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Decision Making Strategy For Decreasing The Potential Hazards of Work Accidents at Division R&D Using SWOT And AHP Methods

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Abstract. PT. XYZ has various divisions, one of them is the R&D division. This division is responsible for research and innovation. The highest impact on accidents caused by a worker injured and bleeding around 14.29%. In addition, the highest potential hazards are raw material spill around 14.29%. Thus, the purpose of this paper is to identify the factors potentially that lead to the high potential hazards in the R&D division. In addition, it also formulates the alternative to decision-making strategies. The research method used the SWOT method and AHP to determine the priority to selecting strategies for reducing the potential for occupational hazards. This study used the questionnaires and distributed among five experts in the company. The result shows that the strategy of Weakness-Opportunity (WO) is the highest weight around 3.38. Then, the calculation by using the AHP method obtained that monitoring and evaluation of occupational health and safety through improvement of Work Instruction became the main priority is equal to 0.32. The AHP method also showed the consistency value of approximately 0.09. Therefore, further research is needed to evaluate the alternatives chosen.
Keywords: Analytic Hierarchy Process (AHP), hazard, OHS, Strategy, SWOT

1. Introduction

Occupational Health and Safety issues in Indonesia are still often overlooked. This is indicated by the high rate of workplace accidents. The number of occupational accidents that occur to Indonesia is still increasing. For example, in 2009 there were around 83,714 accidents occurring in the Indonesian work industry. The total cost to compensate for losses reach 219.7 billion Rupiah. A few years later, in 2013 the number of accidents hit 99,491 cases. That number increased by 18% from the value of 2009 [1].
PT. XYZ is one of the cosmetic manufacturers. One division of the company is Research and Development (R&D). The R&D division has the potential to cause work accidents when doing activities in work and causing losses to workers and to the company. Data onto the R&D division shows that the percentage of the impact/consequence of work accidents at PT. XYZ Division R&D in the category of worker shows that the occurrence of injuries and bruises around 14.30%, hearing loss 7.14%, eye irritation 14.30%, skin burn 7.14 %, respiratory disorders 7.14%, skin irritation 7.14%, fell 7.14%, electric shock 3.57%, bleeding 21.42%, burn 3.57%, damaging tools 3.57%, and WRMSD 35.7%.

Work accidents are catastrophes that occur in the work environment that may arise due to unsafe working environment conditions or because of human error and must be controlled [2]. Therefore, the anticipatory action is needed to prevent work accidents and occupational diseases. The Government of

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Indonesia through the Ministry of Manpower always calls for the application of the Occupational Health and Safety Management System (OHS) and OHSAS: 18001[3].

Propos strategies to control and reduce the consequences and potential hazards of work accidents have been carried out by many previous researchers to implement OHS. For example, identification of potential hazards, assessment, and control of risk management of companies in preparing OHS plans must involve general OSH experts, namely people that have been certified by the Ministry of Labor in the field of occupational safety and health in the cigarette industry [4]. In addition, the application of the use of personal protective equipment as an effort to protect workers in companies [5]. In addition, proposals and corrective actions for Job Safety Analysis for companies and facilitate work safety facilities such as safety devices or personal protective equipment [6].

In order to implement the OHS, different strategies and decisions are needed in each company. One strategy in making a decision can be done by applying the Weakness Opportunity Threat (SWOT) Strength method. Some profit and non-profit organizations have used SWOT as one of their analyzes, such as steel production organization [7]. In addition, to obtain a good strategy, a SWOT analysis is needed to identify the strengths, weaknesses, opportunities, and threats that exist. According to Kotler & Armstrong describes that SWOT analysis is a comprehensive assessment of the strengths, weaknesses, opportunities, and threats of a company [8]. This analysis is needed to determine several strategies that exist on the company so that decisions can be made so that are appropriate to the conditions of the company.

In order to be able to take the right decision in applying the strategy produced by the SWOT analysis, a method is needed to make/analyze decision priorities. AHP is a multi criteria decision-making technique that can help express general decision operations by describing complex problems with multi-purpose, as well as alternative hierarchical structures [9]. In addition, there are many methods that can be applied to analyze the priority to an OHS problem decision, for example Evaluating and Prioritizing of Performance Indicators of Health, Safety and Environment Using Fuzzy Technique for Others Reference by Similarity to Ideal Solution (TOPSIS) [10]. Furthermore, Application of Fuzzy Decision Making Trial. And Evaluation Laboratory (DEMATEL) Method of Analyzing Occupational Risks on Construction Sites [11]. AHP is an effective method of making decisions, especially when there is subjectivity and this is very suitable for solving problems where decision criteria can be arranged into a sub-criteria hierarchy [12]. Thus, this article aims to analyze the right strategies in making decisions to minimize and reduce the potential dangers associated with the security of workers in the R & D division.

2. Methodology

Data collection was carried out in various ways such as field observations, and interviews with five experts such as academics, practitioners, and companies. Questionnaire method is done by giving a list of questions both opened and closed. The questionnaire distribution was divided into two stages. The first stage is shown to determine the internal and external factors whose results are sub-criteria. The first questionnaire will be analyzed using the SWOT method. Furthermore, the second questionnaire are to obtain priority strategies through the proposed alternative strategy in reducing the potential hazard of work accidents. In addition, secondary data will be obtained from various library sources and documents related to research. Based on the data that has been obtained, an analysis is performed using the SWOT method.

Several alternatives obtained through SWOT analysis have not been fully implemented in a company, and not necessarily all can be done simultaneously due to various limitations. Thus, it requires a sequence of policy priorities that will be applied for advanced analysis by applying decision-making techniques using Analytical Hierarchy Process (AHP). The following stages are analyzed using the AHP method.

3. Result and discussion

Identification of the factors related to the strategy for making decisions on reducing potential hazards in the R & D division were done by studying various literature, documents, as well as direct interviews and filling out questionnaires with informants that were believed to know the problem being studied.
Based on the identification of the indicators of internal and external factors, then the SWOT questionnaire was prepared to obtain an assessment of weight and rating. Based on the assessments conducted by experts, the Internal Strategy Factor Analysis System (IFAS) was obtained and the External Strategy Factor Analysis System (EFAS) shown in tables 1, 2, 3, and 4 below.

Table 1. Internal Strategy Factor Analysis System (IFAS)

Strength	Weight	Rating	Weight x Rating
Work safety knowledge of workers	0.05	3	0.15
The availability of competent trainers	0.05	4	0.20
Having good cooperation and relationships	0.04	2	0.08
The number of workers is adequate	0.04	2	0.08
Good arrangement and placement of raw materials / samples	0.04	3	0.12
A good laboratory waste management process	0.04	3	0.12
The raw material is always closed properly	0.05	3	0.15
Replacement of raw materials label routinely	0.04	2	0.08
Total Strength			0.98

Table 2. Internal Strategy Factor Analysis System (IFAS)

Weakness	Weight	Rating	Weight x Rating
Lack of Personal protective equipment	0.05	4	0.20
OHS management systems have not been managed properly	0.06	4	0.24
Lack of IK (Work Instructions)	0.05	3	0.15
Lack of the process of taking raw materials	0.04	2	0.08
Scale calibration for weighing equipment in the laboratory has not been carried out routinely	0.03	2	0.06
The absence of routine and scale checks on machines in the laboratory	0.04	3	0.12
Laboratory temperature is unstable	0.05	3	0.15
Air circulation is not good	0.05	4	0.20
Noise in the laboratory area	0.04	2	0.08
Excessive use of materials	0.03	2	0.06
The raw materials that exceed their useful life	0.04	2	0.08
The machine / past the age limit usage	0.05	3	0.15
Machines often have problems	0.05	4	0.20
Incorrect installation and placement of machine locations	0.05	3	0.15
Total Weakness			1.92

Table 3. External Strategy Factor Analysis System (EFAS)

Opportunity	Weight	Rating	Weight x Rating
Support from management related to Human Resources (HR) training	0.07	3	0.21
There is support from management related to OSH training on a scale basis	0.08	4	0.32
Support from the government	0.06	3	0.18
The good physical condition of workers	0.06	2	0.12
Age of worker	0.06	2	0.12
The level of education of qualified workers	0.05	2	0.10
Government policy on OHS management systems	0.06	3	0.18
There is support regarding training in the Work Instruction method (IK)	0.07	3	0.21
Total Opportunity			1.46

Table 4. External Strategy Factor Analysis System (EFAS)

Threats	Weight	Rating	Weight x Rating
Decreasing opportunities for companies to innovate	0.09	3	0.27
The environmental conditions of workers outside the company are less conducive	0.06	2	0.12
Uncontrolled the behavior of workers outside the company	0.05	2	0.10
Other companies are more aware of the provision of Personal Protective Equipment (PPE)	0.06	4	0.24
The higher cost of weighing calibration	0.08	3	0.24
Higher engine maintenance costs	0.06	3	0.18
There is a risk of fire or explosion	0.06	3	0.18
Decreasing opportunities for companies to innovate	0.07	3	0.21
Total Threats			1.38

Translation of the formulation of strategies that have been made in the form of a SWOT matrix in table 5 below.

Table 5. SWOT Matrix

	Strength (S)	**Weakness (W)**
	Work safety knowledge of worker	Lack of Personal protective equipment
	The availability of competent trainers	OHS management systems have not been managed properly
	Having good cooperation and relationships	Lack of IK (Work Instructions)
	The number of workers is adequate	Lack of the process of taking raw materials
	Good arrangement and placement of raw materials/samples	Scale calibration for weighing equipment in the laboratory has not been carried out routinely
	A good laboratory waste management process	The absence of routine and scale checks on machines in the laboratory

Table 5. SWOT Matrix (cont.)

	Strength (S)	**Weakness (W)**
	The raw material is always closed properly	Laboratory temperature is unstable
	Replacement of raw materials label routinely	Air circulation is not good
		Noise in the laboratory area
		Excessive use of materials
		Raw materials that exceed their useful life
		The machine / past the age limit usage
		Machines often have problems
		Incorrect installation and placement of machine locations
	Total Weight = 0.98	**Total Weight = 1.92**
Opportunity (O)	**Strategy SO**	**Strategy WO**
Support from management related to Human Resources (HR) training	**Total Weight S + Total Weight O = 2.24**	**Total Weight W + Total O = 3.38**
There is support from management related to OHS training on a scale basis		Work safety monitoring and evaluation through improving work instructions (W2, W3, W4, W5, W6, W10, W11, O2, O3, O7, O8).
Supporting from the government	Monitor the implementation of work safety procedures regularly (S5, S6, S7, S8, O8)	
The good physical condition of workers		
Age of worker	Optimizing training and improving employee competencies (S1, S2, O2, O7)	Commitment to the implementation of work safety (W2, W3, W4, W5, W6, W10, W11, O2, O8).
The level of education of qualified workers		
Government policy on OHS management systems	Develop and increase opportunities for employees to innovate (S3, O1, O4, O5)	Focus on providing personal protective equipment (W1, O8)
There is support regarding training in the Work Instruction method (IK)		Maintenance of facilities and infrastructure to support the implementation of work safety (W7, W8, W9, W12, W13, W14, O3, O7).
Total Weight = 1.46		
Threats (T)		
Decreasing opportunities for companies to innovate	Strategy ST	Strategy WT
	Total Weight S + Total Weight T = 2.36	**Total Weight W + Total Weight T = 3.30**
The environmental conditions of workers outside the company are less conducive	Improving workers' welfare (S1, T4)	Improve and prioritize work safety in the R & D Division (W1, T1, T4, T7)
Uncontrolled the behavior of workers outside the company	Increased awareness of workers on hazards and risks at work (S1, T2, T3, T7)	
Other companies are more aware of the provision of Personal Protective Equipment (PPE)		Periodically checking medical workers (W1, W7, W8, W9, T1, T2, T3)
The higher cost of weighing calibration		
Higher engine maintenance costs		Working closely with the agencies engine maintenance service provider (W12, W13,W14,T5,T6)
There is a risk of fire or explosion		
Decreasing opportunities for companies to innovate		
Total Weight = 1.38		

Table 5 shows the alternative strategy with the highest weight is the Weakness-Opportunity (WO) strategy. Furthermore, to determine the position of the company's quadrant based on the value of the factors plotted on the X and Y axes.

Axis X = Weight of Strength - Weight of Weakness
= 0.98 - 1.92 = -0.94

Axis Y = Weight of Opportunity - Weight of Threat
= 1.46 - 1.38 = 0.08

Figure 1 provides information that the results of the R & D division SWOT analysis are in Quadrant III. This division faces opportunities in managing large work safety. However, on the internal side, there are several obstacles. This condition shows an effort to minimize weaknesses to get opportunities. Or in other words, how to strive for development with conditions that favor the weakest conditions but can be used to capture opportunities

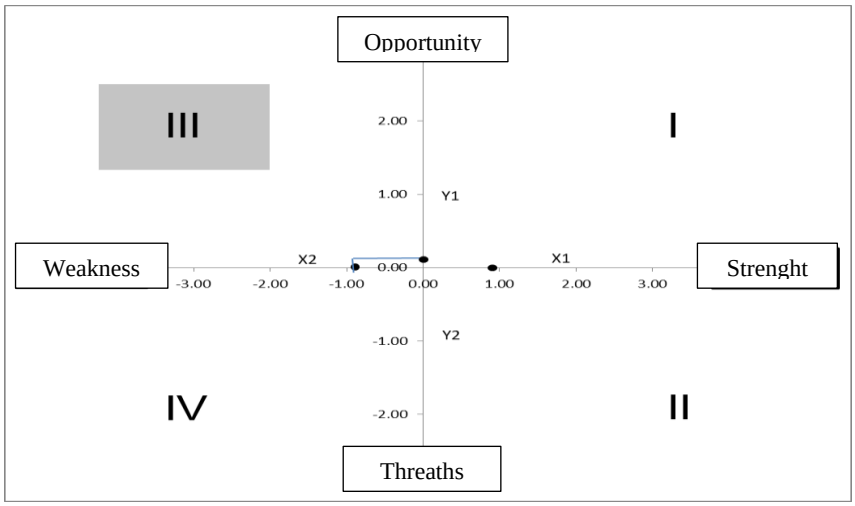

Figure 1. SWOT Analysis Diagram

Based on the SWOT analysis that has been done previously, the sub-criteria results are a WO strategy that is minimizing weaknesses to get opportunities to reduce the potential for work accidents in the R & D division. Thus, there are several alternative strategy proposals obtained from literature studies that are adjusted to the conditions in the R & D division. Several alternative strategies are shown in table 6 below.

Table 6. Alternative strategy

Code	Alternative Strategy
AS1	Monitoring and evaluating OHS through improvement of Work Instructions (IK)
AS2	Committing to OHS implementation not only for management but for the entire personnel
AS3	Improved provision of Personal Protective Equipment (PPE)
AS4	Maintenance and improvement of facilities and infrastructure to support the implementation of OHS

Based on table 10 above, the next step is to analyze the strategy selection using the AHP method. Thus the hierarchical structure of the selection of work accident reduction strategies is shown in Figure 2 below.

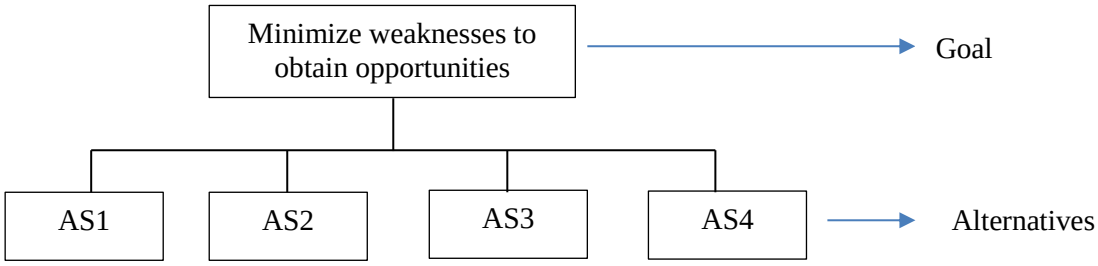

Figure 2. Hierarchical Structure of Alternative Decline in Work Accident Potential

Priority determination of alternatives is obtained from the second stage questionnaire, using pairwise comparisons between alternatives. The results of the assessment of the five experts with pairwise comparisons calculated using the geometric mean. Overall the mean geometric mean results are shown in table 7 below

Table 7. Results of Pairwise Comparison Matrix Using Geometric Mean

Alternatives	AS1	AS2	AS3	AS4
AS1	1.00	2.14	1.38	0.89
AS2	0.47	1.00	1.72	1.55
AS3	0.72	0.58	1.00	1.55
AS4	1.22	0.64	0.64	1.00
Total	3.32	4.37	4.74	4.99

Furthermore, the matrix normalized by dividing the number in each cell with the number of digits in the column in question. From the normalized matrix, the priority weights can be calculated which the mean values (Ẋ) of each matrix row. The results of the matrix normalization are shown in table 8 below.

Table 8 Normalized Weight Pairwise Comparison Ratings

Alternatives	AS1	AS2	AS3	AS4	∑	X
AS1	0.30	0.49	0.29	0.18	1.26	0.32
AS2	0.14	0.23	0.36	0.31	1.04	0.26
AS3	0.22	0.13	0.21	0.31	0.87	0.22
AS4	0.34	0.15	0.14	0.20	0.82	0.21
Total	1.00	1.00	1.00	1.00	1.00	1.00

Based on Table 8, the Consistency Ratio (CR) is calculated. If the Consistency Ratio (CR) is smaller or equal to 10%, the matrix meets the requirements of consistency [12]. Based on the calculation results, the CR value is around 0.09. The consistency value is 0.09 or equal to 9%, so because 9% ≤ 10%, the consistency value is acceptable.

Based on the results of data processing that the hierarchical structure in Figure 2 has been consistent. This is proven by the consistency ratio that is smaller than 10%. It can be seen from the four assessment weights of each alternative in reducing the potential hazard of work accidents, the biggest weight on the sub-criteria is monitoring the evaluation of OHS through the improvement of AS1 Work Instructions (IK) with a value of 0.32, then in the second order is committed to the implementation of OHS not only

for management but for all AS2 personnel with a value of 0.26, then continued with an increase in the availability of AS3 Personal Protective Equipment (PPE) with a value of 0.22, and the last order is maintenance and repair of facilities and infrastructure to support the application of OHSwith value equal to 0.21.

In Figure 1 it is known that the R & D division is in Quadrant III or the Weakness-Opportunity (WO) strategy. This division faces opportunities in very large management. However, on the internal side, there are significant obstacles. This condition aims to minimize weaknesses to get opportunities. With another definition, how to seek development with conditions that favor the weakest conditions but are used to capture opportunities. Therefore, the company is required to constantly improve and improve internal problems, so that it can provide support for business development in the long term. Despite facing various threats, this division still has internal strength. This division faces enormous opportunities, but on the other hand, faces several internal constraints/weaknesses. The focus of this strategy is to minimize the company's internal problems so that it can rely on better opportunities (turn around). One effort that can be done is to carry out a monitoring and evaluation strategy through the improvement of IK. The study conducted by Yogie et al. shows the similar results where one of the Weakness-Opportunity (WO) strategies in his research is related to Occupational Health & Safety Evaluation [13].

In order to realize the monitoring and evaluation of the implementation of OHS through the improvement of the IK, there are several parties that are obliged to support this strategy, such as managers and supervisors in the R & D division as supervisors, OHS implementation team in the R & D division as monitors and evaluators of OHS implementation, and all workers in the R & D division which functions as a participant who contributes to support the implementation of monitoring and evaluation of the implementation of OHS through the improvement of IK in the reduction of potential hazards of work accidents in the R & D division. Therefore, the first step that will be taken is to form a special OHS implementation team that is tasked with monitoring and evaluating all activities of workers in the R & D division. With the monitoring of all activities of workers in the R & D division regularly. Thus, all activities are always within the criteria of work instructions that have been established in the long term. For example, monitor workers when they want to use or when they use tools and machines. Regular routine checks on machines in the laboratory are an effort to improve IK. For example, by checking and routinely cleaning the weighing equipment before and after being used for trial and recording the checking and cleaning of the weighing instrument into the log book.

If the monitoring has been carried out regularly and the IK has been carried out properly, then it is evaluated by the party who is obliged to evaluate the monitoring of the IK. like managers and supervisors and OHS special teams in R & D. If in the monitoring there is still a discrepancy in the procedure for implementing the IK, it will be subject to initial sanctions in the form of reprimand to workers. In addition, if similar things still occur, then there will be sanctions in the form of a Warning Letter (SP) for workers. Thus, the existence of sanctions against the non-conformity of the IK in the R & D division can be minimized to prevent potential hazards of work accidents.

4. Conclusion

From the results of the strategic decision-making process to reduce the potential hazards of work accidents using the SWOT analysis and AHP methods in the R & D division, it can be concluded that the factors that have the potential to cause work accidents in the R & D division are internal factors, such as weaknesses in the R & D division. Furthermore, the determination of the strategy to reduce the potential danger of work accidents in the R & D division was obtained by the Weakness-Opportunity (WO) strategy. By using the AHP method for the selection of strategies in reducing the potential danger of work accidents in the R & D division, the highest AS 1 value is around 0.32 with a consistency value of approximately 0.09. Several suggestions that can be given in this article such as, reviewing and monitoring work instructions especially in the R & D division, routine and periodic checks on machines and tools in the laboratory. In addition, further studies related to the problems faced need to be done in order to provide better references.

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