*Proceeding Book of **The 6th ICMEM 2021**, 11-13 August 2021, Bandung, Indonesia*
***ISBN**: 978-623-92201-2-9*

Selection Method of Operational and Maintenance of Flaring Facility by Using BCOR Factor and Multicriteria Decision Making Analysis (AHP)

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Abstract - The AHP (as one of the Multi-criteria Decision Making) methods with BCOR (Benefit, Cost, Opportunity and Risk) approach can overcome the difficulties in making decision with multi-criteria for selecting the best operation and maintenance flaring facility effort in the petroleum industry, by considering technical, safety, environment, economy (in the situation where the production keep on the decline and the fluctuation of oil price), applicable regulation both in Indonesia and in the world and also the new initiative from World Bank related with environmental protection and air pollution prevention, which is Zero Flaring initiative in 2030.

In this paper, by using the AHP model structure that formed by 5 layers, consist of Goal, Factor (BCOR), Criteria (there are 11 criteria), Sub-Criteria (there are 31 criteria), and Alternatives (1. Flare the gas to nearest flaring facility or 2. Repair the flaring facility). The flaring facility owner in PT. CPI can decide with confidence the best alternative for their operation and maintenance of flaring facility effort to be implemented at the field, based on the analysis results obtained from the AHP method and the BCOR approach by using Super Decision, the highest consideration is based on the highest global BCOR weight is a benefit, followed by risk and the third is cost, and the last one is opportunity. The benefit weight becomes the highest consideration since compliance to safety and environment include in the benefit criteria, besides the optimization of operation and maintenance for safety in design. This is by following per under the value and vision of PT. CPI "To be the global energy company most admired for its people, partnership and performance"

From the AHP analysis with the BOCR factor, the best alternative is to flare the gas to the nearest flaring facility.

Keywords - Analytical Hierarchy Process (AHP), BCOR, Flaring Facility, Multi-criteria Decision Making, Oil and Gas Industry, Operations & Maintenance

I. INTRODUCTION

Oil and gas industry has become the lifeblood and the backbone of energy resources in the world. The challenges faced to date are still the same, is how to meet world energy demand, but in the same time also to minimize the adverse impact on the environment. One of the efforts is to maintain the good operations and maintenance of pollution control facilities, especially for flaring facility.

PT. Chomrong Perminyakan Indonesia (PT. CPI) operates the world's largest steamflood which is located in Torn Field, Riau Province. In carrying out the activities which consist of drilling (from all wells in the operating area), oil processing operations (separation from crude oil and condensate to light and heavy oil, gas, and by-products), and distribution for shipping, PT. CPI is committed to protecting the environment wherever it operates. PT. CPI also applies the same international standards and best practices to environmental management and is constantly looking for new ways to minimize its footprint and improve environmental and social performance, including in managing its flaring activity. According to the regulation, flaring is categorized as one of the methods to control air pollution. *"Pembakaran suar bakar (flaring) adalah pembakaran secara kontinyu maupun yang tidak menerus dari gas-gas yang dihasilkan oleh kegiatan operasi minyak dan gas pada cerobong tetap (stationary stack) baik vertikal maupun horizontal" (Article 1 Paragraph 19)* (KLHK, 2009)

PT. CPI currently is facing a problem with the operations and maintenance of one of the offline flaring facilities. Maintenance can be defined as all activities to maintain the condition of the item/part/equipment or repair it to a good condition **(Dhillon, 2002)**. The oil and gas industry is an industry with a very competitive market, which requires high performance at its facilities. Facilities with high availability, reliability, and maintainability for equipment are an obligation, thus making optimization of maintenance activities a very important thing **(Eduardo, 2012)**

The cost of maintaining equipment and facilities in the oil and gas industry is the third-largest within the production, so optimization for operation and maintenance is very important **(Collins, 2014)**. In the calculation maintenance practice, the cost of maintenance material cost for flaring/EGF facility is assumed to be equal to maintenance labor cost **(John L. Sorrels, 2019)**. However, this maintenance is very important because poor maintenance and failure can result in catastrophic

ISBN*: 978-623-92201-2-9*

consequences such as operational failure or non-compliance with environmental and safety regulations due to air pollution caused by releasing undesirable by-products including noise, smoke, heat radiation, light, sulfur oxides (SO_x), nitrogen oxides (NO_x), Carbon Monoxide (CO) and an additional source of ignition where not desired **(Evans Leslie et al, 2020)**. In adition to air pollution, it can be dissolved in rain water which gets ingested by drinking water or the produced vegetation around the area **(Al-Fehdly et al, 2019)** especially for associated gas or natural gas from TSF area that has high sulfur composition, contained Hydrogen Sulfide (H_2S) or the sour gas that is fatal for human health if inhaled or might cause acid rain to the environment.

Due to the low integrity of the flaring / EGF facility caused by aging, most of the flaring / EGF facilities were damaged in the insulation section. Insulation is a shell that covers the inside of the flaring facility or EGF, its purpose is to reduce noise, luminosity, and heat radiation and provide protection against wind, so that the fire used to burn the associated gases is stable **(Evans Leslie et al, 2020)**.

Considering all the business issues that are now being faced, decision-making using the Multi-Criteria Decision Making (MCDM) tool by using the BCOR factor to get the best alternative for operations and maintenance of flaring facility effort is needed. It is hoped that the best alternative can provide high opportunity and benefit values, while the low for risk and also in terms of costs. AHP can also identify and explain the weighting of the most important criteria in selecting existing alternatives.

II. METHODOLOGY

This research and writing will combine qualitative and quantitative methods. Benefit, Opportunity, Cost, and Risk (BCOR) considerations will be the initial identification in determining the criteria and sub-criteria, that is based on the international standard for flaring and specifically EGF used by the engineering team and FOT of PT. CPI, as well as other study literature and, has been validated in terms of its implementation so far through discussion and coordination with facility owners and also those who are experts in this Flaring / EGF operation. Then, from the criteria and sub-criteria that have been determined for each BCOR factor, Analytical Hierarchy Process (AHP) is used to select the best alternative.

The use of the Benefit, Opportunity, Cost and Risk approach (BCOR Analysis, Saaty, 2001b) as the criteria in the AHP structure, makes it possible to obtain a decision-making analysis that considers the bipolarity nature of each existing attribute, with regards to the alternative that chosen in terms of support and reject **(Tchangani, 2010).**

And further, if the BCOR defines as the criteria and sub-criteria in the AHP structure, Wijnmalen **(Wijnmalen, 2007)** describes the relationship of each criterion as shown in Figure 1.

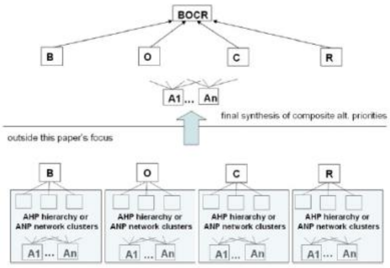

Figure 1. Wijnmalen Final BCOR Value According to ANP-AHP

Velazques and Hester (2013) on **(An analysis of multi-criteria decision-making methods, 2013)** shows why the AHP method is the most recommended method for selecting multi-criteria decision making on maintenance problems in the petroleum industry, as presented in Table 1.

TABLE 1. STRENGTH AND WEAKNESS OF AHP FOR MAINTENANCE IN PETROLEUM INDUSTRY

Method	**Strength**	**Weakness**
Analytic Hierarchy Process (AHP)	a. Availability of software with good graphical capabilities b. Clear hierarchy structure c. Use of qualitative d. Possibility of trades of between criteria e. Rank reversal can occur	The use of rigid scale might not reflected uncertainty

(Saaty, 1982) explains that the AHP application to choose a maintenance policy is a team effort that requires a group of people to make decisions. AHP also not only helps to provide guidance to arrive at the best decision, but also provides a clear rationale for choice made and on the other hand enables analysts to measure its consistency **(Saaty, 1990)**.

A thorough discussion supported with evidence performed to determine the degree of importance of each criterion (using pairwise comparisons and AHP fundamental scale) in the Focus Group Discussion (FGD) that attended by the Subject Matter Expertise and Facility Owner, the results of the pairwise comparison then used as quantitative data. This data will later become the basis for calculations by presenting it in the form of a matrix. The Research Methodology for this final project shown as Figure 2 below.

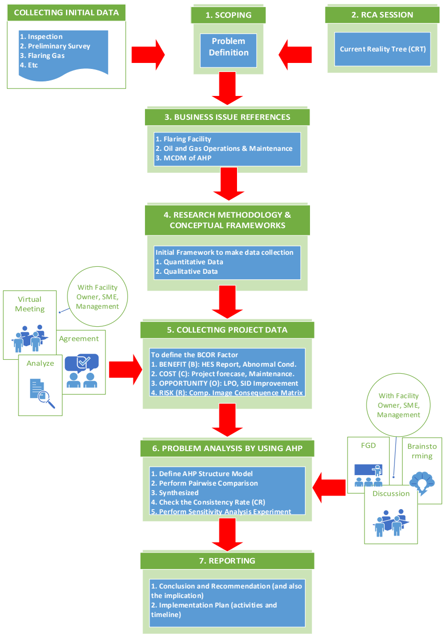

Figure 2. Research Methodology

The step-by-step problem analysis by using Multi-Criteria Decision Making (MCDM) by using the AHP method details below.

2.1 Step 1: Creating AHP Hierarchy Structure Model

Creating a model using hierarchy structure means, include the main objective or goal (Flaring Facility Operation and Maintenance effort), which occupies the top place of the hierarchy, then followed by the Benefit, Opportunity, Cost, and Risk (BCOR) factor approach, continue with the criteria cluster, sub-criteria cluster, and the most below is the alternatives consist of 1. EGF / Flaring Facility Repair; 2. Jumper Line or Connect to nearest EGF / Flaring Facility, as represented in Figure 3. AHP Hierarchy Structure Model.

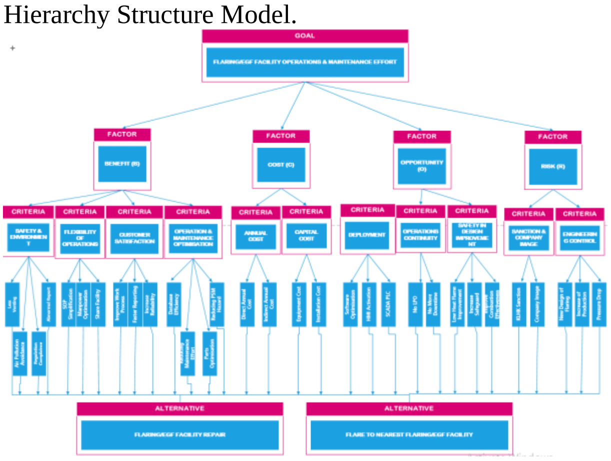

Figure 3. BCOR – AHP Structure for Flaring/EGF Maintenance and Operation Effort

2.2 Step 2: Pairwise Matrix Evaluation or Comparison

Some several ways or methods can be used to evaluate the pairwise matrix. **Wang et al (2007)** define 3 ways, namely:

a. Mean of the normalized values (MNV)
b. The Normalized Geometric Mean (NGM)
c. The Eigenvector Method (EVM) is a method derived from Saaty himself.

However, considering the complexity of the calculations, this final project will use a software called Super Decision V2.X that can be downloaded for free from http://www.superdecisions.com/downloads/ super decision is software support based on AHP and ANP that allows to include intangibles factors in decision making.

2.3 Step 3: Set Priority (weights) among criteria in the hierarchy (synthesized)

(Vidal Ludovic-Alexandre et al, 2011) explained that this weighting will be very important in determining which alternatives to choose (in context-specific criteria).

Table 2. is the fundamental scale of AHP that adopted from Saaty (1987) to weighted the criteria in the pairwise comparison **(Saaty, 2008)**

TABLE 2. THE FUNDAMENTAL SCALE OF AHP (ADOPTED FROM SAATY)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is favoured, and its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

Source: Adapted from Saaty [29].

2.4 Step 4: Consistency Rate Checking of the Matrix

Judgment evaluation in AHP is done by using the Consistency Ratio (CR). Judgment can be accepted if the consistency ratio is less than 0.1 (10%), and if the consistency ratio number exceeds 0.1 then the matrix assessment must be repeated. **(Saaty, 1977)** has set a consistency index (CI), whose value is related to the eigenvalue method **(Ishizaka Alessio, 2009)**. Consistency Ratio (CR) can be calculated using the following formula,

CR = $\frac{CI}{RI}$, where:

a. RI is the Random Consistency Index whose number is a constant of the number of sample sizes (n) under study. Saaty proposed a random consistency index table using a sample size of 500 matrices.

TABLE 3. RANDOM CONSISTENCY OF SAMPLE SIZE 500 MATRICES

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

b. CI is a Consistency Index, which is obtained by calculating using the following formula, CI = $\frac{\lambda_{max} - n}{n-1}$, where the λ_{max} is the maximum eigenvalue and n is the size of the matrix.

ISBN*: 978-623-92201-2-9*

2.5 Step 5: Sensitivity Analysis

The final step in the decision-making process using the AHP method is sensitivity analysis. This stage allows checking whether the resulting outcome changes with changing criteria weights. Experts allow differences in sensitivity analyzes, where this difference usually lies in a variety of graphical representations **(Ishizaka Alessio, 2009)**.

III. RESULTS

The use of the Benefit, Cost, Opportunity and Risk (BCOR) factor approach in determining the criteria in the AHP method allows decision-makers to obtain an analysis that considers the bipolarity nature of each alternative option so that it makes it easier for decision-makers to choose the best alternatives.

In this case, taking into account the BCOR factor in determining the criteria (and sub-criteria) for which the best method that will be chosen for the operation and maintenance of the flaring / EGF facility in FOD Area 5, management and facility owner and related teams will direct to get the best choice with prioritized considerations by the current conditions and situation of the company and organization.

In BCOR analysis, by taking the BCOR ratio for each alternative, the alternative with the highest ratio would be the optimal choice. Practitioners can apply different forms of BCOR analysis according to the business strategy, for example, simple BC (benefit-cost), BCO (more positive), BCR (more negative), or BCOR (more holistic) **(Sarkis et al., 2011; Lee et al., 2012)**

3.1 Pairwise Comparison Matrix Result

A pairwise comparison questionnaire is made to determine the degree of importance of each criterion. Pairwise comparisons were carried out thru Focus Group Discussion (FGD) involving the facility owner, the leadership in TSF as the decision-maker for the operation and maintenance of the flaring / EGF facility, the HES team, the Facility engineering, Cost Controller, as well as the operators who carry out activities in day-to-day operations, the results of the pairwise comparison then used as quantitative data.

49 pairwise comparison matrices developed in the process of selecting alternatives of operations and maintenance flaring/EGF facility effort. 11 matrices are for the comparison among the criteria in each factor/cluster, with the two alternatives. 4 matrices compare among the criteria in each factor/cluster. 1 matrix compares the goal/global (Flaring/EGF Facility Operations and Maintenance Effort) with every 4 factors/cluster (BCOR) same with 1 matrix compare cluster comparisons concerning factor. And 31 matrices are for the comparison among the sub-criteria.

TABLE 4. PAIRWISE CLUSTER COMPARISONS CONCERNING FACTOR

BENEFIT	>=9.5	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	>=9.5	COST
BENEFIT	>=9.5	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	>=9.5	OPPORTUNITY
BENEFIT	>=9.5	9	8	7	6	5	4	3	**2**	1	2	3	4	5	6	7	8	9	>=9.5	RISK
COST	>=9.5	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	>=9.5	OPPORTUNITY
COST	>=9.5	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	>=9.5	RISK
OPPORTUNITY	>=9.5	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	>=9.5	RISK

From the pairwise matrix concerning factor cluster (BCOR), we can understand that decision-makers prioritized benefit and risk factors. This is because, the criteria and sub-criteria (as per Figure 3.) include in the benefit and risk factor consist of environmental and safety compliance for the criteria, with no venting as the sub-criteria for the benefit factor. And for the Risk, No KLHK Sanction and Prudent Operator as the Company image for the criteria. The decision-maker, confirms if the flaring online for 24 hours and no offline, means there is no compliance to the environmental regulation, therefore there will be no KLHK sanction, and Company Image as a prudent operator will still manage.

TABLE 5. PAIRWISE COMPARISONS "B" CRITERIA IN BENEFIT FACTOR/CLUSTER

CUSTOMER SATISFACTION	>=9.5	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	>=9.5	FLEXIBILITY OF OPERATIONS
CUSTOMER SATISFACTION	>=9.5	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	>=9.5	OPERATIONS & MAINTENANCE OPTIMISATION
CUSTOMER SATISFACTION	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5	SAFETY & ENVIRONMENT
FLEXIBILITY OF OPERATIONS	>=9.5	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	>=9.5	OPERATIONS & MAINTENANCE OPTIMISATION
FLEXIBILITY OF OPERATIONS	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5	SAFETY & ENVIRONMENT
OPERATIONS & MAINTENANCE OPTIMISATION	>=9.5	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	>=9.5	SAFETY & ENVIRONMENT

As we can see from the Pairwise Comparisons table for the Benefit factor cluster above, the decision-maker gave 3 or above for the safety and environment criteria, since safety and environment are the priority in PT. CPI for something that needs to be considered in every aspect of the work.

TABLE 6. PAIRWISE COMPARISONS "R" CRITERIA IN RISK FACTOR/CLUSTER

ENGINEERING CONTROL	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	>=9.5	SANCTION & COMPANY IMAGE

While Risk factors include the sanction and company image criteria, that according to the decision-maker won't be occurred and happened if the criteria of safety and environment in the benefit factor have been implemented and done.

3.2 Consistency Test

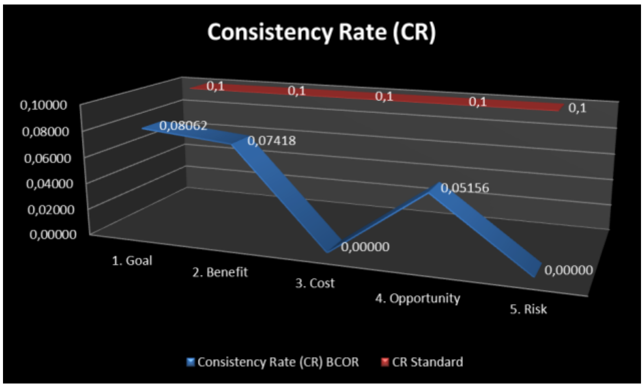

Figure 4. Consistency Ratio (CR)

From the Figure 4. Consistency Ratio (CR) of pairwise comparison for each factor (Benefit, Cost, Opportunity and Risk) and goal (or the global) in this final assignment yields that mostly <0.1 or 10%. Goal CR = 0.08062, Benefit cluster/factor CR = 0.07418, Cost cluster/factor CR = 0.00000, Opportunity cluster/factor CR = 0.05156 and Risk cluster/factor CR = 0.00000.
This illustrates the decisions made by looking at the acquisition of a consistency ratio value of > 0.1, which of course, according to the provisions of Saaty, meets the requirements because it is less than 10% (0.1), so automatically the local decision can be accepted.

3.3 AHP Criteria Priorities Calculation

The next step from AHP methods after pairwise matrix and consistency ratio has been performed, is to calculate the priorities by entering these weighting values into the Super Decision software to determine the priority of each criterion and sub-criterion to the available alternatives, or to find the local and global priorities.

3.3.1 Local Priorities

Local Priority is a grouping of priority values from the cluster/factor benefit, cost, opportunity, and risk. The value of each of the under-benefit criteria, cost, opportunities, and risk cluster/factor can be seen in Figure 5 below.

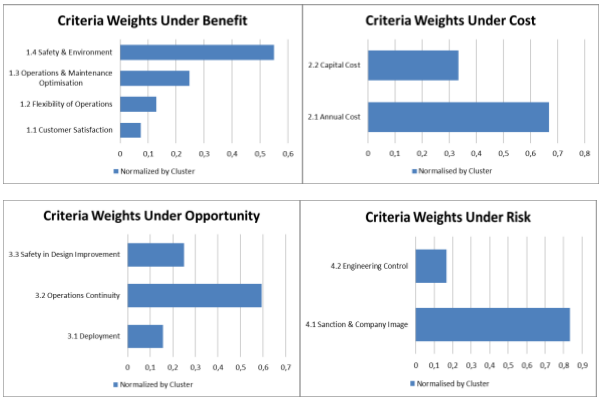

Figure 5 Local Criteria Weight under BCOR Cluster

Based on the weights, the local priorities for alternatives under benefits, cost, opportunity and risk cluster are shown in the Figure 6. below.

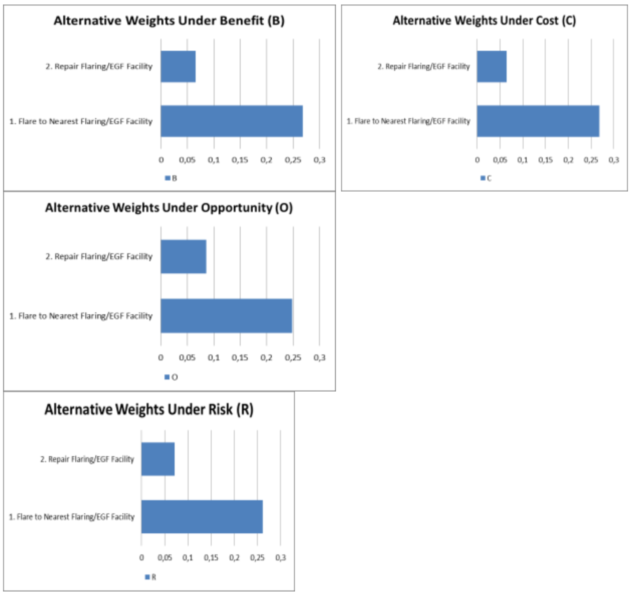

Figure 6. Local Alternatives Priorities

Safety and environment criteria have the greatest value priority (0,549494) under the benefit cluster/factors. This result indicates, that Company considers that this criterion is the most important, due to the value of the Company emphasize the improvement of people safe, creating a safe working area for workers, and effort for the environmental protection (always comply with the environmental regulation) as well as operational safety.

Factor priorities under the benefit cluster are resulting in rank for alternatives. Flare to nearest flaring/EGF facility has the greatest value for all criteria under benefit cluster (0.268219) compare with the other alternative which is repair flaring/EGF facility (0,065114). This is because the alternative for flaring to the nearest flaring / EGF facility is an option based on safety and environmental criteria. This criterion will make the company more compliant with environmental regulations (because the company can still burn the associated gas produced from production wells without having to shut down too long), and another advantage of choosing this alternative is that the company can optimize the maintenance, especially in the situation when the company is about to hand over its work contract to another operator, as well as the limited number of operators who carry out maintenance, due to retirement and the previous transformation program.

For the cost cluster, annual cost has the highest local priority number (0,666667), rather than capital cost (0,333333). As described in the previous sub-chapter that the annual cost consists of fuel cost for initial flame ignition, raw materials, maintenance, while capital cost consists of the cost to repair the flaring facility or to do the jumper line to the nearest flaring facility.

From the cost perspective, the Flare to nearest flaring/EGF facility has the greatest value for cost cluster (0.268519) compare with another alternative which is the repair flaring/EGF facility (0,064815). This is because the capital cost to repair the flaring/EGF facility is higher rather than perform the flaring to the nearest flaring/EGF facility (by doing jumper line construction). For annual cost, flaring to the nearest flare/EGF facility will optimize the use of fuel.

The weight priority for opportunities cluster indicates that Operations Continuity (no lost production opportunity) criteria are on priority (0,593634) and safety in design improvement (additional safeguard to protect people, environment, and Company's assets) is the second priority (0,249311), and deployment (the use and optimization of software and system for maintenance and operation of flaring facility) is the third priority (0,157056).

Alternative Flare to nearest flaring/EGF facility indicates as the highest opportunity (0.247699) rather than repair flaring/EGF facility (0.08563) since according to the simulation made by SME, the time to repair the flaring facility will take 8 months, during that period flaring facility will be shut down, and the treatment of lost production opportunity due to the main facility of good test can not use properly will be happened.

Weight priorities for risk indicate that alternative Flare to nearest flaring/EGF facility has the highest risk (0,261727). Following by an alternative repair flaring/EGF facility (0.071606). This does not indicate that the alternative of flare to nearest flaring/EGF facility has more risk rather than repair the flaring facility, on the other hand, at the time of scoring or weighting in pairwise comparisons, SME and Facility consider that the risk criterion is one of the most important things to prioritize, apart from benefits. Given, the criteria included in this Risk have the potential for sanctions and the threat of damaging the company image as a prudent operator.

3.3.2 Global Priorities

Based on the cluster/factor consideration (global BCOR priorities), the key decision-makers are focusing on the benefit factor (which has the first greatest priority value is for criteria of safety and environment. This means in the selection of operation & maintenance flaring/EGF facility effort, the team focuses more on the Benefit, Risk, and Cost aspects compared with the Opportunity aspect. Understandably, working in the upstream oil and gas industry will have a high risk on safety and environment, and compliance to safety and environment regulation and requirements is mandatory to be implemented in the day-to-day operations.

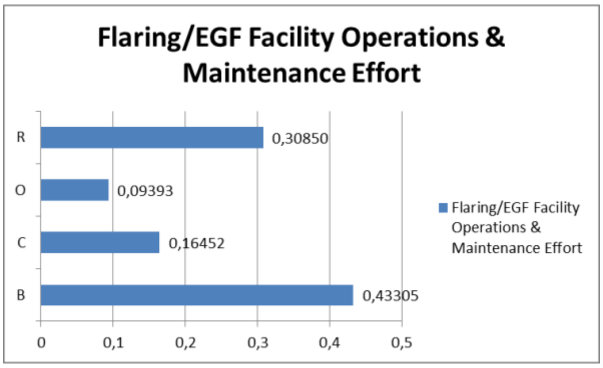

Figure 7 Global BCOR Priorities

Based on the global alternative weight, respondents are selecting flare to nearest flaring/EGF facility effort as the best alternative with the highest final priority value 0.7965, following by alternative repair flaring/EGF facility with the priority value 0.2044 on the second priority.

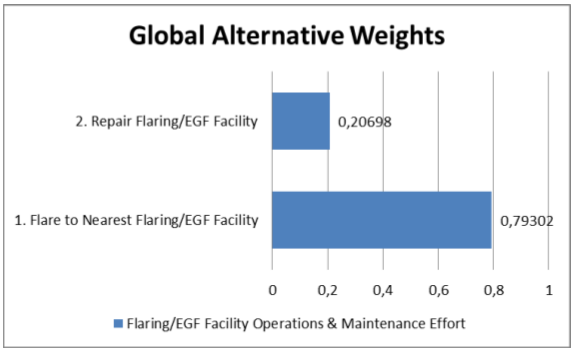

Figure 8 Global Alternative Priorities

3.3.2 Sensitivity Analysis

The final step in the decision-making process using the AHP method is sensitivity analysis. Sensitivity analysis performs intending to eliminate concerns about the uncertainty of problems that will arise, this can occur in determining the pairwise matrix where the value of the element against the pairwise matrix can change from the input received from several respondents. Will there be a change in decision priority through sensitivity analysis that will test all the criteria used as a barometer of the final decision. This stage allows checking whether the resulting outcome changes with changing criteria weights.

When the sensitivity analysis experiment was performed for the global BCOR priorities by using the value in Figure 5 below, by lowering and increasing the normal value, the alternative of flare to the nearest flaring/EGF facility still become the best alternative. It means, whether there is any change from the management policy (if the benefit will be lower than cost or than opportunity, just in case the top management consider that cost will become more priority than benefit), the result remains the same.

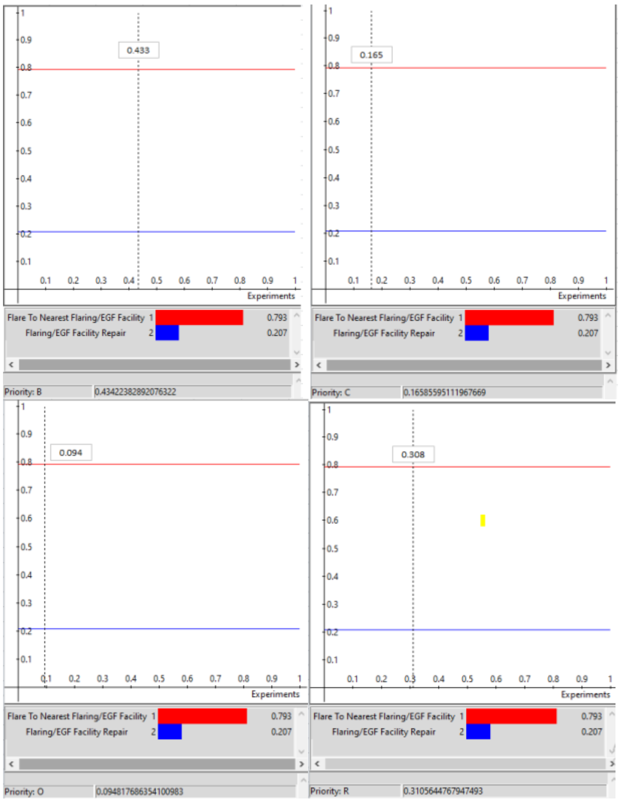

Figure 8 BCOR Sensitive Analysis by Normal Value

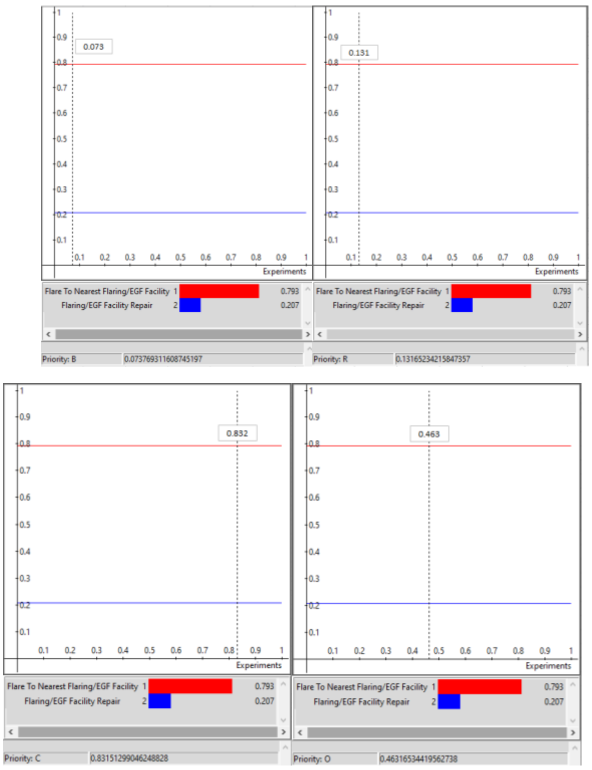

Figure 9 BCOR Sensitive Analysis by Experimen Value

3.4 Abbreviations and Acronyms

AHP	:	Analytical Hierarchy Process
BBOE	:	Billion Barrel Oil Equivalent
BCOR	:	Benefit, Cost, Opportunity, Risk
CFR	:	Code of Federal Regulation (numbering in EPA or standard that used in the US)
CI	:	Consistency Index
CPI	:	Chomrong Perminyakan Indonesia
CR	:	Consistency Rate
EGF	:	Enclosed Ground Flare
FGD	:	Focus Group Discussion
FO	:	Facility Owner
GHG	:	Green House Gas
KLHK	:	Kementerian Lingkungan Hidup Kehutanan
LPO	:	Lost Production Opportunity
MBOPD	:	Thousands of Barrels of Oil Per Day
MBOEPD	:	Thousands of Barrels Oil Equivalent Per Day
MCDA	:	Multi-Criteria Decision Analysis
MCDM	:	Multi-Criteria Decision Making
OEHES	:	Operational Excellence Health, Environment & Safety
PERMEN LH	:	Peraturan Menteri Negara Lingkungan Hidup
SME	:	Subject Matter Expertise
SMO	:	Sumatera Operations

IV. DISCUSSION

1. Assessment or weighting and ranking of alternatives can be used as a reference for PT. CPI (or new operator that will replace PT. CPI), if shortly, a similar analysis for flaring facilities in other areas outside Thorn Field will be conducted (for flaring facility in South or North areas).
2. Sensitivity analysis will help the management of PT. CPI (or new operator) to be able to see how a decision can affect and experience changes when the weight of the BOCR factor is changed. This will help management to shorten the time in making decisions (if the company wants to use the AHP method in making decisions for multi-criteria conditions, without having to make this AHP method from scratch).

V. CONCLUSION

Selecting the optimized, comply to the regulation and the right method for operations and maintenance flaring/EGF facility, particularly in the situation where the work contract will end less than 6 months is crucial for PT. CPI. There are many criteria needed to be evaluated to select the method, to activate the flaring facility, and to reduce the offline time during the operation.

This study has proposed a Multi-Criteria Decision Making (MCDM) through the AHP method with BCOR analysis. There are four (4) factor clusters (benefit, cost, opportunity, and risk) with eleven (11) criteria and thirty-one (31) sub-criteria for each cluster and two (2) alternatives cluster at the bottom of the AHP structured

ISBN*: 978-623-92201-2-9*

model, that defined by the team during FGD. These criteria and sub-criteria in each BCOR factor are used in the AHP modeling to select the best alternative for operations and maintenance of flaring facility effort.

AHP method that used to select the best alternative, could gain the opinion, constraint, consideration from numbers of the respondent and different stakeholders (SME and facility owner) from various units and background, which translated into priorities value of the criteria. From this final project, it is determined there are three (3) major and important criteria needed to select the best effort for operations & maintenance flaring/EGF facility in FOT, are Safety and environment, Sanction and Company Image, and Annual Cost.

Refer to chapter one (1) in this final project about the research question, about the important criteria that should be taken into consideration in deciding what alternative is the best for operations and maintenance flaring/EGF facility effort, it could be concluded that safety and environment (compliance to regulation about no venting policy), sanction and company image as prudent operator and annual cost (that consist of fuel cost, maintenance cost and so on) is the important criteria from the priority value as the result from the AHP method.

Refer to question number two (2) about the best alternative using criteria that have been approved by implementing the Analytical Hierarchy Process (AHP) considering multi-criteria in decision making, the option or alternative of flare to nearest flaring/EGF facility is the best alternative, by having highest priority value (0.79302) compared to repair flaring/EGF facility (0.20698).

ACKNOWLEDGMENT

I wish to express appreciation to:

1. All the anonymous referees for their works.
2. Ibu Yuliani Dwi Lestari, S.T., MBA, Ph.D. as my thesis supervisor who had helped me through advice, support, inspiration, insights, and her valuable time in guiding me to accomplish this study.
3. Pak Dr.Eng.Nur Budi Mulyono S.T., M.T, and Ibu Ira Fachira S.Si., M.T., Ph.D. as examiners during final project oral defense for their insights and suggestions.
4. All the lecturers of SBM-ITB who shared their valuable knowledge, expertise, and experience throughout this MBA Program, and to all staff who help me with administration requirements.
5. PT. Chevron Pacific Indonesia for continuous support on people development through the ESDP scholarship program. And particular to FOD-5 Team for support in completing this thesis.

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