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Occupational Health and Safety Risk Management on Flowline and Facilities Construction Support Services Project in Pertamina Hulu Sanga-Sanga

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Abstract**—** *Construction project activities are not without the risk of work accidents. Occupational safety and health risk management is an effort to manage occupational health and safety (OHS) risks in a comprehensive, planned, and structured manner to prevent unintended accidents. OHS risk management is concerned with the hazards and risks that exist in the workplace and can cause harm to the company. The study aims to examine the potential and risks of work accidents in the Pertamina Hulu Sanga-Sanga Flowline and Facilities Construction Support Services project using the AS/NZS4360 (2004) method. This study employs a quantitative method with a survey approach, distributing questionnaires and conducting interviews. Research respondents include 35 contractor personnel. The primary data was collected using a questionnaire tested for validity and reliability. Furthermore, multiple regression analysis was performed to determine the relationship between the risk of work accidents in each type of construction work and the contractor's performance in project completion. According to the findings, the Flowline and Facilities Construction project at Pertamina Hulu Sanga-Sanga Support Services involves 10 distinct phases: mobilization work; pipe stringing; welding; digging & backfilling; pipe support pilling; pigging; wrapping; holiday tests; hydrates & ties; and pigging; wrapping; hydrates; and ties. Therefore, these steps generate as many as 76 variables and risks.*

Keywords**—** *Occupational healt and safety (OHS), risk management, Pertamina Hulu Sanga-Sanga (PHSS).*

I. INTRODUCTION

The oil and gas industry is complex, requires large amounts of money, and involves cutting-edge technology in the drilling process. Because of its nature, this industry's risks are diverse and high. When carrying out activities, the company faces physical risks as well as legal responsibility (operational risks), as well as financial risks (financial risks), which are unavoidable if the expected oil/gas content is considered uneconomical (speculative risks). Oil and natural gas activities, while having a "relatively low frequency of loss," have a "high potential for loss," and if an incident occurs, it will cause "a very large amount of loss (severity)" and is frequently fatal. [1] A flowline is an oil and gas pipeline transports fluid from the well to the production facility. The pipes that transport fluid from the Wellhead to the Manifold are the flowline pipes' limitation. The length of the flowline can range from tens of meters to hundreds of meters, and there have even been flowlines as long as a kilometer [2].

Construction project activities are not without the risk of work accidents. In this case, the magnitude of the risk is determined by the type of work being performed at the time, the technology, and the risk control/mitigation efforts undertaken. Occupational accidents result from a job or project work [3]. Work accidents are generally caused by two factors: unsafe human actions (unsafe acts) and unsafe environmental conditions (unsafe conditions) [4].

Occupational safety and health risk management is an effort to comprehensively manage occupational safety and health risks, planned and structured to avoid unintended accidents. [5]. OHS risk management focuses on hazards and risks existing in the workplace that can harm the company [3]. The Pertamina Hulu Sanga-Sanga Flowline and Facilities Construction Support Services project is carried out by the service provider PT. Meindo Elang Indah, with a contract value of Rp. 76,388,142,720.00 and funding from Pertamina (Persero) and must be finished in 720 (Seven Hundred and Twenty Days) calendar days from the start date of work outlined in the Contract, June 1st 2022, to May 30th, 2024. This project has a contract value of IDR 76,388,142,720.00, which, according to PUPR Ministerial Regulation No. 10 of 2021, places it in the high-risk category because the contract value exceeds IDR 100,000,000,000 while the project cost is less. As a result of the high level of risk in the project's cost, risk management must be implemented to avoid the high risk of project costs. Applying occupational safety and health risk management has the goals and objectives of creating a workplace occupational safety and health system that involves all parties so that contractors can reduce and prevent work accidents in a construction project and create a safe, efficient, and productive work environment.

II. METHOD

The scope of the project study was carried out at the Flowline And Facilities Construction Support Services Project, Jl. Cendrawasi No. 1 Badak Baru Village, Muara Badak District, Kutai Kartanegara Regency – East Kalimantan. This study was carried out at the Flowline And Facilities Construction Support Services project on Jl. Cendrawasi No.1, Badak Baru Village, Muara Badak District, Kutai Kartanegra City, East Kalimantan. Furthermore, the general data of construction projects can be explained as follows:

a. Project Title: Flowline and Facility Construction Support Services
b. Contract No.: 4710005833
c. Contract Date: 01 June 2022
d. Contract Value: Rp. 76,388,142,720.00 (Incl VAT)
e. Funding: Pertamina (Persero)
f. Service User: Pertamina Hulu Sanga - Sanga

g. Address: Jalan Cendrawasih No. 1 Muara Badak East Kalimantan Post 75382
h. Project Inspection: PT. Sucofindo (Persero)
i. Address: Jl. Perintis, Muara Badak
j. Time for Work Completion: 720 (Seven Hundred and Twenty Days) calendar days from the start date of work as stated in the Contract, namely 01 June 2022 to 30 May 2024.
k. Maintenance Period: The company will issue a final acceptance letter within 3 months of issuing the mechanical completion certificate (FA) for each letter of agreement documents associated with the final punch list.

This study was carried out directly on the construction project site using an observation approach. The data were collected by interviewing the contractor, both spoken and written, and filling out an OHS risk management questionnaire.

Primary data were collected through direct observation. Interviews and surveys are the two types of primary data. Secondary research data is from a project, such as questionnaires [7].

The following stages are included in the activities carried out in this study:

a. Preparation Stage: The problem is identified, and a literature review is done by reviewing previous research from various sources. To learn about the factors that influence occupational safety.
b. Preliminary survey stage. From the literature study, a questionnaire was prepared. Then, designing a questionnaire distributed to respondents. After that, interviews are conducted to determine the factors that affect workplace safety. From this stage will be the formulation of the problem and determine the research objectives.
c. Data collection. Data were collected using a questionnaire related to the Flowline Project's work safety. As a form of data collection, questionnaires were distributed to respondents.
d. Data Analysis Stages. At this point, correlation data was analyzed using Multiple Linear Regression Analysis. This analysis stage used a computer program, Statistical Product and Service Solution (SPSS), to conclude the relationship between factors contributing to workplace safety risks and the decision-making stage. At this point, the data that has been analyzed is used to draw the conclusions of the research objectives.

The following stages of data processing are included in this study:

The first step is to identify potential risks. Data on potential risks were obtained from questionnaires completed by respondents. A risk variable is said to be relevant if it is possible or has occurred in an ongoing project, and it is said to be irrelevant if it is unlikely to occur in an ongoing project. The respondents who will be used in this process are the QHSE, Engineering divisions that understands the risks involved in the project.

The second step is to assess risk. Risk assessment is done by sending Probability and Impact questionnaires to stakeholders in the final project. Risk assessment uses a scale. AS/NZS 4360:2004 uses to calculate probability and impact. The attachment lists probability and impact (Impact). 1–5 calculations are made. Data grouping was based on questionnaire results until the combined table between the two classifications was adjusted. Respondents whose data will be collected in this process include Project Manager, Site Manager, and Supervisor. The collection of questionnaire data is broader because it is believed that when facing risks, all parties should be aware of the risks that have been identified.

III. Result and Discussion

Risk is formulated as a function of probability and impact in risk assessment. Alternatively, the risk index equals the probability multiplied by the impact. The risk index (risk) equals probability multiplied by Consequences. Table 1 shows the results of the risk index assessment for each work item. Table 1 shows the results of the risk rating.

TABLE 1. Risk rating results based on the AS/NZS 4360 risk matrix

No	Working activity	Potential risk
1	Tie in the process to the existing pipe	A fire broke out
2	Tie in the process to the existing pipe	An explosion due to the gas concentration was not identified
3	Tie in the process to the existing pipe	An explosion due to a wrong pipe cut
4	hydrotest process	The worker was slashed by a hose that was detached from the connector
5	The process of excavation and stockpiling	An excavator hit the existing pipe during excavation
6	The process of excavation and stockpiling	The excavator scratched the broken cable while digging
7	hydrotest process	An explosion hit the worker due to excess pressure
8	Grinding & brushing	A broken grinding stone hit the worker
9	Welding Process	Worker squeezed between pipes
10	Welding Process	Workers inhale welding fumes
11	Tie in the process to the existing pipe	The worker's hand gets hit by the hammer
12	Pipe stringing	The worker's hand is caught in the pipe
13	hydrotest process	The worker was hit by a hose detached due to air pressure
14	hydrotest process	A hammer hit the worker's hand during the bolting process
15	Support erection process	An excavator swing hit the worker
16	Pipe stringing	An excavator swing hit the worker
17	Grinding & brushing	The worker's body is exposed to grinding incisions
18	Material Mobilization Process	The worker's hand caught while lowering the pipe
19	Pigging process	Air pressure hazard (hose loose/broken)
20	The process of excavation and stockpiling	The worker fell from the swing of the excavator while working
21	Holiday test process	Worker electrocuted by holiday equipment
22	Personnel Mobilization Process	Car units hit people

23	Erection process support	The underground facility is exposed to piling material
24	Erection process support	The pipe fell on the worker during the erection
25	The process of excavation and stockpiling	The excavator collapsed while digging
26	Tie in process to the existing pipe	The worker's hand is pinched
27	Grinding & brushing	The worker is electrocuted
28	Holiday Test Process	A worker is caught in a pipe while carrying out a holiday test
29	Personnel Mobilization Process	Car collision with another vehicle
30	Cross Piece installation process	Respiratory problems caused when working on the side of the main road
31	Pipe stringing	The worker's leg is caught in the pipe
32	Welding Process	Workers exposed to welding rays
33	Pipe wrapping process	The worker's leg is caught in the pipe
34	Grinding & brushing	Workers are exposed to grinding machine noise
35	Cross Piece installation process	Noise when using the grinding machine when beveling the pipe
36	Grinding & brushing	Workers get sparks and are furious
37	The process of installing cross pieces	Respiratory disorders when welding cross piece
38	Pigging process	Noise and vibration from the compressor
39	Flushing	Air conditioning hazard (hose disconnected/broken)
40	hydrotest process	Workers are exposed to noise and vibration from the compressor
41	Flushing	Noise and vibration from the compressor
42	Holiday test process	Worker slipped while working
43	Welding Process	Workers exposed to hot pipes
44	Material Mobilization Process	The worker's feet are caught in the pipe when lowering the pipe
45	Pigging process	Heat hazard to the compressor
46	Tie in the process to the existing pipe	A worker exposed to condensate spill
47	Hydrotest process	The worker's hand is pinched
48	Welding Process	Workers are electrocuted
49	Pipe wrapping process	The cutter hits the worker's hand
50	Cross Piece installation process	The worker was burnt as a result of being exposed to sparks from a cutting torch
51	Flushing	Heat hazard to compressor
52	Hydrotest process	Workers exposed to heat on the compressor engine
53	Personnel Mobilization Process	The car overturned on the way to work
54	Pipe stringing	The worker slipped while guiding the pipe to the sand bang
55	The process of installing cross pieces	Workers get electrocuted
56	Equipment Mobilization Process	The worker was hit by an excavator swing while climbing into the lowboy
57	Personnel Mobilization Process	The car fell into a ravine on the way to work
58	Flushing	The worker hit the existing pipe
59	Pigging process	Workers are exposed to dust during pigging
60	Pipe stringing	Respiratory disorders due to dust on the road
61	The process of excavation and stockpiling	Worker gets oil when excavator host breaks
62	Flushing	The worker gets an electric shock from the compressor
63	Flushing	Worker slipped
64	The process of excavation and stockpiling	Worker slipped while giving instructions to operator
65	Personnel Mobilization Process	The car unit was damaged when it was used
66	The process of excavation and stockpiling	The worker fell into the dugout
67	Equipment Mobilization Process	A worker fell from a boom truck
68	Grinding & brushing	Workers' hands are exposed to sparks when grinding
69	Pipe wrapping process	Hand caught in the pipe
70	The process of excavation and stockpiling	The worker is exposed to soil material
71	Equipment Mobilization Process	The worker's leg is caught by the excavator track when climbing into the loboy
72	Welding Process	Worker exposed to hot welding wire
73	Personnel Mobilization Process	The car crashed on a broken road
74	Personnel Mobilization Process	Worker's hand caught in the door when entering the car
75	Material Mobilization Process	Materials fall on the road during mobilization
76	Welding Process	Worker punctured by welding wire

Source: Research data (2022)

a. Regression analysis

Linear regression analysis aims to understand the influence of the independent variables on the dependent variable as a whole (at the same time) and individually (partially). The results of multiple linear regression between mobilization work (MB), stringing work (STR), welding work (PLS), excavation and stockpiling work (PDP), pilling pipe supports (PPS), pigging work (PG)), wrapping (WR), holiday test job risk (HL), job risk (HT), and tie this job risk (IT) to performance are presented below (Y). The performance referred to here is the project's performance. As a result, the regression analysis will provide an overview of the risks of specific jobs on project performance.

The following are the results of multiple linear regression equations relating mobilization work risk (MB), stringing work risk (STR), welding work risk (PLS), excavation and stockpiling work risk (PDP), pilling pipe support (PPS) work risk, pigging work risk (PG), wrapping (WR) work risk, Holiday Test (HL) work risk, hydrotest (HT) work risk, and Tie in (IT) work risk to performance (Y) as presented as follows:

Y = 22.802 – 0.182 MB – 0.075 STR – 0.194 PLS – 0.088 PDP – 0.096 PPS – 0.066 PG – 0.028 WR – 0.082 HLT – 0.113 HRT – 0.050 TI + e

TABLE 2. Results of Multiple Linear Regression

		Unstandardized Coefficients		Standardized Coefficients	t	Say.
		B	Std. Error	Beta		
1	(Constant)	22.802	.145		157.617	.000
	Mobilization Risk	-.182	.021	-.167	-8.671	.000
	Risk of Pipe Stringing	-.075	.027	-.094	-2.756	.011
	Welding Risks	-.194	.056	-.182	-3.485	.002
	Excavation and Stockpiling Risks	-.088	.029	-.100	-3.000	.006
	Resiko Pilling for Pipe Support	-.096	.042	-.129	-2.280	.032
	Risk Pigging	-.066	.020	-.098	-3.366	.003
	Risk Wrapping	-.028	.029	-.029	-.968	.343
	Holiday test risks	-.082	.032	-.139	-2.550	.018
	Hydrotest risks	-.113	.039	-.165	-2.883	.008
	Tie In Risk	-.050	.022	-.098	-2.259	.033

Source: Research data (2022)

b. Hypothesis test

This study used multiple linear regression analysis to test the hypothesis. This analysis is used to determine whether there is a relationship between the free variables of mobilization work risk (MB), stringing work risk (STR), welding work risk (PLS), excavation and stockpiling work risk (PDP), pilling pipe support (PPS) work risk, pigging (PG) job risk, wrapping (WR) job risk, holiday test (HL) job risk, hydrotest (HT) job risk, and Tie In (TI) job risk and performance dependent variable (Y). A simultaneous test (F test), coefficient of determination (R2), and partial test are all used to describe hypothesis testing (t-test).

c. Simultaneous Test (F-Test)

The F test, also known as the simultaneous test, determines whether there is an influence on the performance-dependent variable (Y) of the free variable risk of work mobilization (MB), job risk stringing (STR), welding work risk (PLS), excavation and stockpiling work risk (PDP), work risk of pilling pipe support (PPS), occupational risk pricking (PG), work risk wrapping (WR), occupational risk of Holiday Test (HL), occupational risk of Hydrotest (HT), and Tie In occupational risk (simultaneously). The Ftest is used to present the results of simultaneous influence testing in the following section.

TABLE 3. Simultaneous Test Results

Model		Sum of Squares	df	Mean Square	F	Say.
1	Regression	333.386	10	33.339	724.874	.000[b]
	Residual	1.104	24	.046		
	Total	334.490	34			

Source: Research data (2022)

The F test results obtained a calculated F value of 724.874 with a significance value of 0.000. In comparison, the obtained F table values at 10 and 24 degrees of freedom with a 5% alpha are 2.255. These results show that the calculated F value is greater than the F table value (F hit > F table) and the significance value is less than 0.05 (sig 0.05), indicating that there is a significant relationship between mobilization job risk (MB), job risks stringing (STR), welding work risk (PLS), excavation and stockpiling work risk (PDP), work risk on pilling pipe support (PPS), occupational risk pricking (PG), occupational wrapping risk (WR), occupational risk of Holiday Test (HL), occupational risk of Hydrotest (HT), and occupational risks of Tie In (IT) on the performance dependent variable (Y) simultaneously.

d. Partial Test (t-test)

The t-test, also known as the simultaneous test, determines whether there is a relationship between the free variable risk of mobilization job (MB), job risks stringing (STR), welding work risk (PLS), excavation and stockpiling work risk (PDP), work risk on pilling pipe support (PPS), occupational risk pricking (PG), occupational wrapping risk (WR), occupational risk of Holiday Test (HL), occupational risk of Hydrotest (HT), and occupational risks of Tie In (IT) on the performance dependent variable (Y) simultaneously. The t-test is used to present the results of the partial influence test in the following section.

TABLE 4. Partial Test Results

Coefficients[a]			
Model		t	Say.
1	(Constant)	157.617	.000
	Mobilization Risk	-8.671	.000
	Risk of Stringing Pipe	-2.756	.011
	Welding Risks	-3.485	.002
	Excavation and Stockpiling Risks	-3.000	.006
	Risk of Pilling for Pipe Support	-2.280	.032
	Risk of Pigging	-3.366	.003
	Risk of Wrapping	-.968	.343
	Risk of Holiday Test	-2.550	.018
	Risk of Hydrotest	-2.883	.008
	Risk of Tie In	-2.259	.033

Source: Research data (2022)

e. Coefficient of Determination (R2)

The coefficient of determination explains how much the ability of the independent variable explains the variation in the dependent variable. The value of the coefficient of determination that is getting bigger or closer to one indicates the greater the ability of the independent variable to explain the variation in the dependent variable. The following presents the

results of the coefficient of determination using the value of R square or R2.

TABLE 5. Results of the Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998[a]	.997	.995	.2145

Source: Research data (2022)

The analysis results on the coefficient of determination show an R Square score of 0.997. That is, the variable risk of mobilization work (MB), stringing work (STR), welding work (PLS), excavation and backfilling work (PDP), pilling pipe support work (PPS), pigging (PG) job risk, wrapping (WR) job risk, Holiday Test (HL) job risk, Hydrotest (HT) job risk, and Tie In (TI) job risk is 99.7 % of the influence on the performance variable (Y), while other factors explain the rest.

f. Discussion

Risk Assessment Analysis

Based on the results of data processing and risk matrix classification according to AS/NZS 4360 standard, 16 variables with a high level of risk (High risk) were found in Tie-In work, Hydrotest work, excavation and backfilling work, Welding work, stringing work and pilling pipe support work. The 60 variables were obtained for the medium-risk level, while this project was not found for the low-risk level.

IV. CONCLUSION

Based on the results of the risk management analysis of the occupational safety and health (OSH) aspects in the Pertamina Hulu Sanga Sanga Flowline and Facilities Construction Support Services project, several conclusions can be formulated as follows:

There were 10 stages of work in this study, namely mobilization work, rigging pipe, welding, quarrying & stockpiling, piling pipe support, pricking, wrapping, holiday test, hydrotes & tie in with hazard identification, which resulted in 76 risk variables on the Flowline and Facilities Construction Support Services project in Pertamina Hulu Sanga-Sanga.

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