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The Effectiveness of Organizational Factor toward Safety Program Implementation after Mahakam Oil & Gas Field Transition in 2018

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Abstract: ***Safety performance is often used as a one of key indicator to measure Oil and Gas (O&G) operator performance in the world. This indicator is also consistently implementing by Mahakam O&G Field operator in order to ensure the operational activities are operated in safely manner. A production and safety achievement in Mahakam O&G Field has become major stakeholder concerns after transition period in 2018. PT. CCC as new operator is assigned to continue the success story of previous operator specifically to maintain good safety performance. However, the journey to maintain safety achievement in Mahakam O&G Field is not an easy way. Statistically, until June 2018, 1 accident case categorized as lost time injury (LTI), 5 recordable injuries (RI) and 9 near-missed incidents with high potential category have occurred and recorded in company perimeter. Not only the incident case, two serious violation also reported involving several contractor workers who done smoking activity at offshore platform which categorized as hazardous area. Contribution of organizational factors toward safety performance of organization has a significant role to prevent and reduce serious accident case and unsafe behavior. An expert's knowledge to gain specific indicators to measure organizational factors is required. This research offers the model of effectiveness of organizational factors in implementing safety program with Data Envelopment Analysis (DEA) approach. Research result shown that 2 DMU's are efficient, namely Drilling (DRLL) and Exploration (EXPL) and 4 DMU's are inefficient, there are Production (PRO) with DEA score 0.32, Construction (CONS) with score 0.547, Logistic (LOG) with score 0.26 and Well Operations (WLO) with score 0.028. Inefficient DMU's mostly contributed by ineffectiveness of organizational level factor, safety management level factor and working group level to achieve safety outcome. The research result will guide management of organization to put more attention to reviewing ineffective organizational factor specifically during transition period of O&G block in Indonesia.***

Keywords: Organizational factor, Effectiveness, Safety Program, Data Envelopment Analysis (DEA).

1. Introduction

To improve safety performance of organization, coherent action is required in 3 areas: technical aspects, safety management, and human and organizational factors. These different "pillars" of course, not independent from one another: well designed and well maintained facilities, along with clear, applicable rules contribute to safe human activities [1]. Among all, human and organizational factors were most compared as predictors of frequency of accidents, which involving individuals, the work group, the working environment and the living organization [1], [2].

Mahakam Oil and Gas (O&G) Block in East Kalimantan has produced 1.3 Million Standard Cubic Feet per Day (MMSCFD) of gas and 50,000 Barrel per Day (BPD) of oil and condensate in 2017. In the same year, the operator has also achieved 680 days without Lost Time Injury (LTI) contributed by more than 50,000,000 worked man hours. In 2018, management of Mahakam Block is returned to Indonesian government after being managed by foreign contractor as operator for almost than 50 years. This condition is consistent with implementation of Indonesian regulation No.22/2001 about Oil and Gas. Indonesian government through Indonesian State-Owned Oil and Natural Gas Corporation has assigned PT. CCC as new operator to continue success story of Mahakam Block's production and safety performance. However, the journey to maintain safety performance achievement in Mahakam Block is not an easy way. Statistically, until 1st semester of 2018, PT CCC has recorded the occurrences of 1 LTI case, 5 recordable injuries (RI) and 9 near-missed incidents with high potential category in company perimeter. While the differ situation could be found when we compares with the previous operator safety performance in 2017, wherein Mahakam Block was successfully passed the first semester of 2017 without LTI case, 3 RI and 6 high potential near-missed incidents. PT. CCC also reported a substandard behavior who categorized as serious violation where several contractor workers done smoking activity at offshore well platform without authorization which never been happened before.

The situation was happened to coincide with Mahakam Block transition period in 2018 where new operator has committed to continue safety performance from previous operator. Changes in the organization can lead to a change in the organizational culture that can make it more or less supportive of organizational outcomes [4]. Remarkable safety performance has become one of organizational outcomes in Mahakam Block that need to be maintained by whoever the operator is. The transition of Mahakam Block operator has promoted a research question regarding how the effectiveness of organizational factor of new operator to continue the implementation of safety program from previous operator to prevent incident and substandard behavior. The research attempts to develop a model of effectiveness of organizational factors in implementing safety program after Mahakam Block transition period in 2018. The effectiveness model was analyzed by Data Envelopment Analysis (DEA) approach which has been demonstrated to help organizations measure the effectiveness of Safety Management System

(SMS) and determine how to improve SMS-related performance [5].

2. Literature Review

2.1 Organizational Effectiveness

Organizational effectiveness (OE) is an ability of organization to achieve the goal [6]. Its focus is on the output to figure out the essential operating objectives like profit, innovation and finally product quality [7]. There are some basic assumptions for the goal approach; general agreements on the specific goals, people involved should feel committed to fulfilling them and requires certain indispensable resources [7]. The OE models gradually considered the resources and processes necessary to attain those goals (system models), the powerful constituencies gravitating around the organization (strategic-constituencies model), the values on which the evaluation of effectiveness are grounded (competing values model) and the absence of ineffectiveness factors as a source of effectiveness (ineffectiveness model) [8]. Ineffectiveness model evinces a different perspective by conceiving the organization as a set of problems and fault (…) .its basic assumption is that it is easier, more accurate, more consensual and more beneficial to identify problems and faults (ineffectiveness) than criteria of competencies (effectiveness). Hence, organizational effectiveness is defined as the absence of ineffectiveness factors [8]. This concept is used to capture the effectiveness of organizational factor to implement safety program as one of organization outcomes in Mahakam Block.

2.2 Organizational Factors on Safety

Organizational factors can impact safety by: decreasing undesired behaviors, encouraging desired behaviors, and managing the way systems respond to less-than-adequate human performance via barriers and controls [9]. Accident investigation result shown that the performance of operational personnel (employees) and decision makers (managers) was embedded in an organizational context and that understanding how organizational factors influenced and responded to the behavior of frontline personnel was essential to safety management [2, 9]. Based on level of analysis perspective from several previous studies, author derived the organizational factors level on safety into four categories: organizational level factors (management commitment, employee empowerment, attitude & interpersonal relationship), safety management factors (safety activities, safety management system, reporting system & reward system), work group factors (supervision & teamwork) and individual level factors (safety self-efficacy, safety awareness & safety behavior) [3, 10]. Safety requires the presences of certain attributes in the organization that can be achieved by a strategy of control & limitation and proactive development of the system...within this framework, safety performance indicators are seen as organizational tools for the evaluation and improvement of the sociotechnical system function as part of the safety management process of the organization [11].

2.3 Health and Safety Occupational Program

To implement and achieve the target and objective of occupational safety, organization needs to develop health and safety occupational program which include strategy and follow up plan in a document format [12]. In general, there are two indicators used to measure safety performances in organization, there are lagging and leading indicators. Lagging indicators data provide necessary information on safety performance related to injuries and accidents that can motivate people to work on improving safety performance, while leading indicators, or inputs, allow organizations to more proactive to predict safety concerns and that may reduce the likelihood of an OHS incident occurring [13]. Leading indicators relate directly to safety-management activities and are either measure of those activities themselves (…) lead indicators are measures of input, while lag indicators measure outcomes [14].

2.4 Data Envelopment Analysis (DEA) Method

DEA is used to measure the performance of firms or entities which convert multiple inputs into multiple outputs. Firm efficiency is defined as the ratio of the sum of its weighted outputs to the sum of its weighted inputs [15]. The firm under study is called a decision making unit (DMU), the entity that responsible for converting inputs (i.e., resources, money, etc.) into outputs (i.e., sales, profits, certain performance measures, etc.) and whose performance is to be evaluated [16]. It is desirable that number of DMUs equal or exceeds the combined number of inputs and outputs by several times [17]. Each firm's efficiency score is calculated relative to an efficiency frontier that has an efficiency score of 1 (or 100 %); firms operating beneath the frontier have a score inferior to 1 (or 100%) and hence have the capacity to improve future performance [17]. A DEA model assessed the relative efficiency of every DMU relative to the rest of the DMU in terms of safety performance and produced to help organizations measure the effectiveness of their Safety Management System (SMS) and determine how to improve SMS-related performance [16], [5].

This research used constant returns to scale technology (CRS or CCR) as DEA model. This is appropriate when all firms are operating at an optimal scale. Efficiency is defined by Charnes *et al*, (1978, p.430) as "the maximum of a ratio of weighted outputs to weighted inputs subject that the similar ratios for every DMU be less or equal to unity." [17]. Mathematical equation model:

$$\text{Max. } Dk \quad \frac{\sum_{r=1}^{s} ur.\, yrk}{\sum_{i=1}^{m} vi.xik} \leq 1 \qquad (1)$$

Where:

Dk Size of efficiency from DMUk (evaluated DMU).

u_r Output weight r.

v_i Input weight i.

y_{rk} Number of output r resulted by DMUk

x_{ik} Number of input i used by DMUk

s Number of output

m Number of input

Above equation has been transformed to liner programming formula as follow:

$$\text{Max. } Dk = \sum_{r=1}^{s} u_r y_{rk} \quad (2)$$

$$\text{Subject to } \sum_{i=1}^{m} v_i x_{ik} = 1 \quad (3)$$

$$\sum_{r=1}^{s} u_r y_{rk} - \sum_{i=1}^{m} v_i x_{ik} \leq 1 \quad (4)$$

$$u_r, v_i \geq 0 \quad (5)$$

Mentioned function desired to maximize efficiency of evaluated DMU by maximize the number of output (equation #2) and preserves the number of input equal with 1 (equation #3). The efficient DMU will have efficiency score between 0 until 1 (equation#4), where the number of output and input shall be positive (equation #5). This linear programming problem can be dealt following two different approaches. In the first one, the weighted sums of outputs are maximized holding inputs constant (output-oriented model). In the second one, the weighted sums of inputs are minimized holding outputs constant (input-oriented model) [17].

Therefore, the CCR model of DEA will be used to benchmark the level of organizational factors on respective entities (DMU) towards safety program implementation in Mahakam Block. An entity is considered efficient if it has an efficiency score of 1 and will become the efficient frontier, which means, this entity effectively converts its inputs into outputs [16].

3. Research Methodology

The objective of this research is to obtain a model of effectiveness of organizational factor toward safety program implementation after transition period in Mahakam Block based on organizational effectiveness goal and ineffectiveness model. The model is intended to identify inefficient organizational factor on each entities (DMU) that potentially become inhibitor for organization to implement the existing safety program effectively and propose way forward to maximize it. The efficiency score will be computed by using DEA-CCR output oriented model in software MaxDEA 7 Basic. DEA will process the information as a "Black Box" with quantitative criteria (cardinal). DEA has no priori assumptions (…) there is no need to assign weights to the different inputs and outputs [18].

3.1 Research Model and Variables

The research framework is constructed by considering the nature of all safety systems from OSHA (Occupational Safety and Health Administration) that consist of inputs, processes, and outputs as a center of management and control the system [19]. The inputs and outputs are monitored by designated performance indicators. It has been said that indicators should be able to identify organizational practices and processes that antecede (lead) changes in the safety performance of the organization [11]. The inputs of the system leading indicators relate directly to safety-management activities and are either measure of those activities themselves (…) lead indicators are measures of input, while lag indicators measure outcomes [14].

DEA model assumed that organizational factors that consist of organizational level factors, safety management level, work group factors and individual level factors act as input and leading variable to drive entities (DMU) in implementing safety program with outcome (lagging) indicator namely number days without Recordable Injury. The research model available in Figure.1

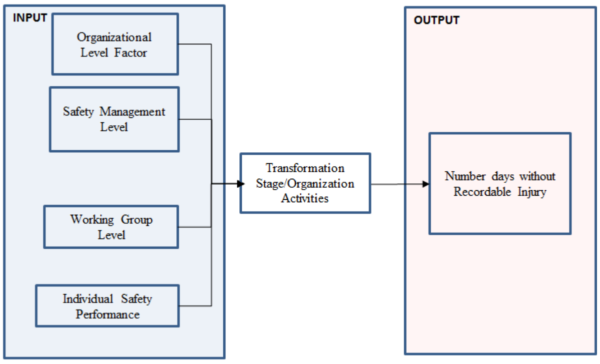

Figure 1: Research Model

The leading indicators of input variables obtained from 14 expert interview results on November-December 2018. The expert has been chosen from safety representative/expert represented respective entities with more than 10 years experienced on his/her field of work and has a background in a certain area and receives recognition from his/her peers in a particular technical field [21]. Organizations feel the need to involve experts more likely when: experts are better, faster, or cheaper than other potential solutions; new information requires frequent updates of assumptions and decisions; and available data are rich, yet some key parameters cannot be estimated [20]. The expert judgment is assessed by using complex weighting factor method to evaluate complex valued criteria based on objective data (level job position, total work experience, work experience in the problem area, educational level), subjective data (level of participation in as problem solver) and self-assessment. After the evaluation, each expert was given their own weighting factor regarding the importance of their judgments on a 10-grade scale and multiplied by 0.1 with the purpose of bringing the value to one [22]. The final product of expert evaluation is competence index that represent by following equation:

$$We = ½ (WST + WTR) \text{.......... } (6)$$

Where,

$$w_{TR} = \frac{1}{n}\sum_{i=1}^{n} w_i \text{ .... } (7)$$

We Expert Competence Index.
WST Weight of Expert Self-assessment/Evaluation Rating.
WTR Weight of Expert Total Rating: Subjective & objective evaluation.
n Number of Participants
Wi Number of Evaluated Data/Weight.

The weight of each coefficient WST and WTR (equation # 7) are considered equal. The competence index of an expert can be treated as a probability of the expert's giving a reliable evaluation, where $0 \leq We \leq 1$ [22].

3.2 Data Collection

Research data is collected from entity's first semester Health Safety Environment (HSE) performance report (period January until June 2018) which consist of leading and lagging indicators. Six entities have been chosen as DMU due to significant contribution of worked man-hours to organization (more than 500,000 worked man-hours in average per month), namely Production (PRO), Construction (CONS), Drilling (DRLL), Exploration (EXPL), Logistic (LOG) and Well Operation (WLO).

4. Result

4.1 Expert Competence Index and Variables Decision

By implementing complex weighting factor method to evaluate expert competence index, author finally decided to use the expertise from 5 out of 14 safety experts who have competence index above from group average competence index, that's equal to 0.735. The judgment from 5 safety experts were used to defined the input variables or leading indicator of the research, that shown in Table 1. The input variables of research should be "less-the-better" type, as a minimum input indicates a good performance.

Table 1: DEA Model: Input Variables based on Five Expert Judgments.

Organizational Level Factor Indicator	Safety Management Level Indicator	Work Group Level Indicator	Individual Level Indicator
Number of unrealized HSE management visit plan	% of 2018 ISRS audit findings with open status	% of anomaly report with open status	safety climate survey result

The performance indicator of input and output variables were collected from 6 entities (DMU) first semester HSE performance report (period January until June 2018) as described on Table 2.

Table 2: Input (Leading) & Output (Lagging) Variable Indicators

DMU	Input Variable				Output Variables
	No of unrealized HSE visit plan	% of 2018 ISRS audit findings open status	% of anomaly report open status	SCL Survey Result	No of Days without Recordable Injury
PRO	1	79 %	29 %	7.85	58
CONS	2	85 %	66 %	7.85	99
DRLL	0	75 %	0 %	7.85	181
EXPL	1	15 %	0 %	7.85	181
LOG	2	80 %	61 %	7.85	47
WLO	1	65 %	6 %	7.85	5

4.2 DEA Analysis

Data processing was done with assistance of software MaxDEA 7 Basic by modeling the CCR-DEA output-oriented with assumption: maximized output by holding constant inputs. Relative efficient score of respective DMU provided in Table 3.

Table 3: Relative Efficient Score of DMU.

NO	DMU	Score	Conclusion
1	PRO	0.32	*Inefficient*
2	CONS	0.547	*Inefficient*
3	DRLL	1	*Efficient*
4	EXPL	1	*Efficient*
5	LOG	0.26	*Inefficient*
6	WLO	0.028	*Inefficient*

From Table.3, we see that 2 DMU's were efficient with score 1, namely Drilling (DRLL) and Exploration (EXPL). Whereas 4 DMU's were inefficient, there are Production (PRO) with score 0.32, Construction (CONS) with score 0.547, Logistic (LOG) with score 0.26 and Well Operations (WLO) with score 0.028. This condition happened due to inefficient of organizational factors on mentioned DMU that inhibit organization to convert input into output effectively. The analysis related to inefficient organizational factors provided in Table 4.

Table 4: Result of DEA Model Variable Analysis

			INPUT								OUTPUT	
NO	DMU	Score	Slack Movement (Visit)	Projection (Visit)	Slack Movement (ISRS)	Projection (ISRS)	Slack Movement (CERMAT)	Projection (CERMAT)	Slack Movement (SCL)	Projection (SCL)	Proportionate Movement (Days without RI)	Projection (Days without RI)
1	PRO	0.32	0	1	-0.64	0.15	-0.29	0	0	7.85	123	181
2	CONS	0.547	-1	1	-0.7	0.15	-0.66	0	0	7.85	82	181
3	DRLL	1	0	0	0	0.75	0	0	0	7.85	0	181
4	EXPL	1	0	1	0	0.15	0	0	0	7.85	0	181
5	LOG	0.26	-1	1	-0.65	0.15	-0.61	0	0	7.85	134	181
6	WLO	0.028	0	1	-0.5	0.15	-0.06	0	0	7.85	176	181

Above table shown the efficient DMU (DRLL and EXPL) is used to benchmarking inefficient DMU by maximize the value of output variable (lagging indicator) to become 181 days. This condition stimulates the existence of slack movement on each inefficient DMU in order to get optimum value of input variables (leading indicator). The slack movement has recommended DMU PRO and WLO to optimizing safety management level and work group level indicator by reducing ISRS audit findings with open status to become 15 % and to close all anomaly report immediately. While DMU CONS and LOG need to optimize organizational level, safety management level and work group level indicator by reducing number of unrealized HSE management visit plan to become one (1), reducing ISRS audit findings with open status to become 15 % and close all anomaly report immediately.

5. Conclusion

5.1 Summary& Recommendation

DEA as a tool to evaluate performance of organization is feasible to become a model to analyze the effectiveness of organizational factor toward safety program implementation. The effectiveness of organizational factor was modeled by benchmarking the relative efficiency of each DMU to convert the input resources (organizational factors) into output (day without recordable injury). The research applied CCR-DEA output-oriented model approach and found that 2 DMU's were efficient with score 1, namely Drilling (DRLL) and Exploration (EXPL). Whereas 4 DMU's were inefficient; Production (PRO) with score 0.32, Construction (CONS) with score 0.547, Logistic (LOG) with score 0.26 and Well Operations (WLO) with score 0.028. Inefficient DMU mostly contributed by inefficient of safety management level factor and work group level factor. Those two organizational factors should become focus attention of new Mahakam Block operator in order to continue the implementation of existing safety program effectively. New Mahakam Block operator management is recommended to put more attention to strengthening safety management level and work group level factor after transition period by taken serious attention to follow up the ISRS audit status and anomaly report since it will reflect the management commitment toward safety program implementation.

5.2 Research Limitation

DEA is a deterministic technique, and as such is limited in that native DEA results cannot be extended to hypothesis testing. The organizational factor that used as research variable was compiled from several literatures and confirmed by expert judgment through interview method. The model presented here requires extensive validation of variable selection, which could provide further data within the scope of the present study. Further research should explore more explanatory variables that obtain by statistically test. The DMU selection could be broaden to benchmark intercompany/organization performance in term of safety performance implementation. However, results from this study could be used as points of comparison for future research as well, and along those lines, the present study would benefit from the availability of actual organization data.

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