the mining side includes a total of 5 Coal Handling Facility (CHF) systems, and the unloading terminal side includes the Kertapati dock and the Tarahan port. To increase coal transport volume by 2026, adequate infrastructure development is needed by adding more CHF on the mining side and for the unloading terminal side, which will involve adding more unloading terminals. The maintenance department is tasked with maintaining the CHF system. Meanwhile, to carry out its maintenance activities on the existing CHF system, the maintenance department is currently facing an issue with a shortage of supervisors. The maintenance department must develop new strategy to optimize its performance in maintaining the existing 5 CHF systems while also preparing to accommodate the addition of CHF 6 & CHF 7 in 2026. This research was conducted using secondary data from maintenance department documentation studies and primary data through interviews with Subject Matter Expert. Value-Focused Thinking (VFT) method was used to identifying and describing values and objectives that are used as the foundation to generating alternatives and attributes for decision making process. Decision making to select the best alternative was conducted using Simple Multi Attribute Rating Technique (SMART) which will evaluate and compare alternatives with multiple attributes involved while each attribute represents a different aspect or criteria that matters in the decision. The research result show that CHF system focused maintenance model is the best alternative to respond additional CHF 6 & CHF 7 operations in 2026 where each Assistant Manager for mechanical and electrical maintenance division will be responsible for a specific CHF system. This research supports the maintenance department in solving the issue of manpower shortages that will inevitably occur in 2026.

Keywords: *Decison Making; Value-Focused Thinking (VFT);*
            Simple Multi Attribute Rating; Technique (SMART)

INTRODUCTION

One of the most important factors in the coal mining industry is the equipment or units used to transport the coal. There are several alternative methods available for material transportation, such as integrated belt conveyor system/Coal Handling Facility (CHF), trucks, train and pipelines according to the type of material and transportation location (Toha, 2002). CHF are typically custom-built to fit variables already explained before, consequently it is rare to find two material handling system that are alike (Toha, 2002). In the area where this research was conducted, three coal transportation methods are used: dump truck to transport coal from the coal mining pit to the entry point of CHF system, followed by a series of belt conveyors that carry the coal to Train Loading Station (TLS), which functions as the final unit of the CHF system. Once the coal is loaded into the coal transport train, the transportation process continues to the port area, where the coal is prepared for sale to customers.

PT Black Energy (company name are disguised to avoid leakage of sensitive data such as manpower information) has infrastructure on both the mining side and unloading terminal side to support a coal transportation target of 33.7 million ton per year by 2024 at the Yellow coal mine. The Company's mining side infrastructure includes a coal loading system known as the CHF (including TLS unit), with a total of 5 CHF systems and the unloading terminal infrastructure includes the Blue dock and the Red port. The company is striving to enhancing its own growth by increase coal transport volume from 33.7 million tons per year to 52 million tons per year by 2026. Therefore, adequate infrastructure development is needed as facilities and infrastructure to support the plan by adding more CHF system and unloading terminal. The Company has a contract to build two new CHF system, namely CHF 6 & CHF 7 in the Yellow coal mine.

Maintenance department is tasked to maintaining CHF system in Yellow coal mine area. The majority of maintenance work is carried out by maintenance groups led by a supervisor who holds an operational supervisor certification and technical competencies in line with their respective job descriptions. Therefore, supervisors play a crucial role in the continuity of maintenance activities within the company. Meanwhile to carry out its maintenance activities on the existing CHF system in Tanjung enim coal mine, the maintenance department is currently facing an issue with a shortage of supervisors. In the current situation, the maintenance department may still be able to perform maintenance work on all CHF system despite a shortage of supervisors. However, will it still be sustainable to maintain this maintenance approach when CHF 6 & CHF 7 begin operations in 2026? What strategy should maintenance department adopt to support the Company's target?

Table 1
Number of supervisor

Supervisor	Permanent	Retirement contract	N/A	Total
Mechanical maintenance	52	9	2	63
Electrical maintenance	58	0	2	60
Total	110	9	4	123

Source : PT Black Energy's maintenance department report, 2025

For mechanical maintenance division there are 11 vacant and temporary supervisor position in dark grey color, meanwhile for electrical maintenance division there are 2 vacant supervisor position also in dark grey color in Figure 1.
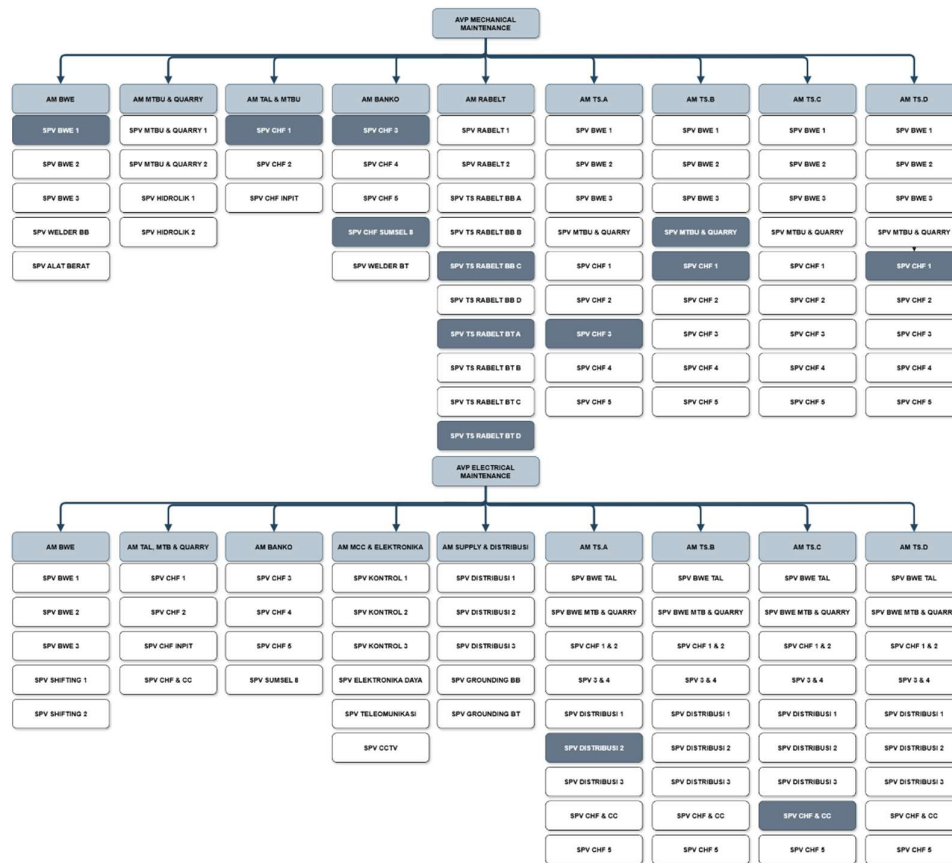
Source : PT Black Energy's maintenance department report, 2025

Figure 1
Supervisor organizational structure

Maintenance department need to consider some important aspect and condition regarding maintenance strategies to adopt in 2026. To ensure that the performance and availability of existing CHF and under construction CHF remain optimal, the maintenance department will require at least an additional 25 supervisors, another condition to consider is there are no promotion opportunities for employees below the supervisor position. In carrying out a research within the company, author will involve top management of maintenance department in further data collection sources and data analysis phase. Top management of maintenance department consist of four position which have the authority to change maintenance department.

LITERATURE REVIEW
Maintenance Management
According to Saputra, et al. (2023), there are significant factors that must be considered while designing the maintenance organization, namely centralization versus decentralization, and internal versus external maintenance (third party). In this research regarding the maintenance department, this transformation involves structuring the organization (maintenance department) by clearly defining the roles and responsibilities of both division and maintenance groups to ensure an effective and efficient maintenance strategy (Chao et al, 2021).

The maintenance strategy must be optimized for a cost-effective scheme, and Reliability Centered Maintenance (RCM) approach provides that solution (Afefy, 2010). The most suitable key function of RCM to be adopted are customized maintenance approach which allow the maintenance department to implement condition-based maintenance job for critical condition and resource allocation for manpower, tools and budget to the areas where they are most needed.

Multi Criteria Decision Making Methods
There are three categories on Multi Criteria Decision Making (MCDM) methods, whose purpose is to bring the MCDM methods together according to some similarities, namely multiple attribute theory, outranking methods and interactive methods (Roy, 1996). Roy (1996) classifies them as follows: unique synthesis criterion approach, outranking synthesis approach and interactive local judgment approach, which is trial-error iterations.

Simple Multi-Attribute Rating Technique
The Simple Multi-Attribute Rating Technique (SMART) is widely used in the field of Multi Criteria Decision Making (MCDM) due to its simplicity (Patel, 2017). One of SMART's strengths is straightforward process, the transparency of the process also supports clear communication with stakeholders, which is valuable in organizational settings (Risawandi, 2017). Goodwin & Wright (2014) stated the central idea of SMART was by splitting the problem into small parts and focusing on each part separately, the decision maker was likely to acquire a better understanding of his or her problem than would have been achieved by taking holistic view. By dividing the problem into small parts and allowing the decision maker to focus on each small part separately, this research aim to simplify his or her judgmental task (Goodwin, 2014).

Value-Focused Thinking
As Keeney (1982) stated, Decision analysis will not solve a decision problem, nor is it intended to. Its purpose is to produce insight and promote creativity to help decision makers make better decisions. Compared to Alternative-Focused Thinking (AFT), Value-Focused Thinking (VFT) offers significant advantages in generating solution alternatives and uncovering decision opportunities. AFT often risks limiting the achievement of fundamental objectives, as decision-makers may concentrate too heavily on evaluating existing alternatives (Keeney, 1992). In contrast, VFT begins with the identification of fundamental objectives, guided directly by underlying values, ensuring that the decision-making process remains aligned with what truly matters (Ramirez, 2020).

Method
This section will explain about the research design, as stated in business issue the maintenance department is currently facing a shortage of supervisors. Author structuring research objective and conceptual framework as a part of literature review created based on initial company information and previously theories collected. Before analysis stage, author need to collect primary and secondary data using qualitative method. Secondary data will be collected from maintenance supervisor job description document, maintenance third-party work agreement contract and maintenance department Key Performance Indicators (KPI) which will be used as one of consideration on designing interview question, while primary data will be extracted from interview session with top management of maintenance department using value-focused thinking method.

Interview with VFT method will identifying and describing values as well as objectives that are used as the foundation to generating alternatives and attributes for decision making process. By considering fundamental objectives and mean objectives, decision makers can make decision based on appropriate attributes and alternatives. Decision making to select the best alternative would be conducted using SMART which will evaluate and compare alternatives with multiple attributes involved represents a different criteria that matters in the decision. After identifying the numerical value that represents the level each attribute for certain alternative, author will aggregate these values to determine the overall score for every alternative.

The alternative that has the highest score with good sensitivity analysis will be selected to become business solution and proposed to Top management of maintenance department as our respond for two new CHF system addition in 2026, furthermore author will continue to create implementation plan to finish this research.
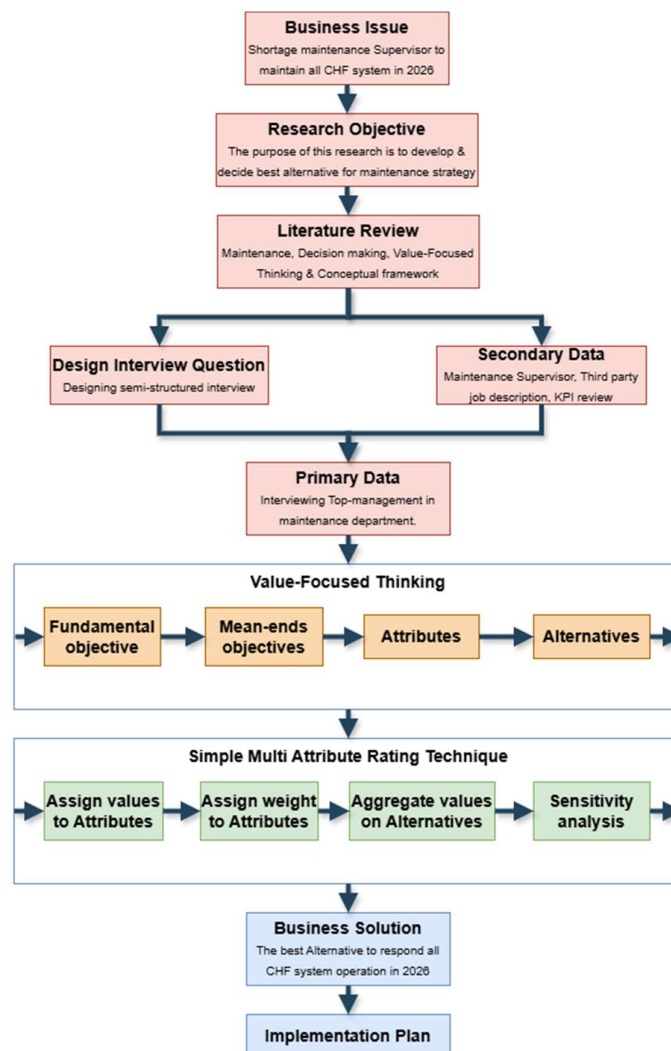
Source : Constructed by authors, 2025

Figure 2
Research Design

Table 2
Subject Matter Expert (SME) profile

No.	Subject Matter Expert	Work Exp (Year)	Responsibility	Subordinate
1	Vice President Maintenance	33	Managing strategic planning and coordinate all maintenance activities in UPTE	754
2	AVP Maintenance Planning	16	Managing and coordinate all maintenance planning & project activities in UPTE	84
3	AVP Mechanical Maintenance	30	Managing and coordinate all mechanical maintenance & project activities in UPTE	394
4	AVP Electrical Maintenance	16	Managing and coordinate all electrical maintenance & project activities in UPTE	276

Source : PT Black Energy's maintenance department report, 2025

The interview results from four SME will be converting into written text then analyzed it using VFT to identifying objectives, structuring objectives then generating atributes and alternatives. The attributes and alternatives generated using the VFT method will be followed by a verification process conducted by the author. This includes cross-checking the accuracy and validity of the data or statement provided by the SME, assessing the reliability of the data, such as identifying any contradictions in the responses given by the SME and ensuring that their responses align with the company's objectives. The results of this verification process will be reported back to Maintenance department Top-management, who in the next step will become the decision makers.

When the verification results of the Attribute and Alternatives show positive outcomes, author can proceed to the next step using the SMART. Author will begin decision making step directly from stage 4. measure the performance of the alternatives on that attribute.

RESULTS AND DISCUSSION
Identify attributes
The interview session consists of 10 questions, starting with experience-sharing questions and progressing to specific questions for the decision-making process. Each SME generate a different number and type of attributes, which can be seen in Table 3.

Table 3
List of Attribute from SME interview

No	Attribute-SME1	Attribute-SME2	Attribute-SME3	Attribute-SME4
1	Job quality control	Job quality control	Job quality control	Job quality control
2	Strategy sustainability	Manpower competency	Strategy sustainability	Manpower competency
3	Manpower competency	Flexibility	Manpower competency	Reporting aspect
4	Reporting aspect	Productivity	Reporting aspect	Flexibility
5	Flexibility	Communication chain	Flexibility	Productivity
6	Productivity	Optimization	Productivity	Optimization
7	Communication chain	Responsive	Optimization	Operational cost
8	Optimization	Operational cost	Operational cost	Added value
9	Responsive		Meritocracy	Work order release
10	Focus		Knowledge dev	
11	Safety aspect		Added value	
12	Operational cost			

Source : PT Black Energy's maintenance department report, 2025

After completing the confirmation of the attribute findings with each Subject Matter Expert separately and concluding with the VP maintenance department, author presents the list of attribute from all AVP maintenance to VP maintenance department for further analysis on which attributes will be used in the decision making process. The transformation of attributes from generated by Subject Matter Expert based on interview analysis and approved by Subject Matter Expert can be seen in Value Tree in figure 3.
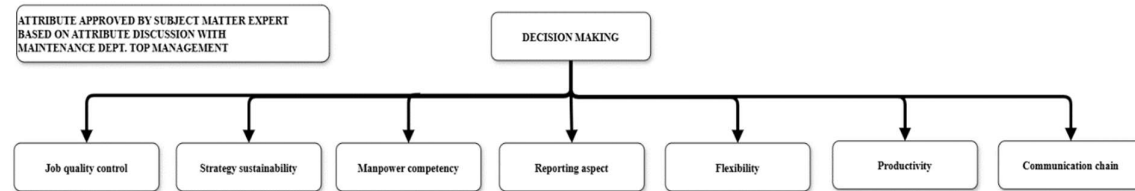
Source : PT Black Energy's maintenance department analysis, 2025

Figure 3
Value Tree

The measurement of value for each attributes will be using direct rating method from four Top-management of maintenance department as decision makers. Direct rating is used because the attributes are an abstract value which need expert judgment to determine how well those attributes perform on selected alternative. The way to measure the attributes value will be explained in the SMART analysis session.

Table 4
Attributes description

No.	Attribute	Description
1	Job quality control	The process of inspecting the quality of maintenance work and the team's compliance with SOP values and Golden Rules guidance (K3).
2	Strategy sustainability	The flexibility level of an alternative in adapting to operational changes in CHF and maintenance department resources in the future.
3	Manpower competency	The team's technical understanding without guidance from superiors, both in the field and during discussions, as well as their ability to provide accurate solutions when facing operational issues/breakdown.
4	Reporting aspect	The completeness, accuracy, and accessibility of the work reports created, as well as on-time submission commitment of requested reports.
5	Flexibility	The team's willingness to work outside their main job desk and assist or collaborate with other teams, as well as their ability to adapt to schedule changes.
6	Productivity	The team's commitment to completing assigned maintenance Work Orders (WO), including the team's speed and effectiveness, as well as the frequency of idle time that may occur when no WO is available.
7	Communication chain	The smoothness and speed of the communication process of an alternative with internal and external stakeholders of the maintenance department.

Source : PT Black Energy's maintenance department analysis, 2025

Identify alternatives
Based on interview results with SME, there are two possible alternatives that could be implemented to respond all CHF system operation (including CHF 6 & CHF 7) in 2026. The Figure 4 and Figure 5 are detailed explanation of each alternative:
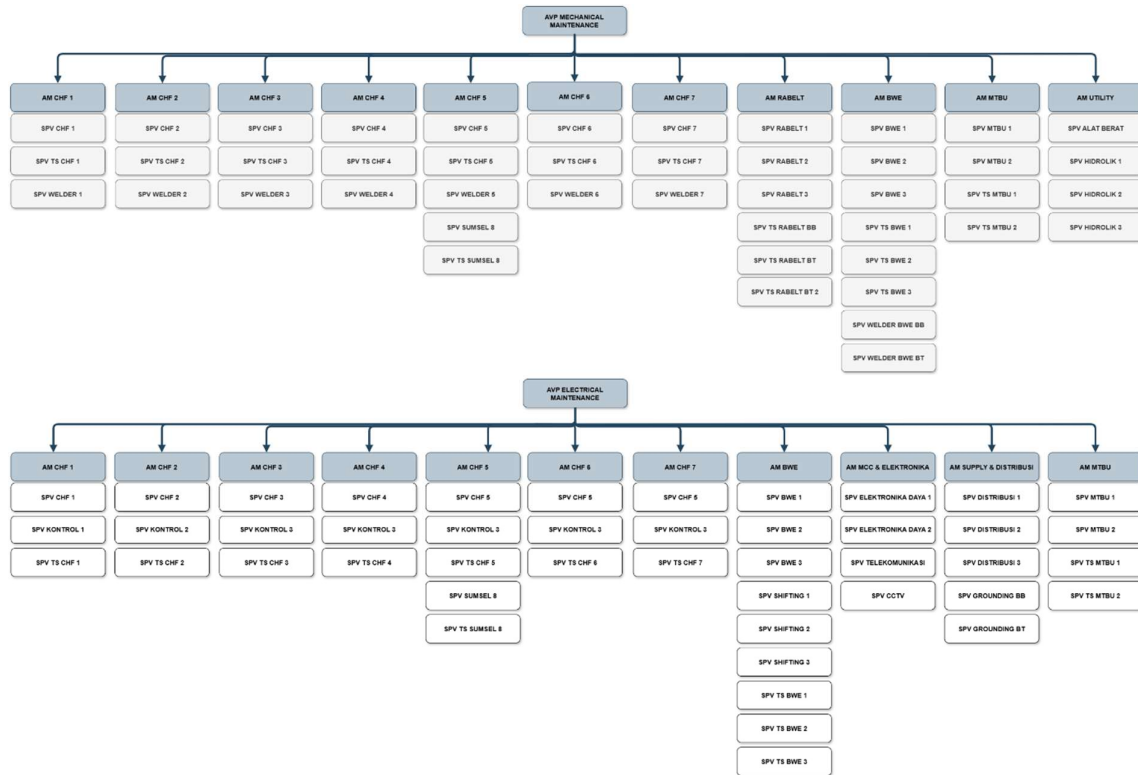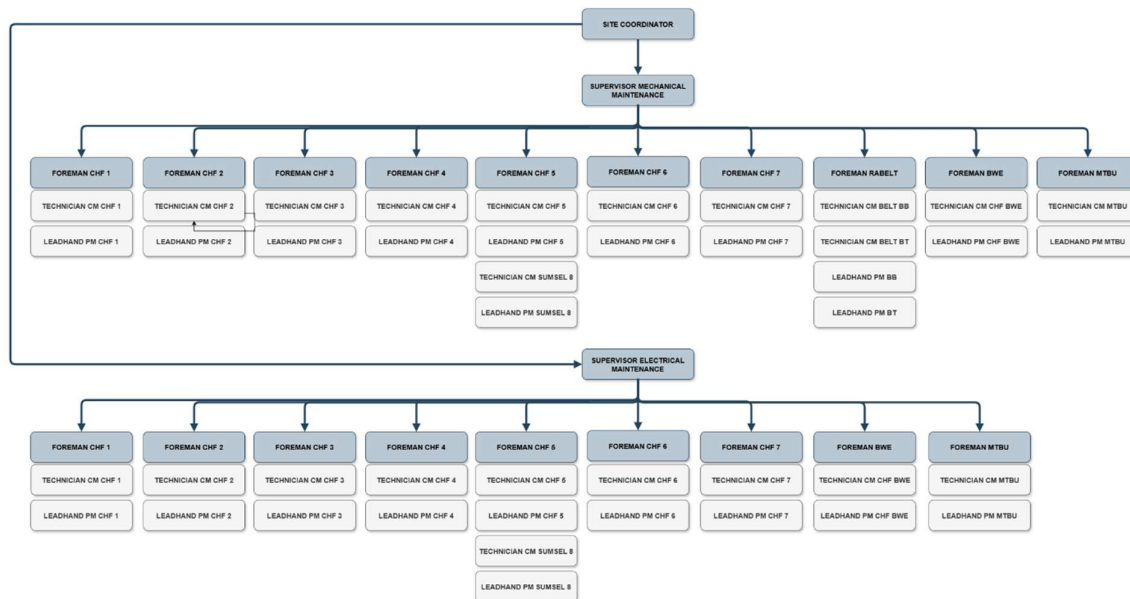
Source : PT Black Energy's maintenance department analysis, 2025

Figure 4
CHF system focused alternative

This alternative emphasizes a focused maintenance approach, where each Assistant Manager for mechanical and electrical maintenance will be responsible for a specific CHF system. The priority for Assistant Manager (AM) positions will be assigned to CHF systems, while a limited number of Assistant Managers will continue handling support and utility maintenance tasks. To manage the need for supervisors in the maintenance department, the supervisor troubleshoot position in this alternative will transition into a troubleshoot evaluator role, allowing them to conduct full-day monitoring without working in a shift system. This alternative requires only one supervisor for troubleshoot tasks, effectively reducing the number of supervisors by three compared to the current maintenance structure for every CHF systems, 90 Man-power requirement (supervisor).

To support the focused maintenance work on each CHF, supervisors who have been working in a centralized support role will be reassigned to each CHF such as Welder (mechanical) & Control (electrical). As a replacement for the troubleshoot supervisor, each troubleshoot team working in shifts will be led by a Leader who holds a general K3 certification after undergoing an assessment process by the maintenance department and the respective outsourcing company.

Source : PT Black Energy's maintenance department analysis, 2025

Figure 5
Third party maintenance service alternative

This alternative excels in optimizing manpower management, as its scope follows the previous alternative (where the maintenance team is assigned to and responsible for each CHF system), but all maintenance tasks will be carried out by a third-party maintenance service team. To manage the need for supervisors in the maintenance department, the roles of supervisors planned maintenance and supervisors troubleshoot will transition into corrective maintenance evaluators and preventive maintenance evaluators, focusing on monitoring and evaluating the work performed by the third-party maintenance service team. The total number of supervisors required for all maintenance tasks on this alternative is only two, effectively reducing four-five supervisor positions compared to the current maintenance structure, 57 man-power requirement (supervisor).

The third-party maintenance service work structure consists of a Site Coordinator responsible for operations, Supervisors overseeing mechanical and electrical work, Foremen coordinating tasks for each CHF system, and Leadhands supervising work during each shift. The third-party maintenance service will handle all maintenance tasks except those related to the mining system (MCC), CFPP (Power distribution), and utilities tasks (Mechanical support).

SMART Analysis
In this session, author will explain how the SMART method can be used to support decision makers to decide the best alternative that already discussed before. SMART method consists of eight stages, with the first three stages already presented in the previous session, these include stage 1 "Identify the decision makers", followed by stage 2 "Identify the alternatives" and stage 3 "Identify the attributes". Stage 4 "Measure the performance of alternatives" which outline how Top management of maintenance department as decision makers assign a rating to each alternative based on its performance value on each attributes in Table 5.

Table 5
Measure the performance of Alternatives

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Productivity Average
CHF system focused maintenance	70	80	80	90	80
Third party maintenance service	90	90	70	80	82,5

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Flexibility Average
CHF system focused maintenance	90	80	90	90	87,5
Third party maintenance service	60	60	60	60	60

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Manpower competency Average
CHF system focused maintenance	90	90	90	90	90
Third party maintenance service	70	60	60	70	65

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Job quality control Average
CHF system focused maintenance	70	60	80	90	75
Third party maintenance service	80	90	70	80	80

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Strategy sustainability Average
CHF system focused maintenance	80	70	80	70	75
Third party maintenance service	90	80	70	80	80

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Communication chain Average
CHF system focused maintenance	90	90	80	90	87,5
Third party maintenance service	60	80	60	70	67,5

Decision makers / Alternatives	SME1	SME2	SME3	SME4	Job monitoring Average
CHF system focused maintenance	60	70	70	80	70
Third party maintenance service	80	80	80	70	77,5

Source : PT Black Energy's maintenance department analysis, 2025

The next step in SMART method is stage 5. Determine a weight for each attribute. Author asked the decision makers to determine weight of the seven approved attributes had the greatest impact on the maintenance department alternatives decision.

Table 6
Weighted attribute

Decision makers / Attributes	VP	AVP MP	AVP MM	AVP EM	Average Weight	Normalized Weight
Productivity (P)	90	80	90	80	85	0,17
Flexibility (F)	50	40	80	90	65	0,13
Manpower competency (MC)	100	100	100	100	100	0,20
Job quality control (JQ)	60	90	70	70	72,5	0,15
Strategy sustainability (SS)	40	60	40	50	47,5	0,10
Communication chain (CC)	70	70	60	40	60	0,12
Job monitoring (JM)	80	50	50	60	60	0,12
				Total	490	1

Source : PT Black Energy's maintenance department analysis, 2025

The next step in SMART method is Stage 6. Take a weighted average of the values. The aggregate value for each alternatives was calculated using an average weight value of attributes rating for Productivity, Flexibility, Manpower competency, Job quality control, Strategy sustainability, Communication chain and Job monitoring. Normalized weight which add up to aggregate value, indicate the impact level of each attributes in the overall decision-making process.

Table 7
Aggregate value for each alternative

| Attributes / Alternatives	P (0,17)	F (0,13)	MC (0,20)	JQ (0,15)	SS (0,10)	CC (0,12)	JM (0,12)	Aggregate weighted value
CHF system focused maintenance	13,88	11,61	18,37	11,10	7,27	10,71	8,57	81,51
Third party maintenance service	14,31	7,96	13,27	11,84	7,76	8,27	9,49	72,88

Source : PT Black Energy's maintenance department analysis, 2025

Based on Aggregate value for each alternative, CHF system focused maintenance alternative has the highest value of 81,51 showing a significant gap compared to Third party maintenance service alternative which valued 72,88. The analysis of SMART process reveals that CHF system focused maintenance alternative performs better in Flexibility, Manpower competency, Communication chain attributes with significant value gap of approximately 2,45 – 5,10 value point, while Third party maintenance service alternative performs better in more attributes (four) such as Productivity, Job quality control, Strategy sustainability and Job monitoring but only with a small value gap of 0,43 – 0,92, which still not enough to surpass the overall value of the other alternative.

Business Solution

Provisional decision is intended to give decision makers the opportunity to re-evaluate the overall value of each alternative by comparing the main attribute such as cost, benefit and others as a basis for consideration using comparison graph and comparison table. Stage 7 usually done because decision-makers find it difficult to assess main attribute equally, however in this research author together with Top management of maintenance department has conducted an analysis and eliminated attributes that were considered to potentially cause confusion during decision making process. Therefore, due to this research conducted a direct rating of same level seven agreed attributes (without main attribute) and considering that only uses two possible alternatives, this Stage 7 will follow the result from SMART Stage 6, which concludes that CHF system focused maintenance is the best alternative for Maintenance department to respond operational changes in 2026.

The last step in SMART method is Stage 8. Perform sensitivity analysis to assess the robustness of the chosen alternative. In this stage, the weight of each attributes will be changed into zero (0) then the aggregate value will be re-calculated to evaluate the stability of two possible alternatives when the impact level of particular attribute is changed.
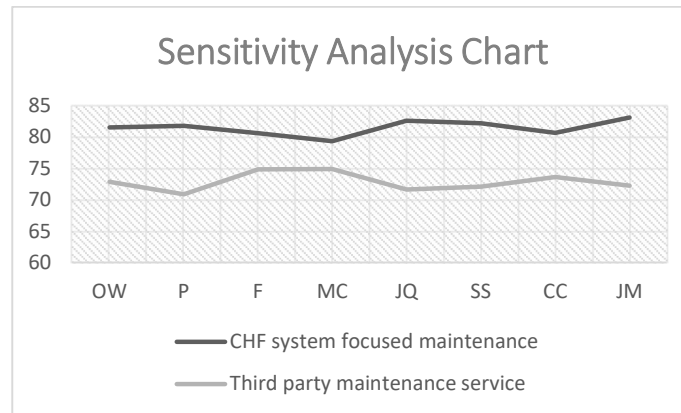
Source : PT Black Energy's maintenance department analysis, 2025

Figure 6
Sensitivity analysis on each attributes

Sensitivity analysis shows how the aggregate value of both alternatives with changes in the sensitivity of each attribute when the weight of a particular attribute is set to zero (0). However, despite all the fluctuations that occurred during the sensitivity analysis across the seven (7) attributes, the final results consistently indicate that the CHF system focused maintenance remains the best alternative same as the Original Weight (OW).

Based on SMART analysis, particularly the aggregate weighted value, CHF system focused maintenance is the best alternative for Maintenance department to respond operational changes in 2026. This decision is further reinforced by the sensitivity analysis which also shows the same result.

CONCLUSION AND SUGGESTION

At the end of this research, author will present the that the alternative for Maintenance department to respond CHF 6 and CHF 7 operations in 2026 namely CHF system focused maintenance and Third party maintenance service. The attribute for Maintenance department to respond CHF 6 and CHF 7 operations in 2026 namely Productivity, Flexibility, Manpower competency, Job quality control, Strategy sustainability, Communication chain and Job monitoring.

The best alternative for Maintenance department to perform maintenance task on the entire CHF system in 2026 is CHF system focused maintenance. This alternative emphasizes a focused maintenance approach, where each Assistant Manager for mechanical and electrical maintenance will be responsible for a specific CHF system. The priority for Assistant Manager positions will be assigned to CHF systems, while a limited number of Assistant Managers will continue handling support and utility maintenance tasks. To manage the need for supervisors in the maintenance department, the supervisor troubleshoot position in this alternative will transition into a troubleshoot evaluator role, allowing them to conduct full-day monitoring without working in a shift system. This alternative requires only one supervisor for troubleshoot tasks, effectively reducing the number of supervisors by three compared to the current maintenance structure for every CHF system.

REFERENCES

Afefy, I. H. (2010). Reliability-Centered Maintenance Methodology and Application: A Case Study. http://dx.doi.org/10.4236/eng.2010.211109

Cao, X. G., Zhang, M. Y., Gong, Y. R., Jia, X. L., & Zhang, R. Y. (2021). Maintenance decision method considering inspection of mining.

Goodwin, P, & Wright, G. (2014). *Decision Analysis for Management Judgment, Fifth Edition.*

Keeney, R. L. (1982). *Decision Analysis: An Overview.*

Keeney, R. L. (1992). *Value Focused Thinking: A Path to Creative Decisionmaking.*

Patel, M. R., Vashi, M. P., & Bhatt, B. V. (2017). SMART-Multi-criteria decision-making technique for use in planning activities. https://www.researchgate.net/publication/315825133_SMART-Multi-criteria_decision-making_technique_for_use_in_planning_activities

Ramirez, L., & Veronica, E. (2020). Structuring and creating alternatives for eggplant loss problem using the value-focused thinking methodology. https://doi.org/10.19053/01211048.11208

Risawandi, & Rahim, R. (2017). Study of the Simple Multi-Attribute Rating Technique for Decision Support. https://doi.org/10.31227/osf.io/xnhtj

Roy, B. (1996). *Multicriteria Methodologi for Decision Aiding.*

Saputra, R., Yudoko, G., & Firman, A. F. (2023). Proposed Strategy of Heavy Equipment Overhaul: Case Study of a Coal Mining Contractor in Indonesia. https://doi.org/10.24018/ejbmr.2023.8.4.2014

Toha, J. (2002). Perancangan, pemasangan & perawatan Konveyor sabuk dan Peralatan pendukung.