Risk management in subsea pipelines construction project using Delphi method, FMECA, and continuous improvement

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RISK MANAGEMENT IN SUBSEA PIPELINES CONSTRUCTION PROJECT USING DELPHI METHOD, FMECA, AND CONTINUOUS IMPROVEMENT

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ABSTRACT

In general, every project has risk including the subsea pipelines construction project. This project leads to many risks. The highest risk of this project was in construction and operation level. The aim of this research is to identify, to assess, to mitigate, and to monitor the evaluation of risk management implementation of the subsea pipelines construction project. Risks are required to be managed. The risk management was integrated by continuous improvement concept using Delphi method, FMECA, DNV RP F107, and PDCA. First step, PLAN, Data was collected from field by using questionnaire. It was also done by data collecting sourced from Marine Transportation Service Department, Balikpapan, Indonesia. The questionnaire was filled by expert respondents. The questionnaire was processed by achieving consensus in four times of Delphi method. Based on Delphi method, there were risk list that was successfully identified by expert judgment, and then the risk assessment was developed by FMECA. Second step, DO, FMECA was done to calculate Risk Potential Number and how much the impact of the risk was. The RPN value was used to classify the risk into major, moderate and minor classes. Third step, CHECK, Risk Mitigation was developed based on Det Norsk Veritas Recommended Practice F107 analysis. Last step, ACT, Mitigation and monitoring evaluation of this project goal was done. The total risk number of Delphi Method was 14 risks classified into 6 major risks, 6 moderate risks, and 2 minor risks. The risks were mitigated to lower the impacts. Based on control questionnaire result, risk impact value could be reduced into 2 minor risks. Continuous monitoring and evaluation of risk mitigation was still done in order to achieve the goal. At the end of this research, risk impact has reduced from $ 8.700.000 to $ 24.750 and this number, equal to 99% efficiency.

Keywords: risk, DNV-RP-F107, Delphi method, FMECA, continuous improvement (PDCA).

INTRODUCTION

Risk is losing benefit or profit of a project, or it can be defined as the possibility of deviation from the expectation (Ahmed *et al,* 2007). Risk can also be defined as an activity that the project's goal is not achieved (Widiasih *et al*, 2015; J., Leo and Susilo, 2010). Risk management is a one way to organize the risk systematically (Kasidi, 2014). Risk management is a field of science regarding to how an organization implements various sizes in mapping out the existing problems using comprehensive and systematic management approach (Fahmi, I, 2013).

The construction of subsea pipelines project was an activity of adding the subsea pipelines channeling gas lift with a diameter of 4 inches along the ±3.35km. The pipeline stretched from Offshore Production Platform *Sepinggan* towards the *Sejadi* Platform, *East Kalimantan, Indonesia*. Platform *Sejadi* was an STS (Stacked Template Structure) with a height of four feet as a structural support which was located in the area of *Sepinggan* Offshore. There were currently three active wells on *Sejadi* platform such as SJ-2RD1, SJ-4 and SJ-5. They were active. Then two wells such as SJ-1 and SJ-3 were present. They were in an inactive state. Diameter subsea pipelines currently installed were 8 inches along the ± 3:35 km. The pipelines were used to drain the oil and gas production from the *Sejadi* to *Sepinggan*. The construction of lift gas pipelines would be built parallel to the production pipeline.

Based on Regulation of Ministry of 2011 Number 68, that the execution of a gas pipeline construction under the sea should be equipped or provided by the risk model study of shipping activities on the gas pipeline such as the fall risk of a sinking ship (ship sinking), the fall of the anchor (dropped anchor), and scratching anchor (dragged anchor) of gas lift pipeline installation activities from *Sepinggan* platform by coordinates of longitude 9842 248.221- latitude 490 185.634 to the *Sejadi* platform by coordinates of longitude 9843 044.695 -latitude 486 988.429. Therefore, a risk assessment was needed on subsea pipelines channeling gas lift by 4-inch diameter ± 3:35 km along the *Sepinggan* platform of the path toward the *Sejadi* platform within the activities of vessels in the shipping lanes Marine Office and Port Authority Balikpapan.

The highest risk of the subsea pipelines channeling was in construction and operation level. The risk assessment of subsea pipelines channeling had been done by the previous research. Pertamina Ltd. EP had taken risk assessment of construction subsea pipelines projects approached by lateral buckling analysis and OFFPIPE software (Afifah *et al,* 2010). Another research had conducted that was approached by environmental impact analysis due to pipelines damage in urban areas (J. T. Shu and Z. W. Zong, 2015). Research about risk assessment project of subsea pipelines used free span analysis (A., Umar *et al*, 2007). Previous research had

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showed risk assessment and risk mitigation of subsea pipelines using numerical analysis for measurement the risk (A., Aljaroud *et al,* 2015).

In this research, risk assessment of subsea pipeline had been done by DNV-RP-F107 standard. But, there was a problem that it could not map the whole of risk and continuous improvement concept. Hence, the research had two aims. First, the risk identification was utilized by Delphi method. Delphi method had function to complete list of risk identified by DNV-RP-F107 before. Then, the risk analysis would be conducted by Failure Mode Effect and Critically Analysis (FMECA) in order to rank the value of risk impact. Second, the risk mitigation of this research would be integrated by continuous improvement concept (Plan-Do-Check-Action). This concept was used as quality control, monitoring, and evaluation of risk mitigation.

RESEARCH METHOD

Data collection and analysis, was conducted firstly by PLAN level. In risk management, it was called by risk identification phase. In this level, the activity was to make a list of the whole risk potentially happened. Data collection had subjective perspective from expertise in Chevron Indonesia Company. Expertise was a man including of an engineer, a senior engineer, a project manager, a marine specialist and an operation specialist who have been experience 5-19 years on this field (Handoko, F. *et al*, 2016). For keeping the objective perspective from them, so that is why this research must be integrated by Delphi method. Delphi method had been conducted by spread questionnaire to expertise for many rounds until it got the consensus. The first round of Delphi had intention to identify all the potential risk happened. Then, the second round of Delphi had aim to assess the risk statement by *likert scale* (point 1-5 that means disagree-very agree). In this round, it was possible to get note from respondent (expertise). The third round of Delphi was used to make summary of previous round result, then re-assessment was done as consistent test. If there was only between the second round and the third one of Delphi that had consensus result, then the fourth round of Delphi would be conducted to confirm and validate the result of Delphi method. This method was utilized for doing consensus by quantitative technique.

The second level was DO. Do could be called as risk measurement in risk management. This step had function to analysis the risk. In this research, it would be integrated by FMECA method. Risk analysis had assessed three parameters namely likelihood, impact, and detection which were have description value for each point scale (1-10). The multiplying of those parameters was risk potential number (RPN). FMECA questionnaire had been fulfilled by expertise. The result of FMECA was the rank of the risk that had first priority to mitigate. The third level is CHECK. In risk management, this phase was called as the risk mitigation. Mitigation was implemented to reduce the risk impact. Then, mitigation strategy had been structured and implemented by monitoring and evaluation phase (action level). In ACTION level, it was integrated continuous improvement concept. In this concept, it had role to see whether risk mitigation doing well or not. After the goal had achieved then did to calculate impact value before and after risk mitigation implemented in order to see the comparison degree. Figure-1 is a research method.

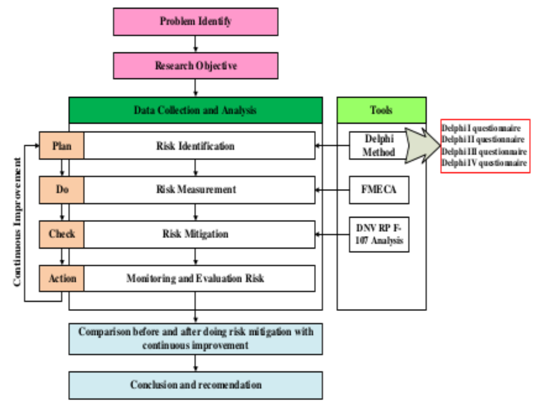

Figure-1. Research method.

RESULT AND DISCUSSIONS

A. Plan

It was used by Delphi method. Delphi method was analytical method statistically using questionnaire gradually to see comment of respondent (expertise) who had solution of the problem. Round I of Delphi method had aim to identify the whole risk that was potential happened. Besides that, in this round, the respondent was tested about their understanding of the project. The respondent had understood well about the project majority. The respondent also had a lot of experience during the project because they have been worked there about for 5-19 years.

Round II of Delphi had intention to assess risk statement that had been identified on the previous round. The assessment had been done by *likert scale* (point 1-5). After the questionnaire spread, then the analysis by basic statistic parameter; sort of mean and median was done. For mean and median value that had been under threshold value (three), the risk was eliminated. Round III of Delphi had aim to re-assess the risk statement and to test respondent on their consistency. After this round, the data was analyzed by basic statistic deviation standard. It means that there was deviation of data. Besides that, it also analyzed by inter quartile range (Q3 - Q1). It means variety of range from round II to III.

In this research, Delphi method had been done after three rounds, because it reached consensus from the second to the third round. This consensus of Delphi method could be seen by reducing value of deviation standard and inter quartile range (IQR) from the previous round to the next round. Figure-2 is the result of Delphi method consensus. Fourteen risks had been identified and validated by Delphi method approach.

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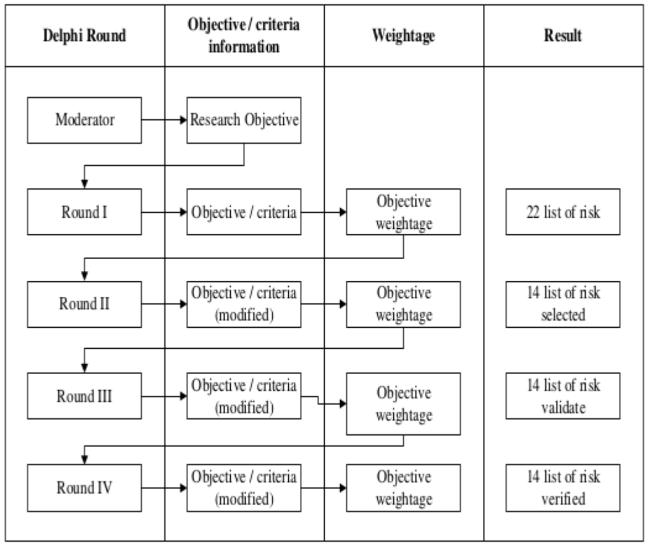

Figure-2. Consensus result of Delphi Method.

B. Do

The next level was 'do'. Do was done by risk measurement. In this research, it was integrated by FMECA method. FMECA method was assessed by three parameters namely likelihood (*occurrence*), *impact* (*severity*), and *detection*. That three parameters had each description of value (had 1-10 point). In this method, it was also defined by how much the impact when it was converted to money. The multiplying of three parameters was the rank of risk namely risk potential number (RPN). Table-1 is the result of risk analysis by FMECA method.

Table-1. Result of risk analysis with FMECA Method.

Risk No.	Risks	Likelihood	Impact	Detection	RPN	Impact (USD)
8	Project delayed	8	9	8	576	2.100.000
5	Failure of pipeline laying (failure of design)	7	9	8	504	1.500.000
10	Leakage of hydro test	8	9	6	432	900.000
3	Pipe failure (due to anchor, leakage, drop anchor, corrosion, fatigue)	8	6	8	384	653.000
1	Poor of stakeholder communication	6	7	9	378	165.000
12	Error calculated of engineering design	8	9	5	360	1.800.000
2	Fisherman friction	9	3	9	243	16.500
7	Failure of existing facility	6	8	4	192	82.500
9	Error of *equipment/ tools* due to installation	7	6	4	168	33.000
14	Fire	7	6	4	168	>8.700.000
4	Drop object	4	8	5	160	30.000
11	*Personal injury*	8	4	5	160	>8.700.000
6	Sea wave / weather	8	7	2	112	8.250.000
13	Difficulty of permit	7	6	2	84	16.500

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C. Check level

The third level was risk mitigation. Risk mitigation was a way to cover and handle the risk. Several risk mitigation had been conducted, such as project delayed that was mitigated by time scheduling project and PTK 07 policy of procurement; leakage of hydro test was mitigated by pipeline installation procedure, pipeline quality control procedure, preventive of broken pipe procedure; difficulty of permit was anticipated by permit implementation based on PTK 043 and had been good coordination of contractor Meindo Ltd.; poor of stakeholder communication was mitigated by weekly meeting based on time scheduling project among Meindo Ltd., Engineering, Marine officer, and Bukaka Ltd.

D. Action

The last step was action level. Action level had meaning to monitor and to evaluate the risk. Several things that had been done for this action were barge and ship contract monitoring 4HTS, 2 crew boat, 2 barge, and 1 DSV. Certification of equipment/tools and expert staff was mitigated by feasibility study of operation test certification and certification of expertise of MIGAS. SOP monitoring was mitigated by SOP that was validated by management. Monitoring failure of pipeline was mitigated by updating of sea mapping, CCTV installation, buoy, and regular maritime patrol. The last step was implementing of control questionnaire. The respondent of this questionnaire was project leader. The result of control questionnaire shown a decreasing value of risk from 14 risks (6 major risks, 6 moderate risks, 2 minor risks) become only 2 minor risks that has been showed on Table-2. Risk effect that could be anticipated reduced from USD 8.700.000 to USD 24.750.

Table-2. The comparison before and after risk mitigation.

Before risk mitigation	After risk mitigation
A. Major 1. Project delayed 2. Failure of pipeline laying (failure of design) 3. Leakage of hydro test 4. Pipe failure (due to anchor, leakage, drop anchor, corrosion, fatigue) 5. Poor of stakeholder communication 6. Error calculated of engineering design B. Moderate 7. Fisherman friction 8. Failure of existing facility 9. Error of equipment/tools due to installation 10. Fire 11. Drop object 12. Personal injury C. Minor 13. Sea wave / weather 14. Difficulty of permit	1. Sea wave / weather 2. Difficulty of permit

CONCLUSIONS

Fourteen risks had been validated by risk identification using with Delphi method. The FMECA Method was used to calculate those 14 risks afterwards. Using FMECA, we had 6 major risks, 6 moderate risks, and 2 minor risks. Risk Mitigation had been done by using the standard from *Det Norske Veritas*, Free span pipe laying analysis, buckling analysis, standard operating procedure, administration policy based on PTK SKKMIGAS, certification of tools and workers, marking of sea lines, and weather monitoring. Those risk mitigations must be monitored and evaluated so that the next step would be continuous improvement. From the PDCA of Risk Mitigation, 14 risks could be reduced into only 2 risks left. The decreasing result of the value of risk effects also occurred after PDCA had been done, from USD 8.700.000 become USD 24.750. Risk Mitigation by continuous improvement contributed to reduce risk to become 99%, hence the project was feasible to be executed.

The suggestion and recommendation for the next research is in the part of doing Delphi Method. The choosing of respondents must be careful and conscientious, and the respondents also must be the ones who understand the research object condition. Factually, in the improvement of design analysis can be done by adding simulations, adding procedures of project implementation procedures, and using Remote Operated Vehicle (ROV) technology as a quality control of subsea pipeline installation. Project of Construction subsea pipeline installation must be executed based on safety standard that has been agreed together.

REFERENCES

Afifah N., Sutomo J. & Rosyid D. M. 2010. Analisa Pengelaran Pipa Penyalur Bawah Laut Ø 6 Inchi. Ocean Engineering ITS Surabaya.

Ahmed Ammar, Kayis, Berman, Amornsawadwatama, Sataporn. 2007. A Review of Techniques for Risk Management in Projects. Benchmarking: An International Journal. 14(1): 22-36.

Aljaroudi A., Khan F., Akinturk A. & Haddara M. 2015. Risk assessment of offshore crude oil pipeline failure. Safety and Risk Engineering Group, Faculty of Engineering & Applied Science, Memorial University, St. John's, NL, Canada. pp. 101-109.

Handoko F., Nursanti E., Harmanto D., Sutriono. 2016. The Role of Tacit and Codified Knowledge within Technology Transfer Program on Technology Adaptation. ARPN Journal of Engineering and Applied Sciences. 11(8): 5276-5282.

I. Fahmi. 2013. Risk Management. Third edition, Alfabeta, 2013, Bandung.

Kasidi. 2014. Risk Management, Second edition. Ghalia Indonesia, Bogor.

Leo. J, Susilo. 2010. Risk Management based on ISO 31000 for non financial company. PPM, Jakarta.

Shu J. T. & Zong Z. W. 2015. Fire Risk Study of Long-distance Oil and Gas Pipeline Based on QRA. China Academy of Safety Science and Technology. pp. 369-375.

Umar A., Hasan I. & Imam, R. 2007. Analisa Free Span Scouring Pipa Bawah Laut Studi Kasus Dry Gas Pipeline, Ocean Engineering ITS Surabaya.

Widiasih Wiwin, Karningsih Putu Dana, Ciptomulyono Udisubakti. 2015. Development of integrated model for managing risk in lean manufacturing implementation: a case study in an Indonesian manufacturing company. Procedia Manufacturing. 4: 289-290.

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