wjpmr, 2019,5(3), 16-28

SJIF Impact Factor: 4.639

WORLD JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.wjpmr.com

Research Article

ISSN 2455-3301

WJPMR

ENVIRONMENTAL RISK ANALYSIS IN PERTAMINA PIPE INSTALLATION MAINTENANCE REFINERY UNIT IV CILACAP ON KALI YASA RIVER, CENTRAL JAVA INDONESIA

Dr. Slamet Isworo[1]* and Poerna Sri Oetari[2,3]

[1]Environmental Health Study Program, Faculty of Health. Dian Nuswantoro University Semarang.
[2]PT. Mitra Adi Pranata. Environmental Impacts Analysis Consultant. Semarang.
[3]Graduate School of Environmental Science, Diponegoro University, Semarang, Indonesia.

***Corresponding Author: Dr. Slamet Isworo**
Environmental Health Study Program, Faculty of Health. Dian Nuswantoro University Semarang.

Article Received on 31/12/2018 **Article Revised on 21/01/2019** **Article Accepted on 11/02/2019**

ABSTRACT

PT Pertamina Refinery Unit IV Cilacap plans to carry out pipeline maintenance on a cross-country track along 5,300 meters. The activities will be carried out in the form of pipe replacement with the aim of increasing the safety of the distribution pipes. Research is a risk analysis study that aims to identify the existence of negative impacts, predict the level of possible emergence of hazards, evaluate risks that may occur and manage risks that may occur due to maintenance activities of crossing oil fuel distribution pipes with Kali Yasa river. **The method** used in this study is the method: American Petroleum Institute (API) 581. This method is a risk assessment method which consists of several stages of assessment are qualitative risk assessment, quantitative risk assessment, and semi quantitative risk assessment. **The results** of the survey and the magnitude of each risk were analyzed and then grouped based on the consequences of the range of risks and the determination of the possibility of the risk of failure from the source of the hazard due to natural factors and human factors. Risk analysis addresses that the risks posed by the construction of Pertamina's oil pipelines are low (low risk) and low to medium (low - medium risk) at the source of the danger of the risk of accidental damage due to human factors. **Conclusion** Risk analysis of pipeline maintenance on cross country lines, PT Pertamina Refinery Unit IV can improve the safety and reliability of Pertamina's pipeline and can predict the risks that may occur, so that risks can be managed properly

KEYWORDS: Risk analysis, Risk identification, Risk level, Risk management, Qualitative risk assessment, Quantitative risk assessment.

BACKGROUND

The regulation on environmental management is an instrument in realizing environmental policies comprehensively, in this case the role of risk assessment and risk management assessment in making environmental decisions. (Áine Gormley ***et al***., 2011). Based on the Law of the Republic of Indonesia No. 32 of 2009, concerning Environmental Risk Analysis is every business and / or activity that has the potential to cause significant impacts on the environment, threats to ecosystems and life, and / or health and human safety must conduct studies and analysis of environmental risks of each activity. (Muhaimin, et al, 2016).

PT Pertamina IV Processing Unit Cilacap is one of the Indonesian Government-owned companies which is a petroleum processing unit, which has the largest production capacity of 348,000 barrels/day, and the most complete facilities. In its activities, maintenance activities are required for all operational supporting equipment, in this case, maintenance on piping lines channeling the production of PT Pertamina. PT Pertamina Refinery Unit IV plans to carry out maintenance of distribution pipes from Area 40 towards Area 70. Activities will be carried out in the form of pipe and cable replacement, with the aim of increasing pipeline reliability and safety. Cross-country lines are facilities that connect between refinery areas 40 and area 70, which consist of pipe sizes that vary from the smallest size of 4 inches to the largest, which is 36 inches, each of which has a different function in its distribution. With various considerations in planning river crossings, the planned installation of crossing pipes is not planted under the river but installed above the river. This is not in accordance with the Decree of the Minister of Mines and Energy No. 300.K / 38 / M.PE / 1997 concerning Occupational Safety of Gas and Petroleum Pipe Pipes Article 13 Paragraph 1 which states that Distribution Pipes are held across rivers or irrigation channels must be planted with a depth of at least 2 (two) meters below the river normalization base or irrigation canal. he planned construction of a pipeline above the river, it is possible to have potential risks during construction and operation. (Environmental Impact Analysis, 2014).

PT Pertamina Refinery Unit IV prepared a risk analysis study on the construction of Pipe Installation Maintenance in the Kali Yasa River. This Risk Analysis Study contains risk factors, the level of risk expected to occur during operations, and activities that need to be carried out to reduce the possibility of hazards in the form of activity risk analysis recommendations (Energy Regulatory Commission (FERC), 2015)

RESEARCH METHODS

This research is a risk analysis study which aims to identify the possible negative impacts, predict the level of possible emergence of hazards, evaluate risks that may occur and manage risks that may occur due to crossing of fuel oil distribution pipes with Kali Yasa Rivers. So that this study is expected to be useful to minimize the risks that might occur in the future, security for the environment and surrounding communities. The risk analysis method used is the American Petroleum Institute 581. This method is one method of risk analysis consisting of several stages of assessment, namely qualitative risk assessment, quantitative risk assessment and semi quantitative risk assessment (American Petroleum Institute, 2008).

The activity plan to be explored in this risk analysis study is the planned installation of crossing oil pipelines for the Kali Yasa Rivers from area 40 towards area 70 with the proponent planned activities are PT Pertamina Refinery Unit IV Cilacap . The scope of the study is the study of the Risk Analysis Plan for the Construction of a Cross Country Pipe in the Kali Yasa River located at the coordinate point of 109 ° 1'16,337 " East Longitude - 7 ° 43'36,365" South Latitude, in Figure 1, below:

Figure 1: Location map of risk analysis of unit IV CILACAP pipeline maintenance activities in Kali Yasa Rivers.

ANALYSIS RESULTS AND DISCUSSION

A. Overview Location Research

Based on the analysis of the samples taken around the study site as supporting data that will be used in the risk analysis of the cross-country pipeline maintenance plan on the Kali Yasa river, including as follows:

1. Hydrology

The Kali Yasa River is a river that is influenced by tides. The Kali Yasa River has high sediment levels, both in the form of suspended load and bed load. Sediment suspended load other than in the form of mud from upstream areas also from rice fields, swamps and municipal waste. The Kali Yasa River is not only designated as a ship traffic lane, especially in the river estuary, but also as a flood channel and rainwater regulator, both from the upstream areas of the Kali Yasa River and Cilacap City, as well as parts of water bodies receiving liquid waste, both domestic and industrial. The transition of river border functions into settlements and production land resulting in reduced river body area. Increased activity and low public awareness about river management causes no river utilization in accordance with its functions, among others as: disposal site liquid and solid waste. This condition resulted in a decrease in river quality, aesthetic disturbances and potential flood hazards. (Cilacap Regency Government 2006).

Surface water quality. Kali Yasa River is a natural river located in Cilacap Regency, this river is used by the surrounding community as a water transportation flow for the surrounding fishermen. With the construction of maintenance of pipes that cross the river Yasa, it will be necessary to analyze the quality of river water to determine the risks that might occur as follows:

Table 1: Analysis of water quality of the Kali Yasa rivers.

No	Parameters	Unit	Analysis results	Criteria for Water Quality, Class II
Microbiology				
1	Faecal Coliform	Total /100 ml	680	1000
2	Total Coliform	Total /100 ml	11000	5000
Physics				
1	Temperature	Celcius	30,0	Deviation 3
2	Dissolved residue	mg/l	36748	1000
3	Suspended residue	mg/l	28	50
Anorganic Chemistry				
1	pH		7,80	6-9
2	BOD_5	mg/l	21,50	3
3	COD	mg/l	30,65	25
4	DO	mg/l	5,34	4
5	Total phosphate as P	mg/l	<0,001	0.2
6	NO3 as N	mg/l	<0,005	10
7	Arsen (As)	mg/l	-	1
8	Kobalt (Co)	mg/l	-	0.2
9	Boron (B)	mg/l	-	1
10	Cadmium (Cd)	mg/l	<0,005	0.01
11	Chrom (Cr^{+6})	mg/l	0,004	0.05
12	Copper (Cu)	mg/l	0,006	0.2
13	Lead (Pb)	mg/l	<0,030	0.3
14	Mercury (Hg)	mg/l	-	0.002
15	Zinc (Zn)	mg/l	0,076	0.05
16	Cyanide (CN)	mg/l	<0,002	0.02
17	Nitrit as N (NO^2)	mg/l	0,039	0.06
18	free Chloride	mg/l	<0,002	0.03
19	Sulfur as H2S	mg/l	0,017	0.002
Organic Chemistry				
1	Detergen (MBAS)	µg/l	<10	200
2	Fenol	µg/l	<1	1
Sampling Hours (Western Indonesia Time		8:50	-	

Criteria for Water Quality, Class II (Government Regulation No. 82 of 2001)

Based on the results of measurements of river water quality in Kali Yasa rivers it is known that there are several parameters that do not meet the requirements are Total Coliform, BOD, COD, DO and Zinc (Zn). The results of the analysis of total coliform in the Kali yasa river were 680 Total/100 ml (1000 total / 100 ml) and Total Coliform was 11.000 total /100 ml (standard 5000 total / 100 ml), BOD5 mg / l was 21.50 ppm (standard 3 ppm), COD mg/l concentration value is 30.65 mg/l (standard 25 mg/l) and DO mg/l concentration value is 5.34 mg/l (standard 4 mg / l). This parameter has exceeded water quality standards that are good for water supply, but can still be used for agriculture, livestock and similar purposes, based on Government Regulation No. 82 of 2001 (Government of the Republic of Indonesia, 2001).

2. Tides

Tides in the Cilacap area are dominantly mixed-type double-day (mixed-semidiurnal), where there are two tides for 24 hours. The interval between high tides and low tide reaches 1.5 - 2 meters. The tide height is 1.95 meters at spring tide and 0.60 meters at neap tide (Gentur et al, 2015 and (Fisheries and Marine Services, Central Java Province, 2001). Based on measurements of daily tide and measurements for 15 days, we obtain surface height data and tidal pattern graphs as listed in Table 2.

Table 2: Surface Height Measurement Results.

HH WL	HH WS	MH WS	MSL	ML WS	LLW S
363,2 00	290,5 02	256,5 84	148,0 67	395,5 14	563,2 93

(Primary data, 2014)
Primary data information
Highest high water level, (HHWL), Mean High Water Springs (MHWS), Mean Sea Level (MSL), Mean Low Water Springs (MLWS), LLWS (lower low water springtide)

3. Tsunami
In general, the South Coast of Java Island is also prone to the tsunami disaster. This is because the two regions are in the earthquake-prone zone as a result of collisions (subduction) between the Indo-Australian oceanic plate and the Eurasian continental plate. The interaction of the two plates continued from the past until now and in the future. Thus, earthquakes can still occur again at any time, as well as the tsunami. (National Disaster Management Agency, 2009).

The Java subduction zone has the potential for seismic magnitude to be lower than the Sumatra subduction zone which averages above 8 on the Richter scale (SR). Earthquake events on the island of Java are smaller than on the island of Sumatra. the impact is even greater, because the Java island plate is 150 million years old. The tectonic movement is so heavy that it is not too pressing towards the island of Java (Masyur Irsyam et al, 2010).

4. Biological Components
Observations of the biological aspects studied were the diversity of plankton found in the Kali Yasa River. The condition of the Kali Yasa River is water flow when the rainy season is quite abundant, and during the dry season the river is still sufficient to drain water even though it is not as big as in the rainy season. Plankton is primarily an important organism in the waters as the end of the food chain, namely as a primary producer. Based on the results of plankton sampling in the Kali Yasa River, 17 genera were found. The results of the analysis can be seen in the table below. Plankton terutama merupakan organisme penting dalam perairan sebagai ujung mata rantai makanan yaitu sebagai produsen primer. Berdasarkan hasil pengambilan sampel plankton di Sungai Kali Yasa ditemukkan 17 genus. Hasil analisa dapat dil ihat pada tabel dibawah ini.

Table 2: Types and Plankton Abundance in the Location of the Kali Yasa River.

No	Genus	River water (Ind/L)
1	Bacteriastrum	5
2	Biddulphia	11
3	Cerattum	2
4	Chaetoceros	41
5	Corethron	2
6	Coacinodtacus	9
7	Cyclops	41
8	Dinophysis	2
9	Dytlium	42
10	Favella	6
11	Nitzchia	34
12	Perinidium	9
13	Rhizosolenia	11
14	Synedra	5
15	Thalesionema	5
16	Thalasiotrix	11
17	Tintinopsis	6
Number of individuals		17
Diversity Index		242
Diversity Index		2,390
Domination Index		0,119

The results of the analysis of aquatic biota (plankton and benthos), which are found in the Kali Yasa River (Lee et al. (1978). It can be concluded that the condition of aquatic biota (Plankton) at the Kali Yasa River is still in good condition or not polluted. (Brower J. Jernold, Z. and Von Ende, 1990).

5. Social, Economic and Cultural
The social, economic and cultural field survey was carried out to obtain responses and initial responses from the community / respondents to the planned cross-country pipeline construction activities at PT Pertamina Refinery Unit IV Cilacap, which were the number of ships passing: 175 ships from all ships registered at the Fishermen Association Cilacap Indonesia as many as 38,000 vessels While the types of vessels that pass through Kali Yasa are compreng vessels and fiber support (Pardi and Afriantoni, 2017). The type of boat that crosses is follow

Figure 2: The ship used by fishermen around Kaliyasa Remarks a). Combreng ships ship height; 3 meters and b). Fiber Ship.

The type of vessel used by fishermen around the location of the cross-country pipeline bridge construction activities has a height that is still below the planned height of a cross-country pipe bridge. Types of vessels such as compreng have a maximum boat height of up to 3 meters from the surface of the water, so ships used by fishing communities around the construction site of cross-country pipelines when crossing the bridge will not cause collisions with pipes. Sail schedule: depart early in the morning at 03.00-06.00 WIB Returns at noon at 13.00-14.00 WIB. The type of vessel used by fishermen around the location of the cross-country pipeline bridge construction activities has a height that is still below the planned height of a cross-country pipe bridge. Types of vessels such as compreng have a maximum boat height of up to 3 meters from the surface of the water, so ships used by fishing communities around the construction site of cross-country pipelines when crossing the bridge will not cause collisions with pipes. Vessels that cross the waters of the Kali Yasa River range from 3 meters to the sea schedule: depart early in the morning at 03.00-06.00 WIB at noon 13.00-14.00 WIB (Cilacap Ocean Fishery Port, 2018 and Minister of Mining and Energy of Indonesia, 1997)

Table 4: Description of the Risk Analysis of the Construction of Pertamina Pipe Bridges on the Social Environment.

No.	Component	Risk Analysis	Information
1	Technical construction of pipe bridges	Not at risk	In general, fishermen who are directly related to pipeline bridge construction projects, fishermen pass every day at the coordinate point of the pipeline bridge construction plan, giving a more positive response to the pipeline construction plan with the following reasons: a. Construction of a pipeline bridge will make the boat traffic on the Kaliyasa River smooth. The existing underground pipes often disturb fishermen, because it often makes the ship leak even damages the propeller of the ship's engine. This condition causes fishermen to often lose money b. Construction of a pipeline bridge will open employment opportunities to the surrounding community, especially during project construction, because usually the project initiator will involve the local community in its construction. According to them this will increase the income of the fishermen, on the other hand they also can still go to sea, especially the fishermen who go out to sea in the afternoon to install fishers and be taken in the morning, so that during work hours they can still participate in project work. c. Although the community gave a positive response to the development plan, they noted that the height of the pipe bridge to be built must be higher so as not to damage the ship

2	Water quality Surface (Kali Yasa River)	Not at risk	The quality of the waters of the Yasa River is often used for the daily activities of the surrounding community (Bathing and washing activities by the community). Based on an analysis of the quality of the waters, the status of the water mash in the category of waters for Class II boiling and is still applied for agricultural and plantation activities The quality of river waters is not at risk for the construction of pipeline maintenance from Area 40 -Area 70 PT Pertamina Refinery Unit IV Cilacap
3.	Transfer place to lean on the ship	At risk	At the time of construction of the pipeline bridge, it is most likely that the fishing boat will be moved to a port pond (where the ship rests at the edge of the port), because this is the only possible way to do it. However, according to the fishing community this method also has a very high risk, namely: a. Theft of a ship's engine. Due to the distance from the ship owner's house, it is prone to theft. It is different when the ship is placed on a river, which in general is adjacent to the house of each owner of the ship, so security is more secure. b. Fishermen have difficulty controlling the ship, because of the possibility of ship theft
4.	Children's play habits near the location of the pipe bridge	At risk	Will change the comfort of small children who often play around the pipe. This happens both during construction and after construction. From the results of observations, the area around the pipe bridge is a region with very high population density and does not have open space for children's play. The only open space that is used as a children's playground is the riverbank area around Pertamina's pipeline. Therefore the land above the pipeline, especially the land close to the planned construction of pipe bridge support, is used as an open space where they play
5	The habit of children swimming	At Risk	It is feared that it will be used by children to swim. Based on observations, every afternoon there are always children who swim because the place is the safest place to swim children
6.	Kali Yasa River as an alternative traditional market	At Risk	Based on observations, the place is used as an alternative market every day by fishermen to sell seafood. If a pipe bridge is made, it will certainly interfere with alternative market activities
7.	Activities of traditional religious activities	At Risk	The fishing community in the area has a tradition of cleaning the village. This tradition is actually one form of routine activities for days where they may not go to sea, that is on Tuesday Kliwon and Friday Kliwon. They believe that on the second day fishermen may not go to sea because there will be danger, so fishermen are not allowed to go to sea. When they do not go to sea, they are used by residents with joint activities to clean the river and the riverbanks. The habit of cleaning is of course going to have a positive impact on the construction of pipe bridges because the area will be relatively clean.

ASME B31.8S-2004 (2004) and ASME B31.8- 2007, (2017)

Income of respondents from basic work as many as 37% of respondents earn between Rp. 500,000.00 to Rp.1,000,000.00 and respondents who earn between Rp. 1,000,000.00 to IDR 2,000,000.00 as much as 42% of respondents, as many as 13% of respondents who have income between Rp. 2,000,000.00 to Rp. 3,000,000.00. This indicates that there is sufficient income, especially with the planned cross-country line maintenance activities expected to increase the income of the population involved in the project. (Primary data, 2017).

B. Risk identification based on hazardous sources

1. Human Factors

1.1. Crossing Activities

Based on interviews with community members, the connecting bridge between the village on the west side of the river and the village on the east side of the river is far from the settlement, so people have difficulty crossing. Usually people cross using the PPC bridge to the north of the village. So that it is possible for residents to use oil pipeline bridges (cross country lines) as a river crossing bridge. This can cause damage to the pipe. (American Petroleum Institute (API). 2009).

1.2. Fisherman Activity (Shipping Channel)

Residents who are along the Kali Yasa River mostly make their living as fishermen. The Kali Yasa River route by residents along the river is used as a transportation route for ships, especially the estuary of the Kali Yasa River to the Ocean. The hustle and bustle of ships carried out by residents of fishermen has the potential to cause the bridge to be hit by a pipe which will cause damage / shift in structure, especially if the passing fishing vessel has a fairly high vessel component. Based.

on its position, the pipe bridge that crosses the Kali Yasa River is flanked by two road bridges, namely the PPC road bridge located ± 315 m north of the pipe bridge and the bridge which is located ± 400 m south of the pipe bridge as shown in Figure 3, as follows.

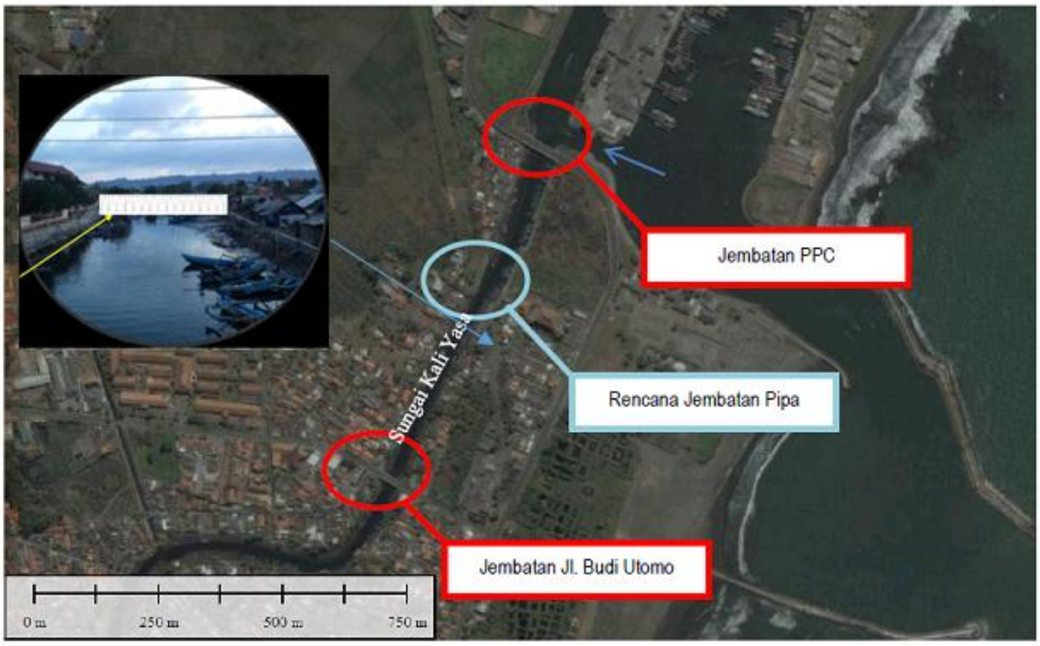

Figure 3: Location of Pertamina pipeline bridge.

Lokasi jembatan berada di atas sungai Kaliyasa, Cilacap, Jawa Tengah yang berfungsi Fungsi dibangunnya jembatan pipa Kaliyasa adalah untuk menghindarkan jaringan pipa milik PT. Pertamina sehingga tidak mengganggu aliran sungai, lalu lintas Kapal dan tidak mengganggu aktifitas Masyarakat sekitarnya

Based on its elevation, the lower part of the second girder of the road bridge is 0.5 m lower than the lower part of the steel bridge pipe structure. So that indirectly because this Kali Yasa River is the shipping lane / exit point of the fishing boat to the sea, then the two road bridges can function as a protective portal for the pipe bridge. Against the potential of being hit by a boat pole. Based on the above analysis it can be seen that the structure of the construction of the pipe bridge is safe from the risk of collision of the boat mast. Bridge Dimensions, the Kaliyasa pipe bridge has a dimension of 58.85 m, the width of the bridge is 6.00 m, height 4.25 m which is divided into two parts (bottom = 2.25m, top = 2.05m).

1.2. Intentional destruction by humans

Intentional human damage, such as iron theft, is one of the possibilities of pipe damage and even the possibility of a large accident / risk. based on a survey conducted on communities around the bridge construction site or various government projects found the occurrence of theft and destruction by some irresponsible humans. These are risk factors that are considered in the PT. Pipeline maintenance project. Pertamina crossed the Kali Yasa river (Sinergisia Pertamina, 2014).

1.3. Open flame activity near the pipe crossing

Open flame activity at a distance very close to the pipe can cause heating of the pipe so that explosions and fires can occur. The use of a fire in the form of combustion of garbage carried out close to the pipe, based on social data, is rarely done. The use of fire is more often done in the form of repairing compreng type vessels, especially when repainting. However, because the location of ship repair is relatively far from the location of the pipe bridge, it can be concluded that the impact of the use of the fire on the pipe bridge is relatively small. (Cilacap Ocean Fishery Port, (2018).

1.4. Smoking Activity

Residents around the cross-country pipeline bridge are types of active smokers. Disposal of cigarette butts near the pipes by local residents can cause fires around the pipe, especially if the cigarette butts burn waste. However, the possibility of this fire is small. (Thomas et al, 2009) and American Society of Mechanical Engineers, 2017).

1.5. Chemicals used in Ship Repair activities

Ships that have suffered heavy or light damage as soon as possible are repaired by fishermen. Ship repair is usually done by lifting the ship ashore. Spills of chemicals originating from ship repair activities can cause a decrease in pipe quality such as corrosion so that it can reduce pipe life, cause leaks and pollution in river rivers (American Society of Mechanical Engineers, 2017).

2. Natural Factors

2.1. Flood

Floods that occur in the Kali Yasa River or in the Yasa River Watershed due to its brackish nature where the oil pipeline (cross country line) passes can cause corrosion and leakage in the pipeline. However, based on interviews with residents around the Kali Yasa River, the height of the flood never overflowed into the settlements so that the risk of damage from flooding was very small (Firesmith, 2003) and (Cilacap Ocean Fishery Port, 2018).

2.2. Tidal

Tidal conditions that occur in the Indian Ocean cause tides in the Kali Yasa River because the river empties into the Indian Ocean. The highest tide height of 3,622 m will not reach the height of the pipe bridge (5.5 m + 6 m land elevation). With 11.5 m bridge elevation while the highest tide position is 3,622 plus the highest compreng boat height that passes 2 m, the pipe bridge elevation is still safe against collisions with boats or corrosion due to tidal inundation (Lucy Amellia et al, 2013). The highest high water level (HHWL) is 3,622 m, so the water level at the peak will not reach the height of the pipe bridge.

2.3. Earthquake

Earthquakes are vibrations or shocks that occur on the surface of the earth due to the sudden release of energy from the inside that creates seismic waves. Earthquakes are usually caused by the movement of the Earth's crust (earth plate). The frequency of a region, refers to the type and size of earthquakes experienced during a period of time.

Based on earthquake data recordings, there are several earthquakes on the South Sea Coast which influence the earthquake up to Cilacap. The Pangandaran earthquake on July 17, 2006 with a magnitude of 7.7 SR. The epicenter was at a distance of 282 km with a depth of 33 km. This earthquake produced a tsunami wave. Furthermore, a relatively recent occurrence was the earthquake on April 24, 2011, with the epicenter located 293 km Southwest of Cilacap with an epicentrum of 10 km and on April 26, 2011 an earthquake measuring 6.3 on the earthquake point was 120 km Southwest Cilacap at a depth of 24 km. Based on the recorded earthquake that occurred far away from the position of the earthquake source to the mainland of Java, the effect of the vibration caused by the earthquake was 3 MMI (Modified Mercalli Intencity). Qualitatively the vibration of MMI has not been able to produce damage / collapse of the building including the pipe bridge structure. The occurrence of the earthquake in Cilacap is more of a tectonic earthquake (due to plate movement). So that the impact of the earthquake is more on tsunami generation. (M Akrom Mustafa and Yudhicara, 2007).

Vibration period checking on the risk of building a pipeline for PT. Pertamina used the Indonesian National Standard (SNI-1726-2002) by using building vibration standard silmulation with the following calculations.

	T_1 □ □ n =	0,51 sc
Information :		
□	= coeficient	
n	= level	

The result of the vibration period from the analysis of SAP 2000 is 0.665 seconds, then for the vibration period (T) is used 0.65 seconds. Calculation of the basic earthquake coefficient (C), for the vibration period (T) of 0.65 seconds, the basic earthquake coefficient C is equal to 0.85. Then the Shear Base Calculation (V) can be calculated as follows

$$V = \frac{C \cdot I}{R} W = \frac{0,85 \cdot 1,6 \cdot 605.366,96}{5,6} = 147.017,69 \text{ kg}$$

Table 5: Shear Base Calculation (V).

No.	Hi (m)	Wixhi (kg.m)	(Wixhi)/ΣWixhi	V (Kg)	Σ Point	V Joint (kg)
1	4,5	567.482,65	0,142	20.840,97		
2	5,5	1.612.978,65	0,403	59.237,13	32	**1.851,16**
3	9,8	1.822.710,43	0,455	66.939,59	32	**2.091,86**
Jumlah		**4.003.171,70**		**147.017,69**		

The calculation of the bridge strength above has been carried out by referring to SNI-1726-2002 where the calculation has been carried out based on the greatest vibration, namely earthquake, so that it can be assumed that if there are vibrations from other factors smaller than earthquake vibrations, the risk of interference with the bridge structure distributor pipe owned by PT. Pertamina which is due to other factors is not significant.

2.4. Tsunami

Tsunamis occur very often on the coast of South Java, where Cilacap Regency is located in the area, because the area is a meeting area between the Australian plate and the Sunda (Eurasian) plate which has high earthquake activity. The meeting zone (subduction) is the main tsunami source area that might affect Cilacap District. One of the recorded tsunami in Cilacap was the result of the Pangandaran tsunami on July 17, 2006 due to an earthquake with a magnitude of 7.7. The quake due to the breaking of the 84 km long crust with a width of

42 km with a sloping shift decreasing ± 3.7 m resulted in a vertical deformation and dislocation of the seabed which disturbed the sea water column resulting in a tsunami that hit the southern part of Java. To see the security of the bridge structure due to the tsunami, an analysis of tsunami wave runup height at the bridge location using a larger Mentawai earthquake scenario (crust broken 330 km wide 50 km wide dislocation / 10 m shift, epicenter 23 km. The results of the analysis using numerical tsunami modeling (COMCOT 1.6) obtained run-off height in Yasa River on the bridge location as in the table below. (S. Son et al. 2011).

Table 6: Tsunami simulation results on the Kali Yasa River with an earthquake model scenario on the Mentawai island.

No.	Time (s)	Kali Yasa (m)	Scenario 1 (m)	No	Time (s)	Kali Yasa (m)	Scenario 1 (m)	No	Time (s)	Kali Yasa (m)	Scenario 1 (m)
1	0	0	0	21	2400	0,15	2,86	41	4920	0	-0,12
2	120	0	0	22	2520	-0,2	1,62	42	5040	-0,02	-0,49
3	240	0	0	23	2640	-0,28	1,4	43	5160	-0,03	-0,28
4	360	0	0,01	24	2760	-0,13	2,8	44	5280	0,13	-0,2
5	480	0	0,01	25	2880	-0,03	3,15	45	5400	0,06	0
6	600	0	0,01	26	3000	0,05	3,09	46	5520	0,75	0,34
7	720	0	0,01	27	3120	0,1	1,27	47	5640	0,64	0,66
8	840	-0,01	-0.01	28	3240	0,09	2,51	48	5760	0,1	0,75
9	960	-0,01	-0.01	29	3360	0,11	2,27	49	5880	1,42	0,56
10	1080	-0,02	-0,01	30	3480	0,13	2,05	50	6000	1,24	0,6
11	1200	-0,04	-0,44	31	3600	0,1	1,78	51	6120	0	0,63
12	1320	-0,01	-0,77	32	3840	0	1,29	52	6240	-0,02	0,64
13	1440	0	-1,1	33	3960	0,13	1,15	53	6360	-0,03	0,62
14	1560	0,94	-0,1	34	4080	0,15	1,01	54	6480	0,2	0.39
15	1680	0,4	-0,18	35	4200	0,4	0,86	55	6600	0,91	0,02
16	1800	0,02	-0,08	36	4320	1,35	0,76	56	6720	0,43	0,21
17	1920	0	0	37	4440	1,68	0,37	57	6840	0,03	0,05
18	2040	-0,06	1.27	38	4560	0,12	0	58	6960	0,04	0,01
19	2160	0,16	1,46	39	4680	0,5	-0,22	59	7080	0,01	0,23
20	2280	0,3	2,61	40	4800	0,19	-0,33	60	7200	0,01	0,04

Calculation results of Run off tsunami waves at the study location show a maximum height of 3.15 m at 2880 seconds (48 minutes). The run-off height of 3.15 m is still far below the height of the bridge abutment (5.5 m + 6 m) so it can be concluded that the pipe bridge structure is safe from tsunami waves. (M. Akrom Mustafa and Yudhicara, 2007).

2.5. Pipe Strength

The risk factor for pipes is leakage. This leak can be caused by various factors

1) The operating pressure of the oil flow exceeds the pressure of the pipe design, because of the inhomogeneity of the material from the pipe and the inability of the pipe to face pressure that exceeds the design pressure, the pipe will break and cause a leak in the pipe. But the pipes used are based on ANSI (American National Standards Institute) / ASME (American Society of Mechanical Engineers) B36.10M and API (American Petroleum Institute) 5L regarding the Standard Wall Thickness (STD WT) pipe so that it is in accordance with applicable rules. For pipes with operating pressure higher than design pressure, the pipe uses Extra Strong Wall Thickness (EXSTR WT). (ASME B31.8- 2007, 2017).

2) Corrosion caused by the water content found in oil, corrosion can also occur due to bends and turbulence in the flow of oil flowing. However, to overcome corrosion, the pipe is protected by Cathodic Protection. The ability of the pipe to withstand corrosion depends on the thickness of the pipe and the corrosion rate which will ultimately determine the age of the pipe.

Risk factors for leakage in Maintenance Plans The construction of a PT pipeline, Pertamina that crosses the river yasa is small (ASME B31.8- 2007, 2017).

C. Qualitative Risk Analysis

Predicted impacts, both in the form of health consequences and damage consequence (impact on the system being reviewed), based on sources of danger are as follows: (American Petroleum Institute. 2008)

C.1. Human Factors

C.1.1. Crossing activities

a. Health consequence - safe.
b. consequence damage - safe

C.1.2. Fisherman Activity (Shipping Flow)

a. Health consequence - safe
b. Damage consequence - minor damage.

C.1.3. Intentional destruction
a. Health consequence - safe until minor injuries.
b. Damage consequence - mild to severe damage.

C.1.4. Use of flame (open flame) near the pipe crossing
a. Health consequence - safe.
b. Consequence damage - safe.

C.1.5 Smoking Activity
a. Health consequence - safe.
b. Consequence damage - safe.

C.1.6. Chemicals - chemicals
a. Health consequence - safe.
b. Damage consequence - minor damage.

C.2. Natural factor
C.2.1. Flood
1) Health consequence – Safe
2) Damage consequence – safe until lightly damaged

C.2.2. Tidal
1) Health consequence – Safe
2) Damage consequence – Safe

C.2.3. Earthquake
1) Health consequence –safe until minor injuries.
2) Damage consequence – lightly damaged.

C.2.4. Tsunami
1) Health consequence –. safe until minor injuries
2) Damage consequence – lightly damaged.

C.2.5. Construction bridge Kali Yasa Construction bridge
1) Health consequence – Safe
2) Damage consequence – Safe

C.2.6. Pipe installation
1) Health consequence – Safe
2) Damage consequence – Safe

Table 5 Below shows the grouping of Environmental Risk Analysis in Pertamina Pipe Installation Maintenance Refinery Unit IV Cilacap on Kali Yasa River,

Table 5: Grouping the consequences of risk.

Consequence Category	Impact on human safety and the environment	Range of consequences
A	a) human safety is safe	<10
	b) Safe environment	0-19
B	a) human safety is safe	10-19
	b) The environment is lightly damaged	20-34
C	a) Humans are lightly injured	20-29
	b) The environment is severely damaged	35-49
D	a) Humans are seriously injured	30-39
	b) The environment is severely damaged	50-79
E	a) Death in humans	>40
	b) The environment is severely damaged	>80

The probability of failure that occurs from each source of danger is as follows: (Ari Sandyavitri 2008)
1. Human Factors
a) Crossing activities: very small
b) Fisherman activity: small
c) Intentional destruction: moderate
d) Use of flame near the pipe crossing: small
e) Smoking activity: small.
f) Chemicals for ship repair: small

2. Natural Factors
a) Flood: Very Small
b) Tides: Very Small
c) Earthquakes: Small
d) Tsunami: Small

3. Bridge Construction: small

4. Pipe: small
The probability of failure is based on the following table: (American Petroleum Institute, 2008)

Table 6: Grouping of possible failures (probability of failure).

Probability	Probability of failure	Probability Range
1	The possibility of failure is very small	0-15
2	The possibility of a small failure	16-25
3	Possibility of moderate failure	26-35
4	The possibility of a big failure	36-50
5	The possibility of a very big failure	51-75

From the grouping of consequences and possible failures a matrix can be made as in the following table (American Petroleum Institute, 2008)

Table 7: Determination of possible failures and consequences based on source of danger.

Danger Source	**Possibility of failure**	**Consequences**
1. Human Factors		
a. Crossing activities	1	A
b. Fisherman activities	2	B
c. Intentional destruction	3	C
d. Waste burning	2	A
e. Smoking activities	2	A
f. Chemicals for ship repair	2	B
2. Natural Factors		
a. Flood	1	B
b. Tide	1	A
c. Earthquake	2	B
d. Tsunami	2	B
3. Bridge Construction	2	A
4. Pipe	2	A

Matrix to determine the risk level for the construction of a pipeline that crosses the Kali Yasa River, as follows

Probability of Failure		**Risk Matrix for Pipeline Risk Asessment**				
5	51-75					
4	36-50					
3	26-35			1c		
2	16-25	1d,1e,3,4	1d,1e,3,4			
1	0-15	1a,2b	2a			
Damage Consequence		0-19	20-35	35-49	50-79	>80
Health Consequence		<10	10-19	20-29	30-39	>40
Consequence Category		A	B	C	D	E
Low Risk		Medium Risk		**Medium-High Risk**		**High Risk**

Figure 3: Risk Level Matrix.

Based on the risk analysis matrix above, it can be seen that the level of risk that might occur based on the hazard sources is as follows

1. Human Factors
a) Crossing activities: low
b) Fishermen's activity (shipping flow): low
c) Intentional destruction: moderate
d) Use of a flame near the pipe crossing: low
e) Smoking activities: low
f) Chemicals for ship repair: low

2. Natural Factors
a) Flood: low
b) Tides: low
c) Earth's echoes: low
d) Tsunamis: low

3. Bridge Construction: low
4. Pipe: low
Based on the above risk analysis (qualitative method) it can be concluded that the risk posed by the construction of an oil pipeline (cross-country line) using pipe bridge construction is generally low (low risk). The source of the danger has a medium (medium) impact, namely intentional destruction.

D. Risk Management
Risk management for each hazard source above is as follows

D.1. Human Factors
1. Crossing activities
a. Management: making a safety fence on an oil pipe that passes through the Kali Yasa River
b. Executor: PT. Pertamina Refinery Unit IV Cilacap
c. Implementation location: on each end of the pipe that borders the river bank
d. Timing: when post pipeline / operational construction

2. Fisherman activities
a) **Management:** Pertamina pipeline bridges are built higher than PPC bridges and Jalan Budi Utomo Bridge
b) **Executor:** PT. Pertamina Refinery Unit IV Cilacap
c) **Location of implementation:** Oil pipeline bridge construction (cross country line)
d) **Time of implementation:** During the process of planning and building an oil pipeline bridge (cross country line)

3. Intentional destruction and pipe theft.
a) Management: reduction and elimination of risks by closing access to pipe bridges, installation of signs containing information about the effects if the pipes

are damaged and reporting and legal sanctions for pipeline damage, for example: "**explosion danger and pollution: pertamina oil distribution pipes. Leaking and destruction report:** (PT. Pertamina Refinery Unit IV Cilacap telephone number). **Legal Sanctions Of Destruction: According To Applicable Regulations** ". Signs must be clearly legible from 10 m.

b) Executor: PT. Pertamina Refinery Unit IV Cilacap

c) Implementation location: on the banks of the Kali Yasa River

d) Time of implementation: when post pipeline / operational construction

4. Use the flame near the pipe crossing

a) Management: Reduction and elimination of risks with a system of installing warning signs prohibiting the use of flames near the oil pipeline area. Examples of signs: "Do not burn the waste and / or use the fire in this area. Danger and fire danger ". Signs must be clearly legible from 10 m.

b) Executor: PT. Pertamina Refinery Unit IV Cilacap

c) Implementation Location: The area around the river that is passed around the oil channel pipeline bridge

d) Timing: At the operational stage.

D.2. Natural Factors

1. Floods and Tides

a) Management: Management and removal of risks due to flooding and tides by constructing oil pipeline bridges (cross country lines) with elevations above the annual floods and highest tides so that the risk of submerged oil pipelines that can cause corrosion of the pipes can be avoided . In addition, the pressure on the pipe can also be avoided due to strong flood currents.

b) Executor: PT. Pertamina Refinery Unit IV Cilacap

c) Location of implementation: Oil pipeline bridge construction (cross country line)

d) Time of implementation: during the process of planning and building an oil pipeline bridge (cross country line)

2. Earthquake

a) Management: Management and removal of risks due to earthquakes by making earthquake-resistant construction in accordance with SNI-1726-2002 Standards

b) Executor: PT. Pertamina Refinery UNIT IV Cilacap

c) Location of implementation: Oil pipeline bridge construction (cross country line)

d) Time of implementation: During the process of planning and building an oil pipeline bridge (cross country line)

3. **Tsunami**

a) Management: Management and removal of risks due to the tsunami by making bridge construction higher than the tsunami runoff, which is 3.15 meters higher than the ground level.

b) Executor: PT. Pertamina Refinery Unit IV Cilacap

c) Location of implementation: Oil pipeline bridge construction (cross country line)

d) Time of implementation: during the process of planning and building an oil pipeline bridge (cross-country line)

D.3. Pipes

a) Management: Management and elimination of risk is to periodically conduct pipe inspections (thicknesses), which are 10 years in each pipe to verify the age of the pipe. Then pipe replacement preparations were carried out at 3 years before the age of the pipe was exhausted and pipe replacement was carried out at 2 years before the pipe's age was exhausted.

b) Executor: PT. Pertamina Refinery Unit IV Cilacap

c) Lokasi implementation: Each oil pipeline installed on a pipe bridge.

d) Time of implementation: During pipeline operations.

CONCLUSION

Based on the above risk analysis (qualitative method) it can be concluded that the level of risk caused by the construction of oil pipelines using bridge pipe construction is low (low risk) and low to medium (low - medium risk) at the source of the danger of intentional destruction.

Based on the above risk analysis (qualitative method) it can be concluded that the risks posed by the construction of oil distribution pipes using bridge pipe construction are low (low risk) and low to medium (low - medium risk) at the source of the danger of intentional destruction.

REFERENCES

1. Áine Gormley, Simon Pollard and Sophie Rocks Environmental Risk Assessment and Management Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, Cranfield University, Bedfordshire, UK, 2011.
2. American Petroleum Institute (API) *Risk Based Inspection Technology API RP 581*. Washington, D.C: API Publishing Services, 2008.
3. American Petroleum Institute (API). *Risk Based Inspection API RP 580*. Washington, D.C: API Publishing Services, 2009.
4. American Petroleum Institute Risk-Based Inspection Technology Downstream Segment Api Recommended Practice 581 Second Edition, September 2008 Washington, DC 20005-4070 USA, 2008.
5. Ari Sandyavitri Analysis of Risk of Construction in Rural Construction Projects (Case Study: Clean Water and Transportation Infrastructure

Development) National Seminar on Indonesian Oleo & Petrochemical Chemical Engineering 2008 ISSN 1907-0500 Bachelor of Civil Engineering Study Program Faculty of Engineering, University of Riau Campus Bina Widya Pekanbaru, 2008.
6. ASME B31.8- 2007, Gas Transmission and Distribution Piping Systems, New York, NY: The American Society of Mechanical Engineers, 2017.
7. ASME B31.8S-2004 (Revision of ASME B31.8S-2001): Managing System Integrity of Gas Pipelines, ASME Code for Pressure Piping, B31, Supplement to ASME B31.8, New York, NY: The American Society of Mechanical Engineers, 2004.
8. Brower J. Jernold, Z., Von Ende, C. Filed and Laboratory Methode for General Ecology. Third Edition. USA: W. M. C. Brown Publisers, 1990.
9. Cilacap Regency Government Cilacap City Drainage Master Plan. Development Planning Agency. Jl Kauman N0. 28 Cilacap, 2006.
10. Cilacap Ocean Fishery Port, Annual Report of PPS Cilacap 2017. Cilacap Ocean Fishery Port. Directorate General of Capture Fisheries. Ministry of Religion and Fisheries. Cilacap, 2018.
11. Firesmith, D.G., Common Concepts Underlying Safety, Security, and Survivability Engineering, Technical Note CMU_SEI-2003-TN-033, Carnegie Mellon University, 2003.
12. Federal Energy Regulatory Commission (FERC), Pipeline Safety New Voices Project – Briefing Paper #9 – Pipeline Routing And Siting Issue, Pipeline Safety Trust, 2015.
13. Gentur Handoyo, Agus A. D. Suryoputro and Ibnu Pratikyo High Tidal Conversions in Cilacap Waters Against Energy Produced. Tropical Marine Journal September, 2015; 18(2): 112–120. ISSN 0853-7291 Department of Marine Sciences, Faculty of Fisheries and Marine Sciences, Diponegoro University Jl. Prof. Soedarto, S.H, Tembalang Semarang 50275, 2015.
14. Government of the Republic of Indonesia, Government Regulation Number 82 of 2001 concerning Management of Water Quality and Water Pollution Control, Jakarta, 2001.
15. Lee et al. Benthic Macroinvertebrate and Fish as Biological Indicator of Water Quality With Reference to Community Diversity Development. New York, 1978.
16. Lucy Amellia Lisnawati, Baskoro Rochaddi, Dwi Haryo Ismunarti Studi Tipe Pasang Surut di Pulau Parang Kepulauan Karimunjawa Jepara Jawa Tengah. Jurnal Oseanografi. Volume 2, Nomor 3, Tahun 2013, Halaman 214-220. Universitas Diponegoro Tembalang Semarang, 2013.
17. Moch. Akrom Mustafa, Yudhicara, Characteristics of Coasts and Tsunami Risks in the South Coast of Yogyakarta. DOI Marine Geology Journal: http://dx.doi.org/10.32693/jgk.5.3.2007.143. (e-ISSN: 2527-8851ISSN: 1693-4415), 2007.
18. Minister of Mining and Energy of Indonesia Decree of the Minister of Mines and Energy Number 300.K / 38 / M.PE / 1997: Occupational Safety of Oil and Gas Distribution Pipes. Jakarta, 1997.
19. Masyhur Irsyam et al Summary of Study Results of the Indonesian Earthquake Map Revision Team, Civil Engineering ITB - Research and Development Road PU-Geophysics ITB, Geotechnology LIPI, Geology Geology Research Center ITB, BMKG-Geofisika, Bandung, 2010.
20. Muhaimin, Boedi Tjahjono, and Darmawan. Earthquake Risk Analysis in Cilacap, Central Java Province J. Il. Tan. Lingk., April 2016; 18(1): 28-34. ISSN 1410-7333 28 Bogor Agricultural Institute, 2016.
21. National Disaster Management Agency, The Study on Natural Disaster Management in Indonesia Volume 3 Final Report: Supporting Reports March Japan International Cooperation Agency Oriental Consultants Co., Ltd. Asian Disaster Reduction Center, 2009.
22. President of the Republic of Indonesia Law Number 32 of 2009 concerning Environmental Protection and Management. Jakarta, 2009.
23. Pardi and Afriantoni Fiberglass Ship Fabrication as an Alternative Material for Replacing Wooden Ships to Increase Fisherman Productivity in Bengkalis Waters. SHIP, ISSN: 1829-8370 Journal of Marine Science & Technology. Semarang, 2017.
24. Sinergia Pertamina Security Problems Due to Theft. Synergy of Operation Unit for Indonesia Pertamina News Edition 3 of 2014 Pertamina EP Indonesia, 2014.
25. Sangyoung Son, Patrick J. Lynett, and Dae-Hong Kim, Nested and multi-physics modeling of tsunami evolution from generation to inundation. Ocean Modelling, 2011; 38: 96–113.
26. Thomas E. Novotny, Kristen Lum, Elizabeth Smith, Vivian Wang, and Richard Barnes Cigarettes Butts and the Case for an Environmental Policy on Hazardous Cigarette Waste. Int J Environ Res Public Health, 2009 May; 6(5): 1691–1705.