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Fuzzy Logic Method To Manage The Risk Of Oil And Gas Pipeline Project To The Enviroment

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Absatract. Pipes are one of supporting infrastructures that are needes in oil and gas project. However, oail ang gas pipeline construction project have very complex risks and have a major impact on the environment. On the other hand, environmental factors are one of the risk factors for oil and gas pipeline projects with a value of 14% [2]. The existence of risk factors that are not managed properly will have a negative impact that accumulates and causes a hazard. Therefore, an affective risk analysis method is needed. The purpose of this study is to analyze the risks of oil and gas pipeline construction projects to the environment using the *Fuzzy Logic* method based on data obtained from questionnaires distributed to Oil and Gas Cooperation Contract Contractors operating in East Java – Indonesia. The results of the analysis show that of the 20 (twenty) risk factors, there are 2 risk factors that are at a high level, namely financial performance risk with a value of 14.9 and contractor experience risk with a risk value of 14.9 and the fuzzy logic method are considered to be used as an effective reference in decision making, this can be seen from the results of the calculation of the accuracy value which shows that the risk analysis system for the environment is accurate with an accuracy value of 0.90 which means the accuracy level is very high.

Keywords: Oil and Gas Pipeline, Risk Management, Environmental Risk, Risk Analysis, Fuzzy Logic

1. Introduction

One of the supporting infrastructure that is needed in the project is a pipeline network that functions to support the transmission and distribution of oil and natural gas both in onshore and offshore areas. The use of pipelines for the transmission process is considered effective and efficient when compared to using other modes of transportation [1], but there are also consequences caused by oil and gas pipeline projects, such as negative impacts caused by the use of hazardous materials, inappropriate methods, human resources [2] [3] incompetence and the existence of equipment and material transportation, especially if the project is located in a densely populated area [4].

According to Rodhi et al (2019), oil and gas pipeline construction projects have very complex risks and have a major impact on the environment [5] [6]. The risks contained in the oil and gas pipeline project can certainly be anticipated with risk management applications, but if risk management has been applied and still causes negative impacts, then this is one of the reasons for the application of unsystematic and ineffective risk management. Therefore, in this case it is necessary to develop a risk management concept that can build an effective risk management system [7].

Risk management is one of the keys to project success, but in its application, risk management standards are not widely understood and their application is still poor, including in the piping sector [8] [9]. One of the reasons for this is that the risk analysis process often encounters obstacles related to limited data and ambiguous data, such as incomplete or unreliable data, and subjective information that depends on the respondent's expert judgment. To anticipate such data, previous researchers proposed fuzzy logic as a tool that can be used for risk analysis [10] [11]

The most important stage in fuzzy is forming membership functions [12]. The degree of membership is a thing that controls the fuzzy, the control is a curve that maps the data input points. There are several forms of membership degrees in fuzzy, triangular membership degrees are considered to have better behavior with fuzzy sets that are evenly distributed and can represent fuzzy sets [13].

2. Research Method

The identification of risk factors was obtained based on the results of the literature review which was then verified with real conditions by distributing a preliminary questionnaire. Then the risk factor assessment was obtained based on the results of distributing questionnaires to respondents consisting of Health, Safety, Environment (HSE) managers and Engineering Project Risk Managers in 4 (four) oil and gas Cooperation Contract Contractors (KKKS) companies in East Java. Furthermore, the data were analyzed using the Fuzzy Logic method. The study location is an oil and gas pipeline network on the island of East Java, as can be seen in the following map

(Source: PGN, 2019 [14])

Figure 1. Oil and Gas Pipelines in Indonesia

3. Result and Discussion

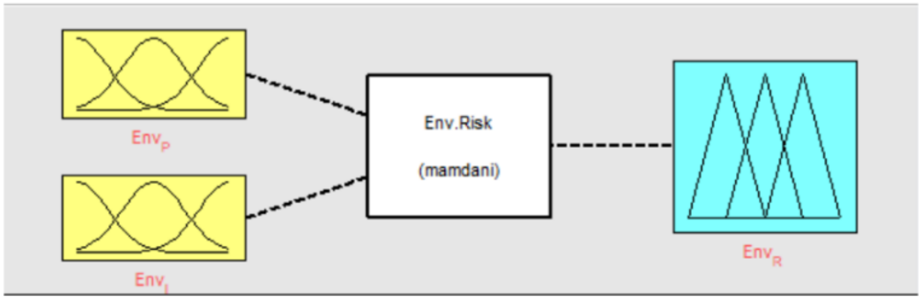
From the results of the identification of risk factors obtained from the literature study and adapted to field conditions, it can be seen that the risk factors that occur in the oil and gas pipeline project are in table 1 below.

Table 1. Risk Factors for Oil and Gas Pipelines

No	Variable	Description
1	Policy	There is a change in government policy (eg local content regulations)
2	Construction technology	Technological failure
3	Health and safety	Compensation in the form of public services
4	Human Resources	Incompetent human resources
5	Employment Opportunity	The emergence of job opportunities for local communities
6	Communication to the public	Poor method of communicating to the public
7	Land use	There is a change in population
8	Conservation of cultural and natural heritage	Does not minimize damage to sensitive landscapes, including areas valuable from a scenic, cultural, historical, or architectural point of view
9	Financial performance	Uncontrolled company finances (Start-up costs and long-term expenses)
10	Energy efficiency	There is no instrument that can measure the efficiency of energy use
11	Design	Environmentally conscious design
12	Material	Inappropriate material selection and use (supplier type and delivery)
13	Metode	Choosing the wrong construction method
14	Standard Operating Procedure (SOP)	SOPs that do not apply the concept of Sustainable development
15	Contractor experience	Inappropriate Contractor Safety Management System in Selecting environmentally responsible suppliers and contractors who can demonstrate environmental performance
16	Reduce	(Design) does not reduce the use of the four common sources used in construction; energy, water, materials, and land, at every stage in the project life cycle
17	Reuse	(Design) does not maximize resource reuse, and/or recycling to reduce waste
18	Recycle	(Design) not using recycled products (reduction of raw materials used in new products)
19	Renewable	(Design) do not use renewable resources to choose non-renewable resources
20	Natural disasters	The occurrence of disasters caused by matters related to climate and geographical factors.

(Source: Identification Results, 2020)

From table 1, it can be seen that there are 20 risk factors identified and validated in the oil and gas pipeline project. The identification results are then analyzed using Fuzzy Logic. In this method the selected function is a triangular function. Meanwhile, the input and output membership degrees are built based on the risk categories that have been used in oil and gas industrial companies, namely low, medium and high as shown in Figure 1 below.



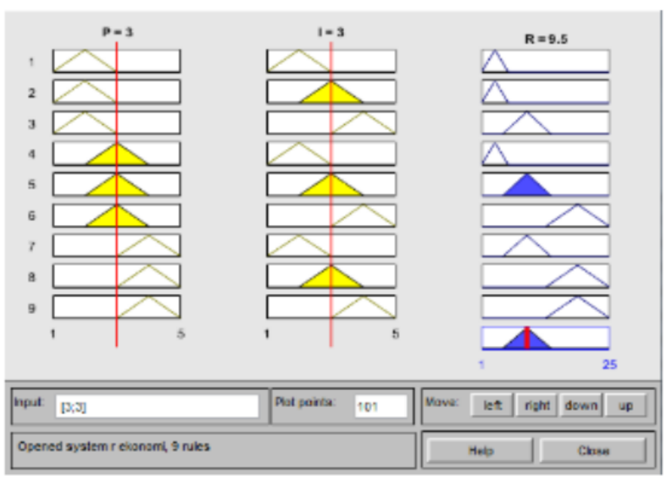
(Source: Analysis Results, 2020)

Figure 2. Membership Function of Oil and Gas Pipeline Network Risk

The next step is to develop system rules that refer to the membership degrees that have been prepared previously. In this study, the rules used are connecting and because it is a form of multiplication, namely

R = P x I
Where:
R : Risk
P : Probability
I : Impact

The results of the fuzzy analysis can be seen in Figure 2



(Source: Analysis Results, 2020)

Figure 3. Graph of The Simulation Results of One of The Risk Factors With Fuzzy

The graph shows that, if the probability (P) has a value of 3 and the impact (I) is also 3 then the resulting risk value is 9.5. All 20 existing risk factors were simulated as shown in Figure 2. Overall, the results of risk analysis using fuzzy are presented in table 2.

Table 2. The Results of The Risk Analysis of The Oil and Gas Pipeline

No (Code)	Risk Factor	Conventional				Fuzzy	
		P	**I**	**R**	**Level**	**R**	**Level**
1	Policy	2	3	6	M	7.4	M
2	Construction technology	3	3	9	M	9.5	M
3	Health and safety	3	2	6	M	7.4	M
4	Human Resources	3	3	9	M	9.5	M
5	Employment Opportunity	3	3	9	M	9.5	M
6	Communication to the public	3	3	9	M	9.5	M
7	Land use	3	3	9	M	9.5	M
8	Conservation of cultural and natural heritage	3	3	9	M	9.5	M
9	Financial performance	2	4	8	M	14.9	H
10	Energy efficiency	3	3	9	M	9.5	M
11	Design	3	3	9	M	9.5	M
12	Material	3	3	9	M	9.5	M
13	Metode	3	3	9	M	9.5	M
14	Standard Operating Procedure (SOP)	3	3	9	M	9.5	M
15	Contractor experience	3	4	12	M	14.9	H
16	Reduce	3	3	9	M	9.5	M
17	Reuse	3	3	9	M	9.5	M
18	Recycle	2	3	6	M	7.4	M
19	Renewable	2	3	6	M	7.4	M
20	Natural disasters	2	3	6	M	7.4	M

(Source: Analysis Results, 2020)

From the table 2 it can be explained that the overall risk value obtained conventionally is at level M (medium), while with the fuzzy method there are 2 risks with codes 9 (financial performance) and 15 (contractor experience) having a higher risk value and being in H level (high). In detail, the results in table 2 can be explained that for risk factors code 1 is for policy risk factors, code 2 is for construction technology risk factors, code 3 is for health and safety risk factors, code 4 is for human resources risk factors, code 5 is for human resources risk factors. employment risk factors.

Code 6 for public communication risk factors, code 7 for land use risk factors, code 8 for cultural and natural heritage conservation risk factors, code 9 for financial performance risk factors, code 10 for energy efficiency risk factors, Code 11 for design risk factors , code 12 for material risk factors, code 13 for method risk factors, code 14 for standard Operating Procedures (SOP) risk factors. Code 15 is for contractor experience risk factor, code 16 is for reduce risk factor, code 17 is for reuse risk factor, code 18 is for recycle risk factor, code 19 is for renewable risk factor and code 20 is for natural disaster risk factor.

The results of conventional analysis for code 1 produce a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 2, conventionally produces a risk value of 6 which is at the medium level (S), while the fuzzy method produces a risk value of 7.4 which is at the medium level (S).

Code 3, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the medium level (S). Code 4, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the medium level (S).

Code 5, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 6, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the medium level (S).

Code 7, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the medium level (S). Code 8, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S).

Code 9, conventionally produces a risk value of 8 which is at the moderate risk level (S), while the fuzzy method produces a risk value of 14.9 which is at the high level (T). Code 10, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 11, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 12, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S).

Code 13, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 14, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 15, conventionally produces a risk value of 12 which is at the moderate risk level (S), while the fuzzy method produces a risk value of 14.9 which is at the high level (T). Code 16, conventionally produces a risk value of 9 which is at the medium level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S).

Code 17, conventionally produces a risk value of 9 which is at the moderate level (S), while the fuzzy method produces a risk value of 9.5 which is at the moderate level (S). Code 18, conventionally produces a risk value of 6 which is at the medium level (S), while the fuzzy method produces a risk value of 7.4 which is at the moderate level (S). Code 19, conventionally produces a risk value of 6 which is at the medium level (S), while the fuzzy method produces a risk value of 7.4 which is at the medium level (S). Code 20, conventionally produces a risk value of 6 which is at the medium level (S), while the fuzzy method produces a risk value of 7.4 which is at the medium level (S). With the results obtained, further control is carried out on the accuracy value, which serves to determine whether the fuzzy analysis is accurate. The accuracy assessment is carried out by calculating the accuracy value of the expert domain scenario with the following formula

$$V = \frac{\Sigma \text{case} - \Sigma \text{ inequality}}{\Sigma \text{case}} \qquad (1)$$

$$= \frac{20 - 2}{20} = 0.90$$

The results of the accuracy calculation show that the risk analysis system for the environment is accurate with an accuracy value of 0.90 which means the accuracy level is very high.

4. Conclusion

The results of the analysis show that of the 20 (twenty) risk factors, there are 2 risk factors that are at a high level, namely financial performance risk with a value of 14.9 and contractor experience risk with a risk value of 14.9. In this study, the results of the analysis using the fuzzy logic method can be used as a decision to make decisions, it can be seen from the results of the calculation of the accuracy value which shows that the risk analysis system for the environment is accurate with an accuracy value of 0.90 which means the accuracy is very high.

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