Tibuana
Journal of applied Industrial Engineering-University of PGRI Adi Buana

p-ISSN 2622-2027
DOI : https://doi.org/10.36456/tibuana.4.02.4013.120-124 *e*-ISSN 2622-2035

Hazard Identification and Risk Assessment with Recommended Alternative Solutions Using the Benefit Cost Analysis Method

Fani Sandy Putra[1], Galih Anindita[1], Rina Sandora[2]
[1]Health and Safety Engineering Study Program, Department of Marine Engineering, Shipbuilding Institute of Polytechnic Surabaya, 60111, Indonesia.
2 Piping Engineering Study Program, Department of Marine Engineering, Shipbuilding Institute of Polytechnic Surabaya, 60111, Indonesia
e-mail : rinasandora@ppns.ac.id

Abstract

Determination of hazard identification and risk assessment on the company can not be separated from the calculation of the cost budget. The aim is to provide recommendations and calculate the profit rate using the Benefit Cost Analysis (BCA) method so that the company will more easily determine the most appropriate and needed alternative in the company. From the incremental analysis calculation, an alternative solution and value obtained from BCA are gas detector H2S B / C ratio 1.14, crane certification B / C ratio 3.66, welding helmet B / C ratio value 5.53, wire rope B / C ratio value of 5.19, O2 detector value of B / C ratio 6.11, small handtruck value of B / C ratio 18.1, fire dry chemical powder B / C ratio value of 22.27, N2 gas detector value of ratio B / C 1.53.

Key Word : Hazard Identification; Risk Assessment; Incremental Analysis; Ratio Value.

I. INTRODUCTION

Occupational accidents can be caused anytime and anywhere so we need to identify hazards and risk assessment. In the risk assessment, recommendations will be given, especially so that the maintenance of tools and the process of handling hazards can be optimized so that from the recommendations that have been identified, then the maintenance activities can be carried out by processing and managed using the BCA (Benefit Cost Analysis) method. According to (Pujawan, I. N, 2012) a benefit benefit analysis is a very commonly used analysis to evaluate government projects. This analysis is a practical way to estimate the usefulness of a policy in the project. In other words, analysis and evaluation are needed from various perspectives that are relevant to the costs and benefits contributed. In this study the BCA method is used to determine the value of cost savings from each solution that will be provided.

II. RESEARCH METHODOLOGY

Benefit cost analysis according to (Pujawan, I. N, 2012) is a very commonly used analysis to evaluate government projects. This analysis is a practical way to estimate the usefulness of a policy in the project. In other words, analysis and evaluation are needed from various perspectives that are relevant to the costs and benefits contributed. Cost benefit analysis is usually done by looking at the ratio between the benefits of a project in the general public against the costs incurred by the government. Mathematically this is usually formulated as follows.

$$^{B}/_{C} = \frac{e \quad b}{e \quad c}$$

Where:

1. Equivalent Benefits: all benefits that have been reduced by negative impacts, expressed in money.
2. Equivalent Costs: all costs that have been reduced by the amount of savings that can be obtained by the project sponsor, in this case the government.

In general it can be said that if the $^{B}/_{C}$ ratio is greater than one then the project can

p-ISSN 2622-2027
DOI : https://doi.org/10.36456/tibuana.4.02.4013.120-124 *e*-ISSN 2622-2035

be accepted and if it is less than one then the project cannot be accepted. Meanwhile, if the B / C ratio is equal to one, project conditions are not different (indifferent) between acceptable or not. Often decisions related to projects not only evaluate an alternative but evaluate several alternatives, so that the selection of alternatives can also be made with incremental analysis. The "do nothing" alternative is still considered in this election. This means that if these alternatives do not have a B / C ratio greater from one then none of the alternatives can be applied.

There are two situations that must be considered, in relation to the analysis of the cost benefits of several available alternatives. First, if the alternative is an alternative that has a "mutually exclusive" nature then it needs to be evaluated individually, that is, each alternative is compared between one and the other to find the best. The second situation, if there are no resource constraints to carry out these alternatives then it is not necessary to choose the best, but must evaluate these alternatives individually. This means that all alternatives that have a B / C ratio> 1 can be applied. Therefore, if this case occurs, there is no need to compare one alternative to another.

An annuity calculation is also needed to equalize the price per period for each alternative solution, or convert a present value to a uniform value for a certain period (N) if the interest rate or price increase is i%. With the following formula:

$A = P(^{A}/_{P}, i\%, N)$

Where:

A = Annuity Value
P = Present Value
i = Percentage of inflation
N = Period

Calculations using the formulas above, the company will find out how much profit the company gets when making these investments so it can facilitate decision making.

III. RESULTS AND DISCUSSIONS

Benefit Cost Analysis is carried out to see the usefulness of recommendations to prevent unwanted events so that the project does not suffer losses. In this study, the author only analyzes recommendations that use BCA analysis for potential hazards that have moderate and high risks only.

Selection of recommendations for toxic gas contamination due to gas leakage:

The following is one of the solutions proposed to minimize the risk of toxic gas contamination due to gas leakage, namely the procurement of a Single Gas Detector H2S tool. The solution will be given 2 alternatives that will be compared to the ratio of the value of benefits and costs incurred:

1). The first alternative: Procurement of a Single Gas Detector H2S. Where the purpose of the procurement of these tools is so that when workers enter the reactor area is not contaminated with toxic gases. The following specifications are proposed.

Table 1 Alternative Tables for a Single Gas Detector

Alternative 1
Single Gas Detector H_2S Specification: -Used only for one type of gas: H2S / CO / O2 -Certified certificate -No need a charger
Rp. 3.400.000,00

p-ISSN 2622-2027
DOI : https://doi.org/10.36456/tibuana.4.02.4013.120-124 *e*-ISSN 2622-2035

2). The second alternative: Procurement of Multi Gas Detector Alert Microclip H2S. Where the purpose of the procurement of these tools is so that when workers enter the reactor area is not contaminated with toxic gas with different specifications. The following specifications are proposed.

Table 2 Alternative Multi Gas Detector Tables

Alternative 2
Multi Gas Detector Alert Microclip H2S *Specification:* *-Can detect 4 gases at once: H2S, CO, O2, and% LEL* *-Certified certificate* *-No need a charger*
Rp. 8.700.000,00

Benefits:

B = Administration fee + General Practitioner + Specialist examination + Inpatient (12 days) + Operator salary

= Rp. 50,000.00 + Rp. 350,000.00 + Rp. 225,000.00 + Rp. 700,000.00 x (12) + Rp. 3,800,000.00

= Rp. 12,825,000.00

B (A) = P (A / P, i, N)

= Rp. 12,825,000.00x (A / P, 3%, 24)

= Rp. 12,825,000.00x 0.0590

= Rp. 756,675,00

Cost:

Cost incurred for the procurement of a Single Gas Detector H_2S = Rp. 3,400,000.00

C = Procurement of a Single Gas Detector H_2S tool

= Rp. 3,400,000.00

C (A) = P (A / P, i, N)

= Rp. 3,400,000.00 x (A / P, 3%, 24)

= Rp. 3,400,000.00 x 0,0590

= Rp. 200,600.00

Calculation of cost benefit analysis

B = Rp. 756,675.00

C = Rp. 200,600.00

Then B / C = Rp. 756,675.00 / Rp. 200,600.00

= 3.77

The second alternative: Procurement of a Multi Gas Detector Alert Microclip H_2S tool has a durability for 6 months.

Benefits:

Calculation of benefits obtained are:

Costs incurred due to work accidents due to the absence of the procurement of Multi Gas Detector Alert Micro clip H_2S at the time of the release of the top cover.

B = Administration fee + General Practitioner + Specialist examination + Inpatient (12 days) + Operator salary

= Rp. 50,000.00 + Rp. 350,000.00 + Rp. 225,000.00 + Rp. 700,000.00 x (12) + Rp. 3,800,000.00

= Rp. 12,825,000.00

B (A) = P (A / P, i, N)

= Rp. 12,825,000.00x (A / P, 3%, 6)

= Rp. 12,825,000.00x 0,1846

= Rp. 2,367,495.00

Cost:

Costs incurred for the procurement of Multi Gas Detector Alert Microclip H_2S = Rp. 8,700,000.00

p-ISSN 2622-2027
DOI : https://doi.org/10.36456/tibuana.4.02.4013.120-124 *e*-ISSN 2622-2035

C = Procurement of Multi Gas Detector Alert Microclip H_2S
= Rp. 8,700,000.00

C (A) = P (A / P, i, N)
= Rp. 8,700,000.00 x (A / P, 3%, 6)
= Rp. 8,700,000.00 x 0,1846
= Rp. 1,606,020.00

Calculation of cost benefit analysis
B = Rp. 2,367,495.00
C = Rp. 1,606,020.00

Then B / C = Rp. 2,367,495.00/Rp. 1,606,020.00
= 1.47

B / C> 1, the recommendation can be taken into consideration by the company.

Incremental Analysis:

The following is a way to calculate alternative solutions to determine economic feasibility by using incremental analysis in table 3.

Table 3 List of Equipment Prices

Alternatif Awal	*Benefit (Rp)*	*Cost (Rp)*
2	2.367.495,00	1.606.020,00
1	756.675,00	200.600,00
Do Nothing	0	0

Table 4 Calculation of Feasibility of Alternative

Alternative Early	Alternative Comparison	*Benefit (Rp)*	*Cost (Rp)*	B/C	Hasil
1	*Do Nothing*	756.675,00	200.600,00	3,77	1
2	1	1.610.820,00	1.405.420,00	1,14	2

Solutions

$$B/C = \frac{B1-D_0}{C_1-D_0} = 3,77 \text{ (alternative 1)}$$

$$B/C = \frac{B_2-B_1}{C_2-C_1} = 1,14 \text{ (alternative 2)}$$

Calculation of table 4 can be concluded that the alternative solution for the second tool, the Multi Gas Detector Alert Microclip H_2S is more feasible than the alternative method for the second tool based on the theory of incremental analysis calculation. From the incremental analysis calculation, an alternative solution has two choices, namely "mutually exclusive", so that from the calculation we will get a decent and efficient result as a suggestion for the company to obtain recommendations. Based on the results of the calculation of the benefit cost analysis carried out, it is concluded that the total data conclusions.

IV. CONCLUSIONS

Results and discussion and analysis that have been carried out, the following conclusions can be drawn:

The selection of alternatives given is based on the incremental analysis calculation on the Benefit Cost Analysis (BCA) method and the calculated B / C ratio to determine the appropriate alternative recommendations, namely:

a. The risk of being contaminated with toxic gas due to gas leakage is the procurement of a Multi Gas Detector Alert Microclip H2S tool having a B / C ratio of 1.14 so that alternatives can be recommended to companies.
b. The risk of crane collapse is training and certification of crane operators having a B / C ratio value of 3.66 so that alternatives can be recommended to companies.

p-ISSN 2622-2027
DOI : https://doi.org/10.36456/tibuana.4.02.4013.120-124 *e*-ISSN 2622-2035

c. The risk of welding rays and welding sparks, namely the procurement of Welding Helmet Auto Dark Wide Lens View tools, has a B / C ratio of 5.53 so that alternatives can be recommended to companies.
d. The risk of being crushed by crane material due to broken steel ropes is the procurement of 9.2 mm x 40 m Steel Sling Wire Rope tool having a B / C ratio of 5.19 so that alternatives can be recommended to companies.
e. The risk of overloading due to crane collapse is training and certification of crane operators having a B / C ratio of 3.66 so that alternatives can be recommended to companies.
f. The risk of shortness of breath for operator workers due to lack of oxygen gas is the procurement of Mini LCD oxygen O2 concentration detector gas analyzer w / alarm tools having a B / C ratio of 6.11 so that alternatives can be recommended to companies.
g. The risk of welding rays and welding sparks, namely the procurement of Welding Helmet Auto Dark Wide Lens View tools, has a B / C ratio of 5.53 so that alternatives can be recommended to companies.
h. The risk of welding rays and welding sparks, namely the procurement of Welding Helmet Auto Dark Wide Lens View tools, has a B / C ratio of 5.53 so that alternatives can be recommended to companies.
i. The risk of disruption to the body position due to lifting wooden stairs is the procurement of Foldable Platform Handtruck Small tools having a B / C ratio value of 18.1 so that alternatives can be recommended to companies.
j. The risk of fire that causes burns to workers due to the process of cooking the asphalt road is the procurement of a Dry Chemical Powder 3 kg Dry Fire Extinguisher Apparatus which has a B / C ratio of 22.27 so that alternatives can be recommended to companies.
k. The risk of detonation caused by leakage of N2 gas is the procurement of a Track Gas Leak Detector has a B / C ratio value of 1.53 so that alternatives can be recommended to companies.
l. The risk of welding rays and welding sparks, namely the procurement of Welding Helmet Auto Dark Wide Lens View tools, has a B / C ratio of 5.53 so that alternatives can be recommended to companies.

REFERENCES

[1] PT. ALP Petro Industry., 2019. Prosedur Identifikasi Aspek K3L-rev2. Pasuruan. PT. ALP Petro Industry.
[2] Pujawan, I. N., 2012. *"Ekonomi Teknik" Edisi Kedua Cetakan Kedua.* Surabaya: Guna Widya.