MATURE OIL FIELD NON-PRODUCING CLUSTER MANAGEMENT DECISION USING ANALYTIC NETWORK PROCESS (ANP)

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ABSTRACT

The Field of X located in Mahakam Delta East Kalimantan has been producing for more than 35 years under TEXPI operatorship. It is currently in declining phase with only 25% drilled wells producing and several production clusters are no longer in use. There are two options for managing the unused equipment, i.e. Preservation and Abandonment. The decision for non-producing cluster management takes long discussion as it involves conflicting interests between Field Operation Division which prefer abandonment for cost saving purpose and Geoscience Division which prefer preservation to anticipate future field revival by applying new technology. Other technical and non-technical aspects need to be incorporated in the decision making in order to ensure a thorough assessment. Cluster X-I, one of Field X non-producing cluster is taken as case study for this research. The methodology used by this research for criteria definition is literature review and expert discussion. The criteria interrelation is verified by Decision Making Trial and Evaluation Laboratory (DEMATEL) and the decision making is performed by Analytic Network Process (ANP) method. The input for DEMATEL and ANP is obtained by questionnaires distribution to TEXPI's experts which are Operation Manager, Geoscience Manager and Bussines and Development Manager and one District Manager as Top Management. There are five criteria defined by this research, namely Economic Performance, Operational Safety, Public Relation & Organization, Technology and Security. All of them are confirmed interrelated. Based on the ANP simulation result, the selected option for non-producing Cluster X-I is Preservation with the priority value of 0.657859.

**Keywords:** Mature Oil Field, Multiple Criteria Decision Making, DEMATEL, ANP, Mahakam Delta

INTRODUCTION

TEXPI is a multinational oil and gas company operating several fields in Mahakam Delta, East Kalimantan, Indonesia. This company has been present in this area for more than 40 years of operation. The company’s production is now in declining phase while the cost associated to the operation is increasing in line with the fields maturity. Efforts are put in place to optimize the expenses from every disciplines.

Having produced over 35 years, oil Field X is considered as mature field (Babadagli, 2005) where the production is in decline mode following the reservoir pressure decrease. From almost 450 development wells drilled since 1974, only 25% are currently still producing. On surface facility side, aging equipment are still used for processing and exporting the production. This situation led to high operating cost (OPEX) due to the more frequent maintenance and repair compared to new installation.
Field Operation Division of the operating company is in the process of reducing cost and one of the proposals is to abandon the non-producing cluster. A cluster is a group of well which consists of several sets of equipment, such as one or more wellhead platforms from which wells are drilled and produced, wellhead flowline from each well, a manifold where wellhead flowlines are gathered, pipeline departure from manifold to processing area and so forth. Cluster X-I of Field X is chosen as a case study for this research.

From economic performance point of view, maintaining a non-producing cluster contributes negative NPV to the company, therefore it will be beneficial to the company to abandon this cluster. Nevertheless, there is still possibility to revive and redevelop the reservoir in this area by applying new technology. Considering this aspect, it is better to preserve the cluster for future use instead of building a new one later on. The above conflicting interests led to long discussion for more than a year between concerned entities.

Apart from the economical performance and technology sides, the decision for non-producing cluster management also need to incorporate other possible aspects for both technical and non-technical to ensure a thorough assessment. This is in line with (Mackie, et al., 2010) statement that in the real world of oil and gas industry, a decision is rarely made using only one measuring criteria.

To facilitate the human decision making within the company which involves several dependence criteria and conflicting interest, this research introduces a multiple criteria decision making method of Analytic Network Process (ANP). This method is an improvement to Analytic Hierarchy Process (AHP) which could not accommodate the interdependence condition among the criteria (Saaty, 2005). The criteria interdependence will be firstly assessed by Decision Making Trial and Evaluation Laboratory (DEMATEL) method (Tzeng et al., 2007).

Based on the above background, the objectives of this research are:
1. To establish the criteria to be used by TEXPI to decide the management of non-producing Cluster X-I at Field X.
2. To select the management option for non-producing Cluster X-I based on the defined criteria.

**METHODOLOGY**

In general, the research process is divided into four main stages, i.e. preliminary study, data gathering, data processing and the last is analysis and conclusion.

**Preliminary study**

The preliminary study is crucial to define the objectives of the research following the problem identification and formulation steps. The problem is identified from TEXPI actual challenge that is not clearly resolved yet due to the conflicting interest between two major entities, i.e. Field Operation Division and Geoscience Division, in deciding the scenario of non-producing cluster management. Due to the limited timeframe, one particular case is selected for this research, namely Cluster X-I of mature oil Field X located in Mahakam Delta.

**Data Gathering**

The data gathering is initiated with literature study and preliminary survey or expert discussion. There are several type of literatures used for this research such as books, papers, journals, and also TEXPI internal document. The preliminary survey is performed by discussion with TEXPI experts as respondents concerning the research subject and the criteria.
to be applied based on literature review and also company specific requirement. Two types of data are gathered, namely primary and secondary data. The result of the above steps is be used to define the criteria required to support the decision making process and the alternatives of non-producing cluster management. Having completed the criteria and sub criteria definition, it is important to determine the relationship among the criteria and sub criteria in order to set up the decision network.

Two sets of questionnaire are developed for evaluation input;

- DEMATEL method to assess the interdependence among the criteria.
  For this survey, experts are expected to give the feedback on the influence level of each criterion by the following scale referred to Lee et al. (2011);

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No influence</td>
</tr>
<tr>
<td>1</td>
<td>Low influence</td>
</tr>
<tr>
<td>2</td>
<td>Medium influence</td>
</tr>
<tr>
<td>3</td>
<td>High influence</td>
</tr>
<tr>
<td>4</td>
<td>Extremely high influence</td>
</tr>
</tbody>
</table>

- ANP method for the multiple criteria decision making.
  The questionnaire for ANP is developed in pairwise comparison for both criteria and subcriteria with Saaty’s (2005) 9 scale as reference.

  There are three experts from different entities who will be taking part as respondent, i.e. Operation Manager of Field X, Geoscience Manager of Field X, Business and Development Manager of Field X. One feedback from East Kalimantan District Manager representing the management of TEXPI will be used to define the priority of the above three contributors for decision making to capture the company policy and vision particularly on the non-producing cluster management subject.

Data Processing

This stage is basically performing DEMATEL calculation and ANP simulation. For DEMATEL, data from the questionnaire is used to build series of matrices to calculate the interdependence degree of each criterion and draw network relation map to simplify the interdependencies in an easy-to-understand structure and to clearly express relationship between factors, levels of influences, and the degree of impacts (Lee et al., 2011). For ANP, there are three steps to be performed within this stage, i.e.

a. Network modeling based on the interdependence result from DEMATEL.
b. Criteria Weight Determination and Pairwise Comparison Matrices
c. Supermatrix Formation including consistency ratio verification.

  The above steps will be performed by SuperDecisions® software.

The last step in this stage is performing sensitivity analysis in order to capture the dynamic environment of the decision making process. The sensitivity analysis will also be performed by SuperDecisions® software feature.

Analysis and Conclusion

The analysis and discussion will be performed on the result obtained from DEMATEL calculation for the criteria interdependence and the software SuperDecisions® simulation for ANP for the decision making. This step also includes the sensitivity analysis. The final step of
this stage is establishing conclusions based on the result of the research. This step is important to ascertain that the research objectives are answered by the conclusions. In addition to the above, suggestion to future research will also be proposed.

RESULT AND DISCUSSION

The criteria and subcriteria were determination by literature study and separate experts discussion. The hierarchy is depicted by the following figure;

![Research Hierarchy Tree](image)

Figure 1. Research Hierarchy Tree

Those criteria and subcriteria were used to develop the questionnaires for both DEMATEL and ANP. Data collected from respondents is then processed using Microsoft Excel® for DEMATEL evaluation and SuperDecisions® software for ANP.

The result from DEMATEL evaluation is presented by the following Total Influence Matrix.

Table 2. Total Influence Matrix

<table>
<thead>
<tr>
<th></th>
<th>Economic Perf</th>
<th>Ops Safety</th>
<th>PR, Organization</th>
<th>Technology</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Perf</td>
<td>0,52</td>
<td>0,63</td>
<td>0,55</td>
<td>0,50</td>
<td>0,39</td>
</tr>
<tr>
<td>Ops Safety</td>
<td>0,68</td>
<td>0,40</td>
<td>0,47</td>
<td>0,43</td>
<td>0,36</td>
</tr>
<tr>
<td>PR, Organization</td>
<td>0,55</td>
<td>0,43</td>
<td>0,28</td>
<td>0,33</td>
<td>0,31</td>
</tr>
<tr>
<td>Technology</td>
<td>0,77</td>
<td>0,63</td>
<td>0,53</td>
<td>0,35</td>
<td>0,43</td>
</tr>
<tr>
<td>Security</td>
<td>0,72</td>
<td>0,67</td>
<td>0,54</td>
<td>0,45</td>
<td>0,29</td>
</tr>
</tbody>
</table>

The yellow highlighted cells represent values above threshold of 0.5. Based on the above highlighted input, a network relation map is built illustrating the influence between criteria. The axis and ordinate, D+R and D-R respectively, were obtained from the sum of each row (D) and column (R) of the Total Influence Matrix. When (D-R) value is positive it is called as net causer, otherwise it is called as net receiver.
Based on the above network relation map, an ANP model for decision making is developed as shown by the following figure;

The input data for the above simulation model is taken from Geoscience Manager feedback, who has been prioritized based on TEXPI Management feedback also simulated by ANP, i.e. 71.7% for Geoscience, 19.5% for Field Operation, and 8.8% Development.

The ANP simulation resulted to criteria weight of 42.2% for Operational Safety, 33.4% for Economic Performance, 11.5% for Technology, 7% for Public Relation & Organization and 5.9% for Security criterion with inconsistency ratio of 0.05923 which is below the 0.1 threshold.

For the management option, the simulation result shows Preservation as the selected scenario instead of Abandonment with 0.657859. Sensitivity analysis shows that the priority change on each criterion and subcriterion will not change the final scenario, i.e. Preservation.
CONCLUSION AND RECOMMENDATION

Having performed all the research stages, it could be concluded that:

1. The criteria used to decide the management of non-producing Cluster X-I at Field X; are Economic Performance, Operational Safety, Public Relation & Organization, Technology and Security.
2. The selected option for managing non-producing Cluster X-I is Preservation.

The recommendation for the future researches is among others;

1. To define the criteria, subcriteria and their weight for non-producing cluster or other TEXP1’s unused equipment management using more comprehensive method such as Delphi or Focused Group Discussion (FGD).
2. To perform decision making of non-producing cluster or unused equipment management by means of ANP model Benefit, Opportunity, Cost, Risk (BOCR) to capture the different view of this research.

REFERENCES


