

Decision Making to Improve Reliability Water Injection Pumps at PH Gathering Station at PT.ABC

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Abstract - XYZ is a global energy company with substantial business activities in the more than 25 countries. The company's objective is to deliver higher returns, lower carbon, environment compliance and superior shareholder value in any business environment. PT.ABC, as XYZ subsidiary in Indonesia, always make improvements and find the best solution in every disruption in its operation as well as in facing challenges to overcome issue of water injection pump's reliability that led to Loss Production Opportunity. Prompt and precise decisions must be conveyed immediately considering that all facilities managed by PT.ABC will be handed over to the next operator in near time. By Kepner Tregoe tool's situation and problem analysis is performed and found that the root cause is the vibration. 4 alternatives have been put forward as solutions and quick decisions must be taken to ensure the facility can be operated in compliance with EPS. Through Multiple Criteria Decision-Making SMART analysis, Pipe Stress Analysis and Stiffness Improvement is chosen as the best current solution.

Keywords - decision making; Kepner Tregoe; Reliability; SMART; quick decision

I. INTRODUCTION

For more than 140 years, XYZ has strived to earn a distinguished track record for operating with integrity and for holding ourselves accountable to the high expectations of their global stakeholders. XYZ take this responsibility seriously and are proud of our role in delivering the affordable, reliable, ever-cleaner energy that is vital to human progress. Deliver energy without harm to environmental is one of XYZ Value to protect people and the environment, as strategy and sustainability to deliver energy.

XYZ has specific standards in managing the environment, called the Environmental Performance Standard (EPS). This EPS applies to all upstream XYZ businesses and projects, as a guidance for standardization and practice. One of the operating activities that is align with Environmental Stewardship is producing or lifting oil with zero water discharged/disposal (ZEWADI).

XYZ through the Indo-Asia Business Unit which manages upstream business in the Southeast Asia region, especially in the Indonesian region and this can be tracked since 1924, through by it's subsidiary, PT. ABC which is part of Upstream & Gas (U&G) in efforts to maintain the environment in the Upstream and Gas (U&G) business has set a program Zero Water Disposal/Discharge

(ZEWADI) in the Sumatera Operations (SMO) for their operation to lifting oil and gas while comply with U&G's EPS initiative to eliminate surface water discharge worldwide. This will exceed what is required by current GOI regulation but should ensure compliance with any potential future Government of Indonesia (GOI) regulations regarding produced water disposal through end of contract.

This research conducted at PH Gathering Station (GS) that acknowledged as the facility that adhere to the ZEWADI program where the produced water must be reinjected into the injection wells by Water Injection Pumps (WIP) after the water and oil separation process has been carried out, as noted that Petapahan oil field, lifted the oil followed by high produced water. However, over time the reliability and availability of water injection pumps at PH GS decreased. Inspections carried out showed increased vibrations in several pump units. In addition, the pump failure occurred several times due to water surges. When more than 1 pump unit failure to operate (out of service), either due to planned repairs or unplanned shutdown, the opportunity to lose production (Loss Production Opportunity / LPO) occurs. Based on historical data, there have been several incidents where more than 1 unit of the water injection pump has shut down and has created an opportunity to lose production. It is showed at the figure below.

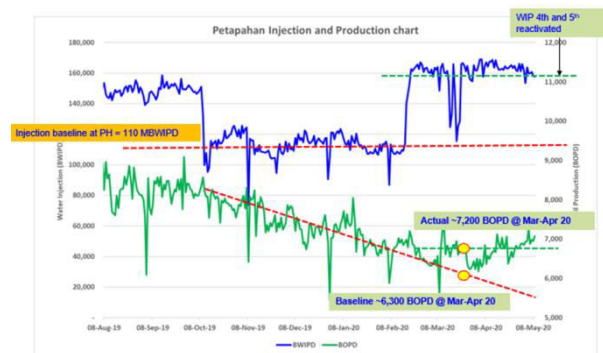


Fig. 1. Petapahan Injection and Production Chart

Therefore, the reliability of Water Inject Pumps (WIP) facility is very important to sustain the operation in order to achieve oil production targets. This research will find out the best solution to the WIP reliability problems that occur at the PH Gathering Station.

II. METHODOLOGY

Considering the expiration of the Rokan Block Product Sharing Contract (PSC) which managed by PT. ABC is near, it requires a simple, easy and fast decision-making method to manage the various attributes that are used as factors in making decisions analysis. Kepner Tregoe (KT) is using for Situation Analysis and Problem Analysis, then finding the root of the problem based on the facts.^[3] Selection alternatives were analyzed by using the Simple Multi Attribute Rating Technique (SMART). Analysis and application of the Kepner Tregoe (KT) and SMART methods will be carried out with focused group discussions consisting of various disciplines and experts in their discipline (Subject Matter Expert/SME).

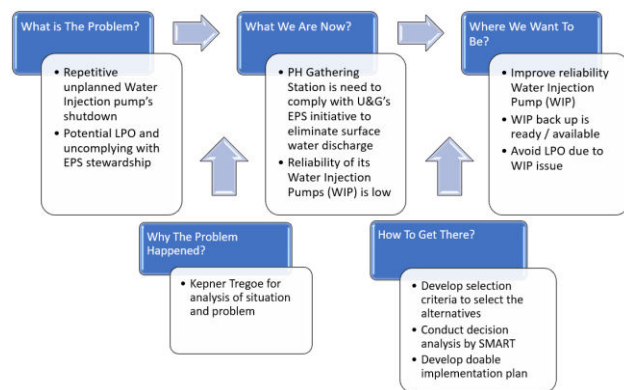


Fig. 2. Conceptual Framework

The Situation Appraisal and Problem Analysis of Kepner Tregoe have conducted to determine the root cause.

The current situation and problems analysis will be completed by utilize Rational Management methodology of Kepner-Tregoe (KT), which will provide the lead situation analysis to define the root cause.^[2] Process for decision making will be exercised by Simple Multiple Attribute Rating Technique (SMART) process, there are eight (8) stages that must be done to find and ensure the selected alternative as a problem solving.

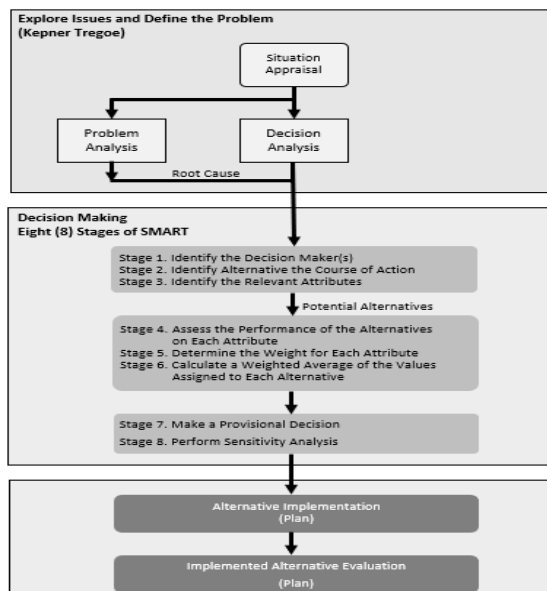


Fig. 3. Methodology Flowchart

TABLE 1
KT - SITUATION APPRAISAL OF WATER INJECTION PUMPS

Situations/Problem	Timing (H/M/L)	Trend (H/M/L)	Impact (H/M/L)	Process (PA/DA/PPA)
Reliability issues on WIP which impacted to LPO	H	H	H	PA
Dispose produced water to the environment	H	M	M	PA
Reducing the flow or production to adjust the availability of WIP at PH Gathering Station	M	M	H	PA

It is important to exercise Problem Analysis begins with defining the problem, it has to be cleared object. The statement of the problem is "Reliability issues on Water Injection Pump at PH Gathering Station (GS) which lead to ZEWADI not achieved and impacted to LPO". The Problem Analysis (PA) is conducted to define the problem described on the following table 2,

TABLE 2
KT - PROBLEM ANALYSIS OF WATER INJECTION PUMP AT PH GATHERING STATION

DESCRIBE THE PROBLEM: "Reliability issues on Water Injection Pump at PH Gathering Station which lead to ZEWADI not achieved and impacted to LPO"				
	Specifying Question	IS	IS NOT	What is Distinctive About
Identity	WHAT is the problem	Unplanned shutdown on WIP due to Lack stiffness of pumps skid (vibration issue) and pipe stress	Other WIP malfunction such electrical, control system issue	Vibration issue lead to multiple impact to pump's mechanical parts
	WHAT is the impact of the problem	Shut off oil wells to mitigate excessive produced water to comply with ZEWADI	Other mitigation to meet ZEWADI	
LOCATION	WHERE is the WIP's problem occur	IS observed at PH Gathering Station	IS NOT observed at other Gathering Station	PH Gathering Station is declared and comply to ZEWADI
WHEN	WHEN was the WIP's problems occurred	IS first observed in 2018 & 2019	Could be but IS NOT reported before Q2 2018	Comprehensive reporting, recording and study of repetitive operational disruptions was started on 2018.
HOW MUCH	HOW MUCH LPO	IS Led to Loss Production Opportunity (LPO) more than 5000 BOPD	NA	NA
	TREND	Increasing	NA	NA
POSSIBLE CAUSES:			THE MOST POSSIBLE CAUSE:	
1. Low reliability of Water Injection Pump due to multiple failure of equipment			Pump System lack of stiffness which led to vibration issue	
2. Pump System lack of stiffness which led to vibration issue				
3. The equipment and facilities have lack of maintenance				

Based on Kepner Tregoe Problem Analysis (PA) can be concluded that the root cause of top event Reliability issues on Water Injection Pump at PH Gathering Station which lead to ZEWADI not achieved and leads to incompliance of EPS is Pump System lack of stiffness which led to vibration issue.

The next step is conducting decision analysis by utilize Simple Multi Attribute Rating Technique (SMART). SMART is a multi-criteria decision method. This multi criteria decision-making technique was created based on the theory that each alternative consists of several criteria accompanied by a value and each criterion has a weight indicating how important it is compared to other criteria. This weighting is required in the process of evaluating each alternative to get the best choice. SMART is a linear additive model to predict the value of each option. The SMART method is known due to its simplicity in responding to the requisites of decision makers, how to respond to it and the speed in determining the decisions to be taken.^[1]

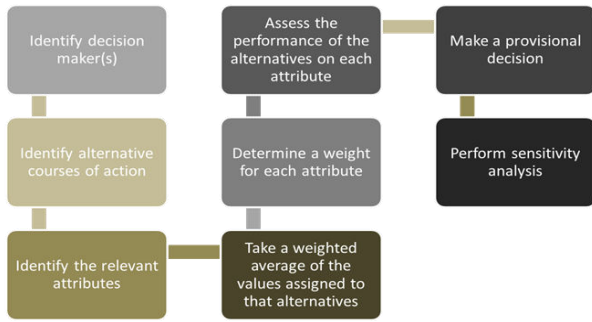


Fig. 4. SMART Process Flow Chart

The issue regarding WIP occurs PH GS, which is organizationally located at Plant Operation South. So that the Decision Executive (DE) is the highest leader within the organization that impacted, that is Manager of Plant Operation South. DE will be assisted by the Decision Review Board (DRB) to provide input to the DE regarding the proposed alternative.



Fig. 5. Decision Makers of Reliability Improvement WIPs

The alternatives proposed for solving the WIP problem in PH GS are developed through a Focused Group Discussion (FGD) which consists of the experts in their expertise, such Reliability & Rotating Engineer, Operation Representative and Maintenance Representative. The alternatives are

- 1) Fabricate and replace pumps skid by manufacture.
 This alternative will replace the pump's skid of WIPs with the new ones. The estimate project's cost is USD 735M, the timeline for construction and put in service will take up to 18 months.
- 2) Pipe Stress Analysis (PSA) and stiffness improvement WIPs.
 Pipe stress analysis indicated that any modification performed within reasonable piping routing resulted no reduction to piping load imposed to WIP pump nozzles. Knowing that any simulated piping modification did not reduce the piping loads, it was decided that efforts should be directed to increase pump structure rigidity. The estimate project's cost is

USD 300M, the schedule for construction and put in service will take up to 3 months.

- 3) Relocate idle Water Injection Pump from another GS.
 This alternative will relocate idle WIP from other GS and then to be installed at PH GS as new additional WIP. Idle WIP in other GS has an operating system that is similar to the WIP in PH GS. The estimate project's cost is USD 350M, the schedule for construction and put in service will take up to 5 months.
- 4) Rental Water Injection Pump.
 This alternative will begin by develop contract for Rental WIP which include operation and maintenance, the company will use rental service for WIP operation complete with operation and maintenance. The total schedule required for this alternative to be completed until Put In Service (PIS) is more than 18 months to replace existing WIP with the rental units, the contract value will almost USD 1 million.

The key in determining attributes in this study is to be the most important thing in the alternative determination stage. business solutions that will be studied will be explored deeper by reconstructed value trees as divided the attributes into two categories, the Cost and the Benefits which will then be followed by the sub-category below

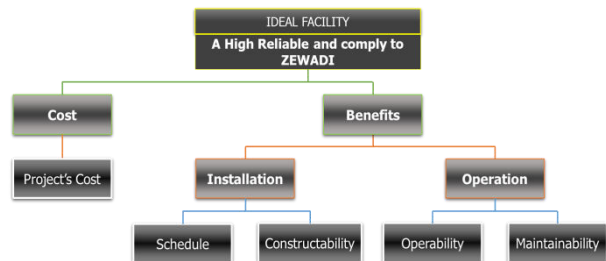


Fig. 6. Value Tree of Attributes for Decision Criteria

Considering end of contract (EOC) of Rokan Block, attribute schedule is the most important to be achieved. WIP problem solving is expected to be completed before the EOC.

The discussion group participants in FGD were asked to give their opinion, their understanding of each alternative that will be presented with each criterion or attribute. then give weight to each criterion or attribute that is adjusted to current conditions in mitigating reliability issue on Water Injection Pumps (WIP) at PH Gathering Station. During the discussions, consistency of attributes / criteria and rating was reviewed to ensure consistency. The swings weight and normalized weight factor of each attribute or criteria is shown below at figure 7.

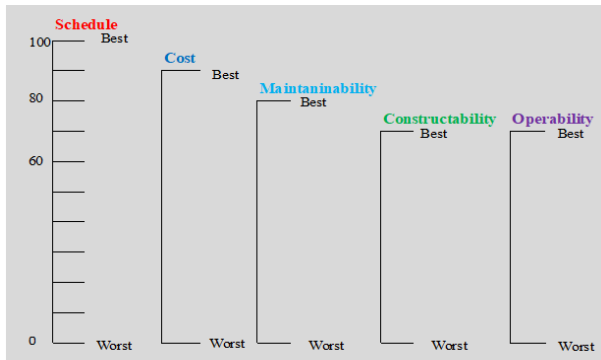


Fig. 7. Weighing of Each Attributes or Criteria

III. RESULTS

Based on calculation of aggregate scoring against to attributes or criteria which have been specified, it found that the best alternative for problem solving reliability issue of Water Injection Pumps at PH Gathering Station is alternative 2, which is Pipe Stress Analysis (PSA) and stiffness improvement WIP.

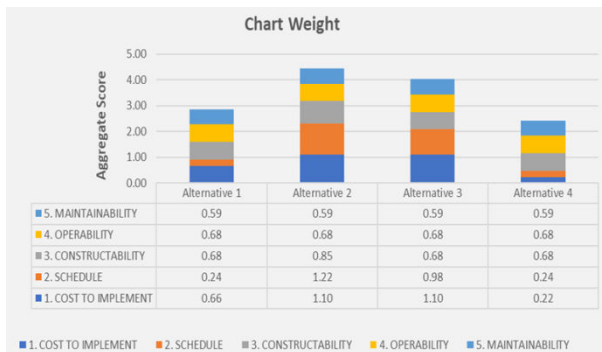


Fig. 8. Aggregate Scoring for Alternatives Against to Attributes or Criteria

To convince the selected alternative, cost and benefit analysis should be conducted to provide more comprehensive information for DE and DRB members in order to take the final decision for problem solving,

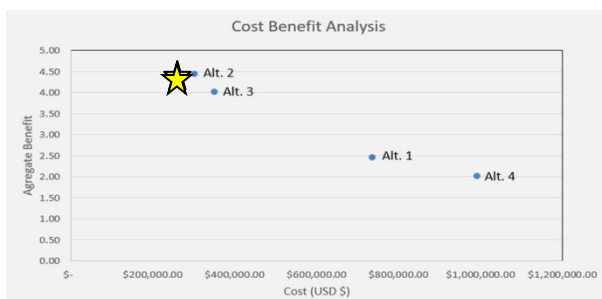


Fig. 9. Cost and Benefit Analysis for Each Alternative

Based on cost & benefit analysis at figure 9, the alternative 2 has ultimate result with less cost and high benefit. Efficient frontier would not be applicable on this result.

All of those analysis based on Kepner Tregoe and SMART was presented to the Decision Executive (DE) and the Decision Review Board (DRB). In the process, each alternative is explained its advantages and disadvantages, then the author proposes the chosen alternative (based on Focused Group Discussion) to get endorsement and approval from DE and DRB, so that it can proceed to the construction stage.^[4]

IV. DISCUSSION

The schedule aspect is the ultimate aspect with the lowest cost of investment on this project. To evaluate how robust the solution, the sensitivity analysis can be done. Sensitivity analysis shows how the changes in the decision criteria's weight can influence its aggregate score.

The Consistency for the solutions obtained is conducted by changing the attribute weights which will then be analyzed through sensitivity analysis. In this case, sensitivity analysis will be carried out by changing the weights in the subcategory, Cost and Schedule.

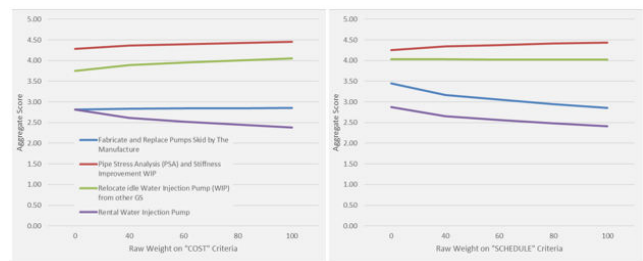


Fig. 10. Chart of Sensitivity Analysis

The sensitivity analysis result in Schedule and Cost criteria have not significant change that it's impacted to the selected alternative. The proposed alternative Pipe Stress Analysis (PSA) and stiffness improvement WIPs is still the highest aggregate score among the other alternative.

The selected alternative will be proposed into a project and will execute by Project Team in PT. ABC in order to improve reliability Water Injection Pumps (WIP) which led to compliance of Zero Water Discharge/Disposal (ZEWADI) and moreover to sustain oil production by avoiding Loss Production Opportunity (LPO).

A structured implementation plan could be increased confidence to decision makers that the project is feasible to implement. Thus, the project planning process can begin, starting with the engineering process, purchasing materials, selecting resources and the construction phase in the field. The sequence of implementation and execution plan as follow:

- Stakeholder analysis and engagement plan,
- Project team charter and resource plan,
- Work breakdown structure and contracting strategy,

- Risk and contingency plan,
- Project schedule estimate.^[4]

V. CONCLUSION

The equipment reliability and facilities integrity issue due to vibration leading to operational disruptions which are led to Loss Production Opportunity (LPO) and incompliance to EPS is the symptom. Kepner Tregoe (KT) tools of Problem Solving and Decision Making (PSDM) help the author to find the facts that exist and occur at the site, then explore deeper to define the problems and determine the root cause .

The sensitivity analysis of Simple Multiple Attribute Rating Technique (SMART) applied to the selected alternative, and it has shown that if the weight of benefit subcategory (Cost and Schedule) goes higher than other attributes. As discussed during small group discussion, the schedule subcategory is considered as the most significant criteria since PT ABC will facing end of contract on Production Sharing Contract (PSC) with Government of Indonesia (GOI).

By involving the experts and the affected team in the Focused Group Discussion is enable author to more effective in analyzing, assessing and determining problem solving. Focused Group Discussion is very effective in exercising the Simple Multiple Attribute Rating Techniques (SMART). in some cases, SMART decision tool can be suitable to assist in quick and effective decision making. In this case, it is proven that the SMART decision tool can be used properly and deliver the right decision according to the current conditions.

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REFERENCES

- [1] Dodi Siregar, 2017, The Article – Research of Simple Multi-Attribute Rating Technique for Decision Support.
- [2] Gita Kurnia, 2020, Jurnal Teknologia – Improving Airport On-Time Performance Using Kepner-Tregoe Problem-Solving Approaches.
- [3] Kepner, C.H. and Tregoe, B.B., 1981, The Ne Rational Manager, Princeton: Princeton Research Press.
- [4] Project Resources Company, 2011, “Chevron Project Management System”, 2nd Edition, CPMS Handbook.