Decision-Making Process to Improve Efficiency and Effectiveness of The Remediation Planning and Implementation Process: A case study of an oil and gas company in Indonesia

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Abstract

The upstream oil and gas industry has an impact on the environment, especially the emergence of waste, both exploration and production waste. Crude oil spills occur at the earth's surface during the production process, transportation, and storage of oil. There are various factors and ways to improve the efficiency and effectiveness of the planning and implementation process, some of which are the utilization of process capacity, volume allocation, schedule, resources and equipment that need to be elaborated to achieve the remediation target. PT. XYZ realizes that from the remediation process carried out in recent years, it appears that the alignment between COCS volume and processing capacity is a very important factor in synergies with the land acquisition process to carry out the maximum implementation process according to the target. The author uses the Kepner-Tregoe Situation Analysis (SA) and Root Cause Analysis (RCA) methods and the approach uses the Kepner-Tregoe Potential Problem Analysis (PPA) and Decision Analysis (DA) to identify the source of the problem at PT XYZ. Problems have been identified through Root Cause Analysis, Cause-and-Effect Diagram and categorized into several important factors, namely process, people, planning and scheduling and regulation.

Keywords

Decision-Making Process, Remediation, Crude Oil Contaminated Soil Restoration, Kepner-Tregoe, Root Cause Analysis

1. Introduction

There is no denying that the upstream oil and gas industry has an impact on the environment, especially the emergence of waste, both exploration and production waste. Waste that is primarily in the form of sludge oil includes toxic and hazardous waste (B3). Crude oil spill occurs on the earth's surface at oil production, transportation, and storage. Soil contaminated with oil (COCS) is dangerous for human health, flora, and fauna. Therefore, one of the actual problems for the normal functioning of biological and ecological systems in the regions with oil production is efficient remediation and utilization of COCS.

1.1 Objectives

The main reviewed objective of this final project is to improve decision-making process in PT. XYZ, which will improve efficiency and effectiveness of planning and implementation of remediation process. PT. XYZ has developed several strategies to accelerate the remediation process and meet the needs and timeline. The strategy includes calculating of the capacity of the land/area to be remedied against the utilization capacity and processing facilities.

Waste management activities are the responsibility of the company which as a result of its operations and exploration pollutes the surrounding environment refers to Article 1.1. Peraturan Pemerintah Republik Indonesia, Hazardous and Toxic Materials hereinafter abbreviated as B3 are substances, energy, and/or other components that due to their nature, concentration, and/or amount, either directly or indirectly, may pollute and/or

damage the environment, and/or harm the environment, health, and survival of humans and other living things (Peraturan Pemerintah Republik Indonesia Nomor 101 Tahun 2014 Tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun).

In order to improve the remediation process, the following is the research framework used by the author throughout this research. Most of the data used in this research are qualitative data obtained from various methods, such as interviews and discussions, team meetings, literatures, studies and expert judgments. Then the data obtained will be used in the analysis and the basis for formulating the proposed solutions. These two methods and approaches are used by the author to attempt and identify the source of the problem at PT. XYZ, namely Kepner-Tregoe Situation Analysis (SA), Potential Problem Analysis (PPA), Decision Analysis (DA) and Root Cause Analysis (RCA).
Those RCA and Kepner & Tregoe approaches were then applied to the remediation process (stage 1 – 6) below and the result are as follows:

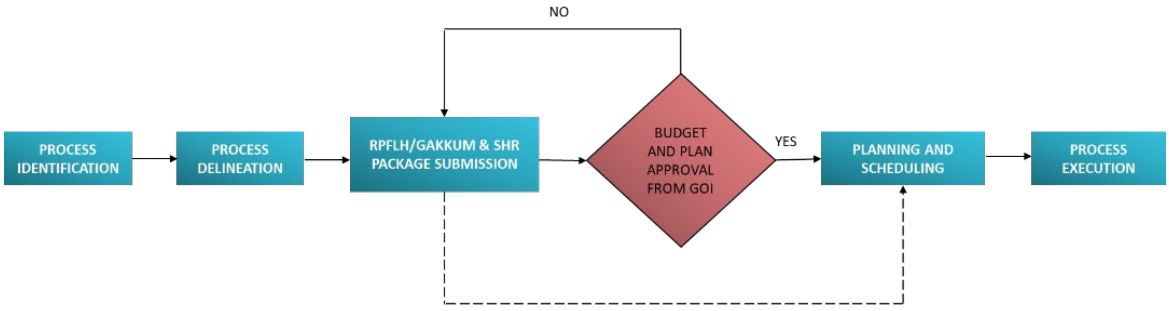

Figure 1. Remediation Flow Process

- **Process identification (Stage 1).** The land identification process is carried out thoroughly, site by site and ensures that all procedures for leasing or purchasing land are carried out completely in accordance with applicable regulations. Conduct intensive socialization and coordination with landowners to ensure all their concerns regarding land status, territorial boundaries, compensation process, documentation, legal aspects and duration of the clearing process are captured and communicated clearly and in detail. There are several people assigned to ensure there are no problems with the landowner, and if there are problems they are immediately followed up so as not to interfere with the overall remediation process.

- **Process Delineation (Stage 2).** The Delineation Process is the process of confirming oil-contaminated soil by measuring the area, depth, and thickness of oil in oil-contaminated areas. The COCS volume estimation process uses 3D Model and Geoprobe Technology. With a 3D Model, each site that is included in the plan to clean up oil contaminated soil will be modeled and interpret data on the thickness and depth of COCS from the ground surface. The accuracy of COCS volume estimation improve by around 10-20% from the existing process.

- **RPFLH/GAKKUM & SHR Package Submission (Stage 3).** RPFLH is *Rencana Perlindungan dan Pengelolaan Lingkungan Hidup* which is the process of submitting a plan to clean up oil-contaminated land, complete with a detailed schedule and budget to the Indonesian government, represented by SKK Migas and the Ministry of Environment. The implementation of this process is to ensure that there are no land problems during the preparation and implementation process as well as the accuracy of the COCS volume estimation. The number of areas/locations to be cleared along with the volume will be used as a source of data to be submitted to the government. To speed up the preparation process, data and information from both area/locations and COCS volume estimation in parallel will be used for the scheduling and resource planning process (manpower and equipment) while waiting approval from the government.

- **Budget and Plan Approval from GOI (Stage 4).** The challenge of this process is that it takes a long time for budget and plan approval due to incomplete data and information and other considerations from the government such as budget allocation because this process will not bring benefits to Indonesia when compared to the budget spent on exploration and operating processes that will generate profits. The delay on this process will result in

delays in the implementation process and not achieving the process remediation target. To anticipate this, in the implementation process, it is necessary to carry out intensive coordination and communication with the government regarding plans and involvement in repairs as well as coordination meetings with the government to complete all required documents and information, including progress updates on the preparation of plan to clean up oil-contaminated soil.

- **Planning and Scheduling (Stage 5).** The planning and scheduling process is very important to prepare all the necessary resources such as manpower, equipment and standard operating procedures (SOP) to support the implementation plan. All of these processes require quite a long time in preparation both contractually and administratively. Future implementation is to maintain the existing process by ensuring that the previous process from stage 1 to stage 3 runs according to plan as described in the previous point above. An initial planning system is required pending approval of plans and budgets from the government.

- **Process Execution (Stage 6).** The implementation of the execution process is the process of cleaning oil-contaminated soil from the location/area, classifying the land based on the TPH value and sending the soil to a processing facility for further processing. All the above processes are carried out in accordance with the planning that has been carried out from stages 1 - 5 and with the schedule and budget that has been approved by the government.

2. Literature Review

The discussion in this paper refers to Peraturan Pemerintah Republik Indonesia which requires the company's responsibility to clean up oil-contaminated land resulting from operations and exploration activities. Article 1.14. states that B3 Waste Producer is any Person who because of his business and/or activities produces B3 Waste (Peraturan Pemerintah Republik Indonesia Nomor 101 Tahun 2014 Tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun). Based on these considerations, it is considered necessary to establish rules on the procedures for the recovery of waste-contaminated land, namely the issuance of Peraturan Menteri Negara Lingkungan Hidup. In Article 1.1. defined that Contaminated land is land exposed to hazardous and toxic material waste (B3), whereas in Article 1.4. Recovery is a series of contaminated land handling activities that include planning, implementing, evaluating and monitoring activities (Peraturan Menteri Negara Lingkungan Hidup Nomor 33 Tahun 2009 Tentang Tata Cara Pemulihan Lahan Terkontaminasi Limbah Bahan Berbahaya Dan Beracun). PT. XYZ then identified the practice of the bioremediation process that has been carried out in the last few years and using the RCA and Kepner & Tregoe approaches to further analyze the frequently encountered problems that are often encountered and prepare preventive and contingent actions to increase effectiveness and efficiency of the remediation process.

3. Methods

This research follows five main stages. Stage 1 is to identify the challenges and problems encountered through team discussions and meetings. This process aims to ascertain the business problems that will be analyzed in this research. In Stage 2, historical data analysis and Root Cause Analysis (RCA) will be explained, including Cause-and-Effect Diagram and Kepner-Tregoe Concept; Situation Appraisal/Analysis to identify the timing, trends and impacts. Stage 3 contains further explanation of Kepner Tregoe Problem Analysis (PA), Potential Problem Analysis (PPA), and Decision Analysis (DA); the problems will be analyzed, identify preventive/contingent actions, carry out risk assessments and generate potential alternatives that can be used to increase the efficiency and effectiveness of the planning and implementation process to solve the problem. In Stage 4, propose solutions from these alternatives to improve planning and scheduling process will be discussed. In Stage 5, conclusion, recommendations, and implementation plan will be outlined.

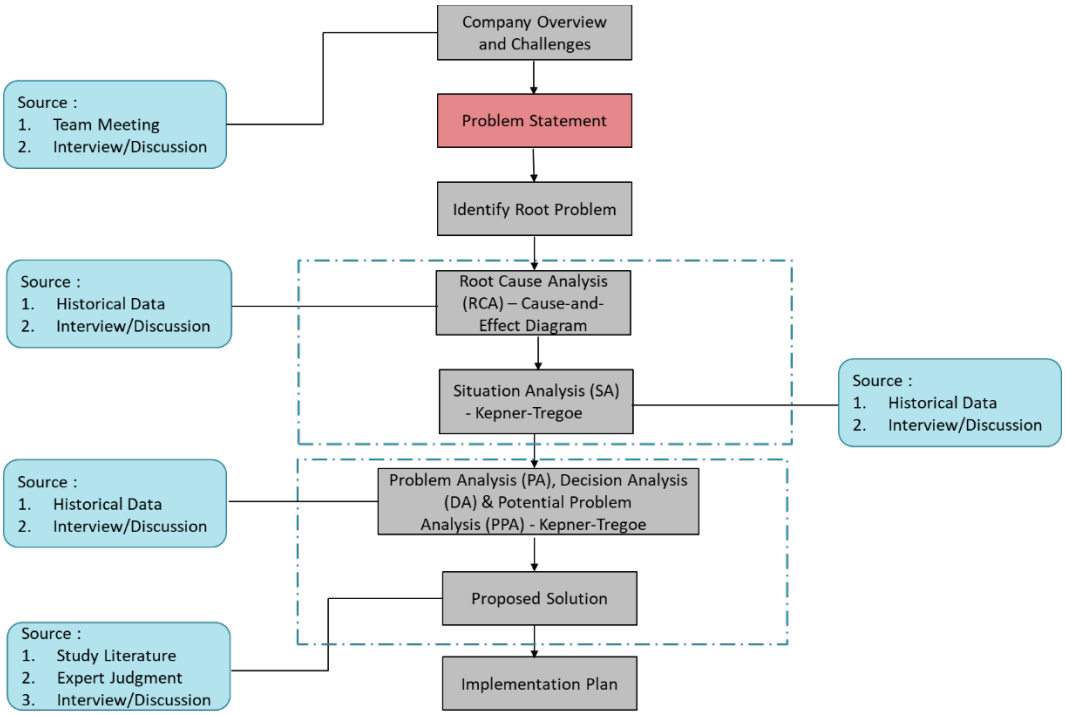

Figure 2. Research Framework of Remediation Process

4. Data Collection

Finding a solution to have a proper planning and scheduling process to carry out a remediation project involving several activities, namely problem analysis, collecting and analyzing recorded data (including lesson learned and best practices) and conceptual framework in an attempt to direct the research process in order to find a suitable solution.

There are various factors and ways to improve the efficiency and effectiveness of the planning and implementation process, some of which are the utilization process capacity, volume allocation, schedule, resources and equipment that need to be elaborated to achieve the remediation targets.

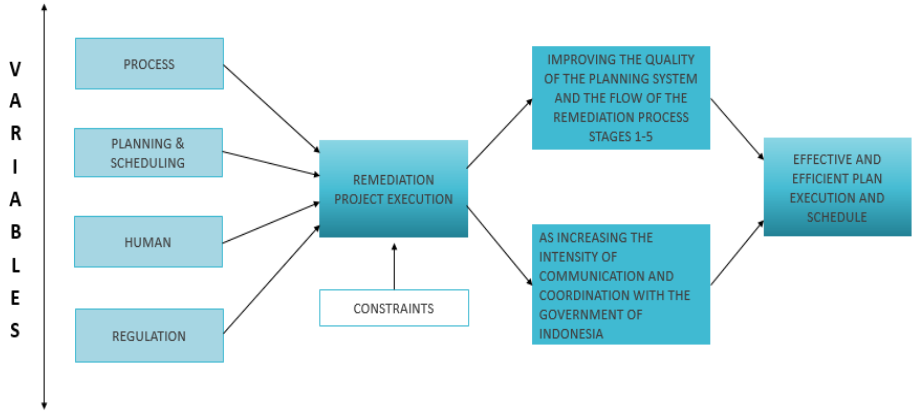

Figure 3. Conceptual Framework of Remediation Process

Within this conceptual framework, there are 4 (four) critical variables that need to be managed properly and 2 (two) ways to improve the implementation plan and schedule, namely improving the quality of the planning system and the flow of the remediation process Stages 1-5 as well as increasing the intensity of communication and coordination with the Government of Indonesia. PT. XYZ realizes that from the remediation process carried out in the last few years, it can be seen that the quality of the remediation process flow planning system Stage 1 – 5 still has several problems that need to be improved so that the remediation process can be carried out properly. This conceptual framework is then used to carry out further analysis of the remediation process flow using the Kepner-Tregoe approach for further study and analysis as well as to prepare solution and implementation plan to improve the efficiency and effectiveness of the remediation process.

1.1 Process Identification

The land identification process is carried out thoroughly, site by site and ensures that all procedures for leasing or purchasing land are carried out completely in accordance with applicable regulations. Conduct intensive socialization and coordination with landowners to ensure all their concerns regarding land status, territorial boundaries, compensation process, documentation, legal aspects and duration of the clearing process are captured and communicated clearly and in detail. There are several people who are assigned to ensure there are no problems with the landowner, and if there are problems, they are immediately followed up so as not to interfere with the overall remediation process.

1.2 Process Delineation

The COCS volume estimation process using 3D Models and Geoprobe Technology. With the 3D model, each location included in the plan to clean up oil-contaminated soil will be modeled and interpret the COCS thickness and depth data from the ground surface. The combination of 3D Models and Geoprobe Technology can increase the accuracy of COCS volume estimation by about 10-20% from the existing process, according to the experimental data that has been carried out. By implementing this process, it is expected that the COCS volume estimation results will be the same as the actual volume when the implementation process is carried out.

1.3 RPFLH/GAKKUM & SHR Package Submission

The implementation of this process is to ensure that there are no land problems during the preparation and implementation process as well as the accuracy of COCS volume estimation. The number of areas/locations to be cleared along with the volume will be used as a source of data to be submitted to the government. To speed up the preparation process, data and information from both area/locations and COCS volume estimates in parallel will be used for scheduling and resource planning process (manpower and equipment) while waiting approval from the government.

1.4 Budget and Plan Approval from GOI

The challenge of this process is that it takes a long time for budget and plan approval due to incomplete data and information and other considerations from the government such as budget allocation because this process will not bring benefits to Indonesia when compared to the budget spent on exploration and operation processes that will generate profits. The delay on this process will result in delays on the implementation process and not achieving the process remediation target. To anticipate this, in the implementation process, it is necessary to carry out intensive coordination and communication with the government regarding improvement plans and early involvement as well as coordination meetings with the government to complete all required documents and information, including updating the progress of the preparatory plan to clean up oil-contaminated soil.

1.5 Planning and Scheduling

Planning and scheduling process is very important to prepare all the necessary resources such as manpower, equipment and standard operating procedures (SOP) to support the implementation plan. All of these processes require quite a long time in preparation both contractually and administratively. Future implementation is to maintain the existing process by ensuring that the previous process from stage 1 to stage 3 runs according to plan as described in the previous point above. An initial planning system is required pending approval of plans and budgets from the government.

1.6 Process Execution

The implementation of the execution process is the process of cleaning oil-contaminated soil from the location/area, classifying the land based on the TPH value and sending the soil to a processing facility for further processing. All the above processes are carried out in accordance with the planning that has been carried out from stages 1 - 5 and with the schedule and budget that has been approved by the government. The challenges ahead that must be ensured in the implementation process are related to 2 (two) things, namely Limited Processing Capacity and High Remediation Cost:

a. Limited Processing Capacity

From the data and information, TPH with a value of 1 - 15% can be calculated which will then be sent to the bioremediation (SBF) process. The SBF process itself has a cycle time and capacity that must be adjusted so that synergy between processes can be carried out properly and smoothly. Average Cycle Time for Bioremediation process is around ~ 13 weeks (3 months) to remediate oil contaminated soil to be <0.1%. PT. XYZ needs to make adjustments between the capacity and cycle time of the SBF to ensure all COCS with a TPH range of 1 - 15% can be processed at the SBF.

b. High Remediation Cost

The costs used for the implementation of the remediation process are very high, so it is necessary to manage remediation costs as efficiently as possible. PT. XYZ must ensure the accuracy of planning and scheduling process starting from the estimation of the number of sites, the COCS volume, TPH distribution and the cost of processing facilities. To ensure all processes run according to PT. XYZ's plan, it is necessary to use and apply technology (i.e. 3D Model and Geoprobe Technology) to detect the presence of COCS and improve the accuracy so that the planned implementation process follows the actual and manage distribution management to each processing facility and conduct periodic reviews to see the accuracy of the plans made against the actual process.

5. Recommendations

5.1 Human Resources (Manpower and Equipment)

In the implementation process, the number of crew and equipment can be adjusted to the case or condition in the field, namely equipment damage occurs when the site becomes a target for immediate completion, the transfer of crew and equipment between sites and areas can be carried out. However, coordination and alignment with cross-functional teams must be carried out to ensure that there is no significant impact on other areas.

In addition to the above process, the most important thing is to ensure the availability of resources (manpower and equipment) where it takes a long time to prepare these resources through administrative processes and contracts with business partners (contractors). This guideline approach is used to determine the number of /crews needed to carry out the process of cleaning oil-contaminated soil with margin +/-10% as a safety factor.

Table 1. Guideline Approach to Determine Fleet Requirements for Remediation Process

NO.	VOLUME RANGE (M_3)	DURATION (MONTH)	AVG. AREA (HA)	#RESOURCES (FLEET)
1	0 – 2,000	3	0.5	1
2	2,000 – 5,000	5	1	1
3	6,000 – 10,000	7	1	1
4	11,000 – 15,000	8	2	2
5	16,000 – 20,000	10	2	2
6	21,000 – 40,000	14	3	3
7	41,000 – 80,000	18	5	4 - 5
8	81,000 – 160,000	24	14	7 – 10

The guide used to determine the amount of equipment needed for an area of 1-3Ha is 1 (one) excavator, motor grader, compactor, smooth drum, dozer and 10 (ten) units of dump trucks. The amount of equipment needed will also be greatly influenced by the condition of the area and the distance from the cleaning area to the processing facility.

5.2 Land Status

PT. XYZ has a good plan to overcome this problem by carrying out the land identification process thoroughly, site by site and ensures that all procedures for leasing or purchasing land are carried out in full in accordance with applicable regulations. Conduct intensive socialization and coordination with landowners to ensure all their concerns regarding land status, territorial boundaries, compensation process, documentation, legal aspects and duration of the clearing process are captured and communicated clearly and in detail. There are several people assigned to ensure there are no problems with the landowner, and if there are problems they are immediately followed up so as not to interfere with the overall remediation process

5.3 COCS Volume Estimation

PT. XYZ realizes that this process is very important in the remediation processes and applies 3D Models and Geoprobe Technology. With a 3D Models, each location included in the plan to clean up oil contaminated soil will be modeled and interpret data on the thickness and depth of COCS from the ground surface. The data is then used as information for soil sampling using Geoprobe Technology. The combination of 3D Models and Geoprobe Technology can increase the accuracy of COCS volume estimation improve by about 10-20% from the existing process, according to the experimental data that has been carried out.

5.4 Long Time Required for Budget and Plan Approval

The recommendation are as follows:

- Conduct intensive coordination and communication with the government regarding the remediation plan.
- Complete the required data and information as needed.
- Conduct initial engagement and coordination meeting with the government to discuss all necessary documents and information including the latest developments of the preparation plan for cleaning up oil-contaminated soil.

5.5 Long Time Required for Process Execution

The recommendation are as follows:

- Use and apply technology (i.e. 3D Models and Geoprobe Technology) to detect the presence of COCS and improve accuracy.
- Conduct intensive socialization and communication with landowners regarding the remediation plan and process.
- Conduct intensive coordination and communication between functional teams to ensure resource allocation.
- Conduct close coordination with each team both internally and externally by holding daily, weekly and monthly meetings to understand the actual daily target against the actuals and make necessary adjustments.

5.6 Limited Processing Capacity Availability

The recommendation are as follows:

- Manage COCS distribution management to each processing facility and conduct periodic reviews to see the accuracy of the plans made against the actual process.
- Conduct further assessment and research to see opportunities to shorten the cycle time of the SBF process.

5.7 High Remediation Cost

The recommendation are as follows:

- Use and apply technology (i.e. 3D Models and Geoprobe Technology) to detect the presence of COCS and improve the accuracy so that the planned execution process is following the actual.
- Manage the distribution of COCS to each processing facility and conduct periodic reviews to see the accuracy of the plans made to the actual process.

6. Conclusion

6.1 Human Resources (Manpower and Equipment)

The number of crew and equipment is adjusted to the number of sites and the volume of COCS that will be cleaned every month.

6.2 Land Status

Ideally, the status of the land or area to be rehabilitated is secured early in the process before entering into the package submission. In some cases, landowners complain behind the proceedings.

6.3 COCS Volume Estimation

COCS volume calculation is an important process in the planning phase and this process should be aligned with the overall remediation process from approval of plans and budgets to process implementation.

6.4 Long Time Required for Budget and Plan Approval

This process takes a long time because the approval procedure from the government takes a long time for the verification process and the data, documents and information provided are incomplete.

6.5 Long Time Required for Process Execution

The number of COCS that exceeded the initial estimate resulted in complaints from land owners because it was considered that the remediation process was not in accordance with the original plan.

6.6 Limited Processing Capacity Availability

The number of incoming COCS is greater than the capacity of the SBF and the SBF has a cycle time of ~3 months to clean oil contamination in the soil.

6.7 High Remediation Cost

The implementation process was not carried out as originally planned because COCS was found outside the areas identified at the beginning of the plan.

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Biographies

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Gatot Yudoko earned his Ph.D. degree from School of Planning – the University of Waterloo, Canada in 2000. Until this present day, he supervises students and conducts research in areas such as sustainable operations strategy, green logistics/supply chain, technology and industrial policy in developing countries.