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# DECISION ANALYSIS OF OFFSHORE CHANNEL MAINTENANCE DREDGING IN PT. PQR

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**ABSTRACT**

*The offshore channel maintenance dredging completion date, which was performed by PT. ABC (PT. PQR's contractor) using crane barge XYZ, was delayed to 19 May 2023 (43.4 days delayed). Two main problem were identified using Kepner Tregoe Situation Analysis (KT-SA) based on the company data processing and one most main contributing problem (lack of daily sediment production; the initial plan was 1500 $m^3$/day) then be analyzed using Kepner Tregoe Problem Analysis (KT-PA) and the root cause was constructed using cause-map with brainstorming method included in the process between author and some of PT. ABC dredging crew in crane barge XYZ. Substitute, Combine, Adapt, Modify, Put on another use, Eliminate, Rearrange (SCAMPER) technique then be brought in the brainstorming session with PT. ABC dredging crew on crane barge ABC to bring alternative solutions for the root cause of the problem. Furthermore, the SCAMPER result be brought to brainstorming with PT. PQR dredging operation assistant manager, as the problem holder and matter expert, and filtered to three most possible alternative solutions. These three most possible solutions then examined using Simple Multiple Attribute Rating Technique (SMART) method with eight stages were performed. The criteria used in this method are offshore channel dredging project cost, offshore channel dredging project schedule, coordination with other entity, and permit to work (PTW) & derogation. The objectives of this research are knowing what factors affecting the dredging project in PT. PQR offshore channel case and the alternative solution to be brought in the next offshore channel maintenance dredging.*

## INTRODUCTION

Maintenance dredging is performed in order to maintain the water depth of the port from sedimentation (Bray et al., 1997; Zikra et al., 2021). PT. PQR has some working base which has direct boundaries with river and sea since most of PQR wells are located at swamp and offshore area thus, they are completed with jetty. Working base with direct boundaries with river categorized as swamp working area and the one with the sea categorized as offshore working area (Inácio et al., 2022; Kocik et al., 2022). The seafaring line that headed to the swamp working base jetty are not routinely be dredged because there are no big ships activities that required too deep riverbed and the sedimentation is not as significant as it is at offshore (Gearhart, 2020; Lubchenco & Haugan, 2023). While for offshore working base, the seafaring line channel is routinely be dredge (yearly basis) for the requirement of supply barge moor at the jetty (Moore et al., 2021; Paik & Thayamballi, 2007). This project often called as PQR offshore channel maintenance dredging.

PQR Offshore channel was side by side with commercial beach and civils pond thus it was unable to make dumping area near the shore (environmental and societal sensitivity issue). By this condition, the type of dredgers or dredging barge utilized for this project is clamshell dredging barges where the sediments will be brought to designated dumping spot at offshore area, instead of cutter suction dredger (CSD) since CSD required dumping area which can be reached by its High-Density Polyethylene (HDPE) hose (Eisma, 2005; Witthohn, 2022).

The dredging target depth of the channel was +/- 3 m, the width of the channel is 40 m, and the length of the channel is 1,595 m. Calculated by volume calculation compared to the existing depth given in the pre-dredge sounding data performed on 25 October 2022, the initial volume of sediment to be dredged was 144,925 $m^3$. Dredging Operation department of PT. PQR planned the offshore channel maintenance dredging to be finished in 96.6 days using clamshell dredger completed with its supporting fleets such as one Anchor Handling Tug (AHT), two Tugboats (TB), three Hopper Barges (HB) for sediments container, and one aluminium Seatruck (ST).

The realization of this offshore channel maintenance dredging completion was longer than the planning. Refers to Figure 1, The maintenance dredging completion planning was in week 14 (5 April 2023 – 96.6 days) but in realization it was done in week 20 (19 May 2023 – 140 days).

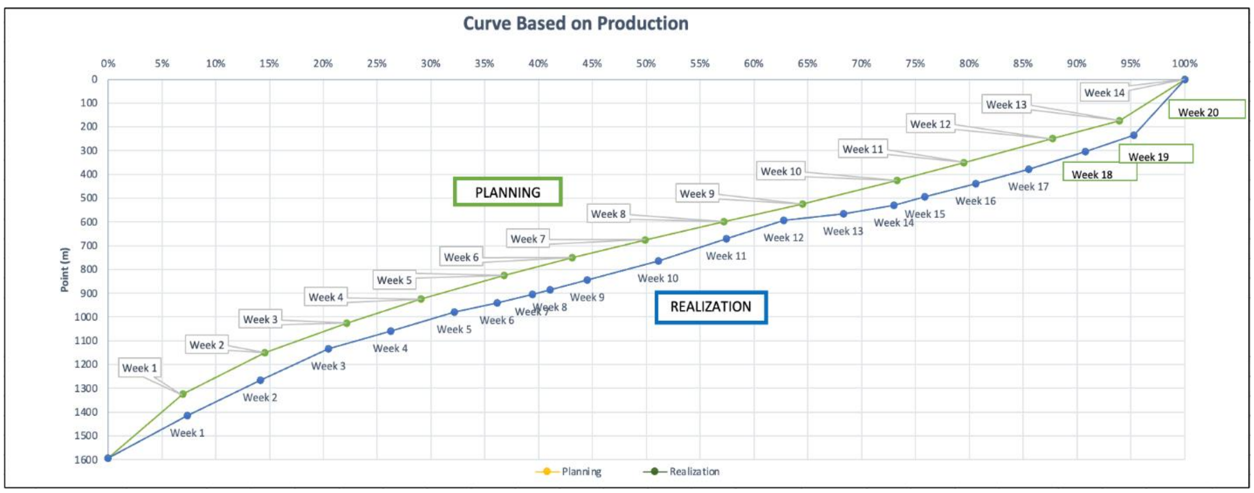


**Figure 1.** Progress Curve of Channel Maintenance

This offshore channel maintenance dredging is yearly basis operation which means that the channel will be dredged again in the upcoming years. This research goals is to provide solutions to the problem thus this long completion delay can be prevented in the next dredging operation.

## METHOD

There were primary and secondary data used for this research. The primary data were collected during brainstorming with PT. ABC (contractor) site personnel and with PT. PQR dredging operation team, and interviewing PT. ABC fleet management representative. While the secondary data were collected from company reports, company website, and online sources. The overview design for this research is shown in Figure 1.

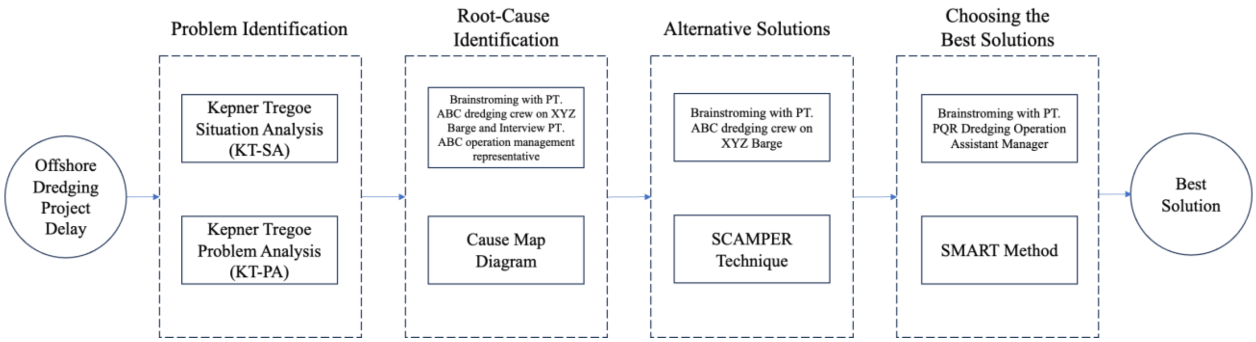


**Figure 1.** Research Design

This research was started with problem identification from the business issue occurred by performing Kepner Tregoe-Situation Analysis (KT-SA) based on the PT. PQR company data processing. There were two problems occurred as stated in Table 1.

**Table 1.** KT-SA of Offshore Maintenance Dredging Completion Delay

| Situation/ Problem | Timing (H/ M/ L) | Trend (H/ M/ L) | Impact (H/ M/ L) | Process (PA/ DA/ PPA) |
|---|---|---|---|---|
| Average daily sediment production could not meet 1,500 m3/day | H | M | H | PA |
| Dredging barge was having non-productive time and off hired due to crane problem | H | L | H | PA |

The trend of dredging barge crane problem based on the PT. PQR data was low which the event was not likely to occur in every month while for the daily sediment production below target, is medium thus almost every month this event was occurred. Thus for this research, author dug deeper about the problem 1 and start the problem analysis using Kepner-Tregoe Problem Analysis tools as seen in Table 2.

**Table 2.** KT-PA of the Problem 1 in Previous Table

| | | Specifying Question | Is | Is Not | What Is Distinctive About |
|---|---|---|---|---|---|
| **What** | Identify: | What is the problem? | Average daily sediment production could not meet 1,500 m3/day as per initial plan | Average daily sediment production is 1,500 m3/day or more | The number of HB operated, the less the number of HB, the less the production |
| **Where** | Locate: | Where is the problem occur? | Offshore Channel in PHM offshore site | In other PHM site | HB problem when the project started to begin |
| **When** | Timing: | When does the problem? | In 31 December 2022 | Before 31 December 2022 | Fleet management problem in PT. ABC |
| **Extent** | Magnitude: | How many days the delay be, caused by the problem? | 39.4 days | None | Lack of sediment production |

The main problem had been identified, and to find the root cause to know what kind of alternative solution to be proposed, author was performing brainstorm session with PT. ABC dredging crew on crane barge XYZ, was performing interview the PT. ABC operational management representative, and was processing the PT. PQR company data. The result of these steps then was put into a cause map diagram as shown in Figure 2. Based on the cause map method, it was found that the major root cause of the problem stated previously, is contractor crew does not have the idea how to predict when some equipment in HB must be renewed especially the ones that excluded during 3rd party inspection.

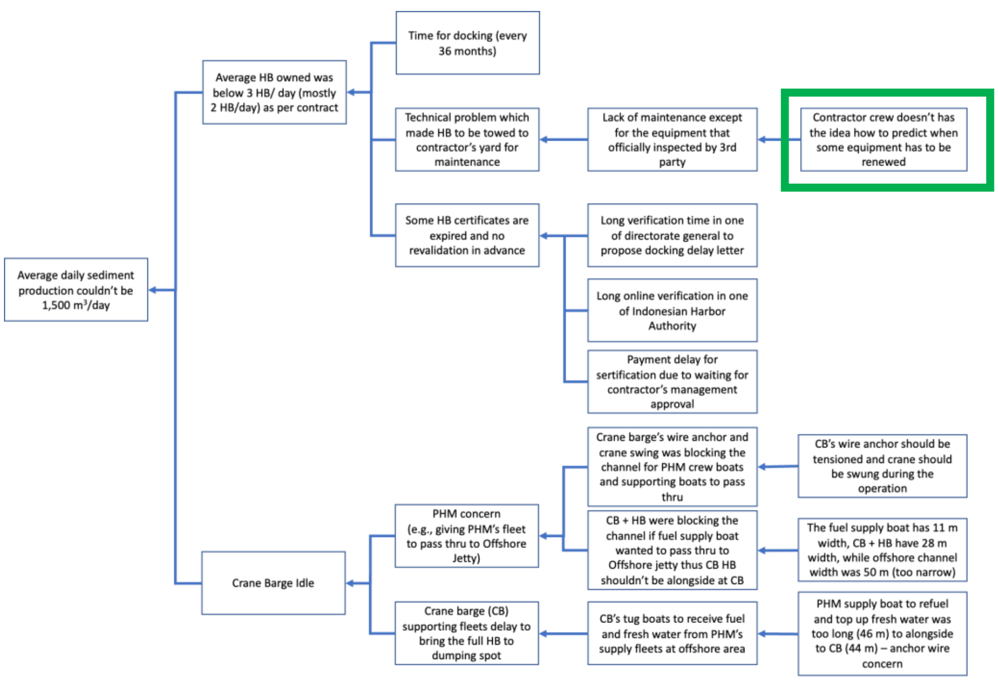


**Figure 2.** Cause Map Diagram

After the root cause was found, the brainstorming session was continued to seek the alternative solution. The alternative solution was discussed using SCAMPER (Substitute, Combaine, Adapt, Modify, Put to another use, Eliminate, Reverse/Rearrange) technique SCAMPER represents a set of techniques used for generating or revising ideas. It involves the use of idea checklists specifically designed to foster creative problem-solving and encourage imaginative thinking (Eberle, 1997). The result can be seen in Table 3.

**Table 3.** Generating Alternative Solutions Using SCAMPER

| Technique | Alternatives Solutions | |
|---|---|---|
| Substitute (S) | 1 | Substitute the HB with the "healthier" one. |
| | 2 | Substitute the contractor working. |
| Combine (C) | 1 | including the non 3rd party inspected critical equipment, such as ramp door chain and shackle, into the 3rd party inspection list |
| Adapt (A) | 1 | Adapt the planning based on actual HB working availability. |
| Modify (M) | 1 | Modify the way the PT. ABC crew maintain the HB starting with providing proper maintenance and modification log book |
| | 2 | Modify the 3rd party inspection scope thus the current critical equipment which is not included in the current 3rd party inspection scope. |
| | 3 | Modify the HB ramp door mechanism so all equipment to open and close the ramp door will be easily inspected. |
| Put to Another Use (P) | 1 | Not an option since the broken HB cannot be used effectively anymore |
| Eliminate (E) | 1 | Eliminate the use of downgraded equipment on HB without 3rd party inspection |
| Reverse/ Rearrange (R) | 1 | Rearrange the planning with contractor which has complete set of HB and has HB spare on their yard |

These set of alternative solution were then be brought by the author to PT. PQR dredging operation manager as the problem holder, matter expert, and decision maker to filtered further based on the fact on site. Table 4 is showing the overall comment of decision maker and the green block are the most possible alternatives solution to be implemented based on the discussion.

From above table, especially at the “problem holder comment” column, not all proposed solutions can be implemented as best proposed solution based on the fact from brainstorming with PT. PQR dredging operation assistant manager. The ones that can are marked with green color:

1) S2: Substitute the contractor working. This alternative is simply once the contractor working has problem with their HB and cannot be repair on site (need to be towed to the yard) and they have no HB spare to replace the problem one, the contractor then just swapped with the other one who has three HB set so the production could meet 1,500 $m^3$/day as per plan.
2) M1: Modify the way the PT. ABC crew maintain the HB starting with providing proper maintenance and modification log. This purpose of this alternative is to increase the sense of belonging of the crane barge crew. Thus they have a well equipment preparation and well maintenance planning.

3) R1: Rearrange the planning with the contractor which has complete set of HB and has spare on their yard. This alternative purpose is to utilize a contractor which has full HB as per contract and they have HB spare on their yard just in case there will be any problem during the the project, thus a quick HB replacement can be done in less time.

**Table 4.** Filtered Proposed Solution

| Technique | | Alternatives Solutions | Problem Holder Comment |
|---|---|---|---|
| Substitute (S) | 1 | Substitute the HB with the "healthier" one. | Cannot be implemented if PT. ABC didn't has the "healthy" spare HB at their yard |
| | 2 | Substitute the contractor working. | Can be an alternative solution |
| Combine (C) | 1 | including the non 3rd party inspected critical equipment, such as ramp door chain and shackle, into the 3rd party inspection list | Can be an alternative solution but it needs further discussion with contractor since it will be resulted to higher their cost |
| Adapt (A) | 1 | Adapt the planning based on actual HB working availability. | Cannot be implemented since PT. ABC is still failed to provide number of HB as per contract requirement |
| Modify (M) | 1 | Modify the way the PT. ABC crew maintain the HB starting with providing proper maintenance and modification log book | Can be an alternative solution |
| | 2 | Modify the 3rd party inspection scope thus the current critical equipment which is not included in the current 3rdpa rty inspection scope. | Can be an alternative solution but it needs further discussion with contractor since it will be resulted to higher their cost |
| | 3 | Modify the HB ramp door mechanism so all equipment to o pen and close the ramp door will be easily inspected. | Cannot be implemented, since this will need major engineering study and major modification |
| Put to Another Use (P) | 1 | Not an option since the broken HB cannot be used effectively anymore | - |
| Eliminate (E) | 1 | Eliminate the use of downgraded equipment on HB without 3rd party inspection | This can be implemented only if point C and M2 are implemented |
| Reverse/ Rearrange (R) | 1 | Rearrange the planning with contractor which has complete set of HB and has HB spare on their yard | Can be an alternative solution |

After the alternatives has been narrowed down into three solutions, the best from those three will be evaluated by using Simple Multiple Attribute Rating Technique (SMART) method. The decision criteria used to evaluate each filtered alternative solution are shown in the table 5.

**Table 5.** Decision Criteria Used in This Research

| Attribute | Information |
|---|---|
| Offshore Channel Dredging Project Cost | The required budget to perform the dredging operation which including fuel, fresh water, standby rate due to company reason, and cubication. |
| Offshore Channel Dredging Project Schedule | The estimation of time and duration required to complete the offshore channel maintenance dredging project. The schedule holds significant importance as it contributes to the measurable success of the project and contributes to the other site dredging schedule puntuality |
| Coordination with Other Entity | Offshore Channel is flanked with underwater hydrocarbon flowline thus, dredging operation in that area invlolved many other Entity such as production, survey and marine team prior and the project execution |
| Permit to Work (PTW) and Derogation | Dredging near the flowline requires complex permit to work since to position the dredging barge it required to drop the anchor below 100 m from flow line. By this as well, specific derogation for specific name of dredging barge is required. |

## RESULT AND DISCUSSION

The assignment of weight for each criterion was done during the brainstorming session with PT. PQR dredging operation assistant manager as matter expert. The result is shown in Figure 3.

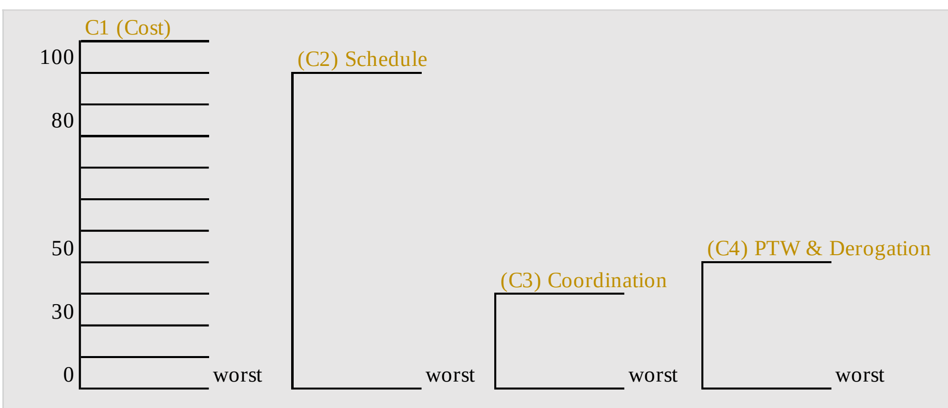


**Figure 3.** Weight for Each Criteria

After weighing the criteria, the next step was calculating the aggregate weight. The aggregate weight is the total from the result of normalized weight of each criteria times the score of each criterion in each alternatives solution. The detail results are shown in below set of tables.

**Table 6.** Aggregate Weight of Alternative 1 (S2)

| Criteria | Alternative 1 (S2) | | |
|---|---|---|---|
| | Normalized Weight (a) | Score (b) | (a) x (b) |
| C1 | 0.370 | 1 | 0.370 |
| C2 | 0.333 | 1 | 0.333 |
| C3 | 0.111 | 1 | 0.111 |
| C4 | 0.185 | 1 | 0.185 |
| Total Aggregate Weight | | | 1.000 |

**Table 7.** Aggregate Weight of Alternative 2 (M1)

| Criteria | Alternative 2 (M1) | | |
|---|---|---|---|
| | Normalized Weight (a) | Score (b) | (a) x (b) |
| C1 | 0.370 | 2 | 0.741 |
| C2 | 0.333 | 1 | 0.333 |
| C3 | 0.111 | 2 | 0.222 |
| C4 | 0.185 | 2 | 0.370 |
| Total Aggregate Weight | | | 1.667 |

**Table 8.** Aggregate Weight of Alternative 2 (M1)

| Criteria | Alternative 3 (R1) | | |
|---|---|---|---|
| | Normalized Weight (a) | Score (b) | (a) x (b) |
| C1 | 0.370 | 2 | 0.741 |
| C2 | 0.333 | 2 | 0.667 |
| C3 | 0.111 | 2 | 0.222 |
| C4 | 0.185 | 2 | 0.370 |
| Total Aggregate Weight | | | 2.000 |

Once the total performance has been computed for all the alternatives, it becomes possible to make a tentative decision. At this stage, a comparison can be made between the performance of different alternatives, and adjustments to the model may be considered if needed (Wright & Davidson, 2020).

**Table 9.** Aggregate Weight Summary

| Criteria | Alternative Solutions Aggregate Weight | | |
|---|---|---|---|
| | **S2** | **M1** | **R1** |
| C1 | 0.370 | 0.741 | 0.741 |
| C2 | 0.333 | 0.333 | 0.667 |
| C3 | 0.111 | 0.222 | 0.222 |
| C4 | 0.185 | 0.370 | 0.370 |

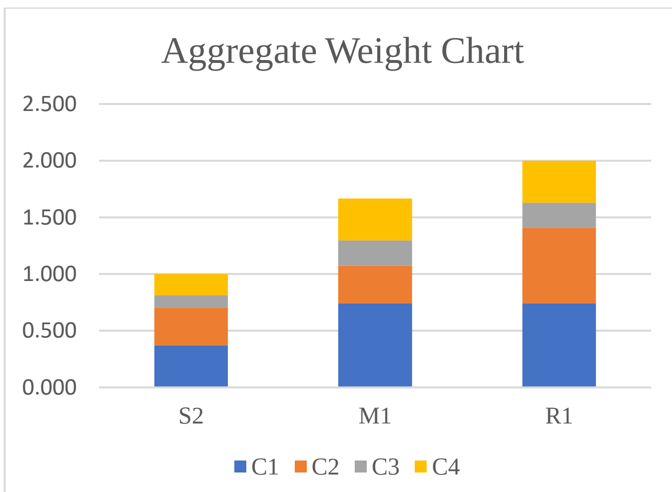


**Figure 4.** Aggregate Weight for Alternative Againts Criteria

From the aggregate weight calculation (both table summary and chart), it was found that the best alternative to solve the problem of hopper barge problem that made the number of HB is not as per contract is alternative 3 (R1), to utilize the contractor which has ready complete set of HB and they have spare HB on their yard.

## CONCLUSION

Based on the study that has been done related to the PT. Pertamina Hulu Mahakam (PHM) offshore channel maintenance dredging, where the business issue was the average daily sediment production could not meet 1,500 m3/day thus it made the completion of the project was delayed, the author concludes that the root cause was the dredging crew didn't know how to predict when some equipment needs to be replaced especially the ones that excluded in the 3rd party inspection agenda, based on the Kepner Tregoe Problem Analysis (KT-PA) and cause-map diagram.

The alternative business solution then be developed using Substitue, Combine, Adapt, Modify, Put on Another Use, Eliminate and Rearrange (SCAMPER) Technique and was filtered based on the fact on site:

1) S2: Substitute the contractor working;
2) M1: Modify the way the PT. ABC crew maintain the HB starting with providing proper maintenance and modification log; and
3) R1: Rearrange the planning with the contractor which has complete set of HB and has spare on their yard.

After performing eight stages of SMART, the best solution for Offshore channel maintenance dredging business issue is to Rearrange the planning with the contractor which has complete set of HB and has spare on their yard.

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