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BEHAVIOR-BASED SAFETY APPROACH AND RISK MANAGEMENT EDUCATION AT FOREST PRODUCT PROCESSING INDUSTRY

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Abstract

Background: The case of fire (2015) and the high prevalence of irritant contact dermatitis to workers were evidence of the lack implementation of safety management system in the Gum Rosins and Turpentine Factory as one of the forest product processing industry in Indonesia. The Behavior-Based Safety approach program and Risk Management education need to be undertaken to protect workers from occupational diseases and accidents. **Objectives:** This paper aims to discuss the effectiveness of the Behavior-Based Safety approach program and Risk Management education in the Gum Rosins and Turpentine Factory, East Java, Indonesia. **Methods:** This program was carried out on 56 workers in the Gum Rosins and Turpentine Factory, treated with the Behavior-Based Safety approach program and Risk Management education with Define-Observe-Intervene-Test (DOIT) method. Then their cognition changes of safety culture were evaluated by pre-test, post-test and observation. Lastly, this research has identified factors related to workers' safety culture at the Gum Rosins and Turpentine Factory. **Results:** The results showed that the safety culture cognition of the workers shows an improvement from 60% to 78%. Based on statistical test, the significant factors related to workers' safe performance are communication style (p-value 0,011), supervision (p-value 0,007), punishment system (p-value 0,029) and rewards system (p-value 0,003) from the management. **Discussion:** The insignificant increasing of safety culture cognition was due to the lack of commitment by the company for safety management system implementation. Behavior-Based Safety approach and Risk Management education accentuate expanding safety culture. Those are not a substitute for an effective existing thorough health and safety program, but advantageous devices that will improve the impact of officially existing practices.

Keywords: Behavior-Based Safety, Risk Management, Safety culture, Forest Product Processing Industry

Introduction:

Indonesia was classified as a country that has the largest forest in the world with 120,6 million hectares or 63% of the nation's entire land area. The areas of Indonesian forest was classified into three functions, namely Production Forest (57%), Conservation Forest (18%) and Protection Forest (25%) (Nurbaya *et al*, 2018). The Production Forest, as the biggest one, is managed by a State-Owned Enterprise (SEO) and supported by 21.638 employees spread across 3 regions and 5 industrial divisions. The SEO was officially responsible for the production of log and processed wood, forest chemical products, forest seeds, food and health products, also the management of ecotourism (Perhutani, 2015).

Forest product processing become one of the most hazardous industrial sectors in most countries. There are trends of rising accident rates and a high incidence of occupational diseases and early retirement among forestry workers (International Labour Organization, 1998; Michael & Wiedenbeck, 2004). The nature of the work done by workers in these occupations and the types of equipment and materials they handle present many on-the-job hazards. These hazards and injuries resulting from such incidences include: being caught-in or struck by machinery, falling from a height, heavy lifting or repetitive movements, twisting or reaching and inhaling noxious or toxic chemicals. (Mong'are, Mburu, & Kiiyukia, 2017; Michael & Wiedenbeck, 2004).

Human factors contribute 80-90% of all industrial accidents (Adu et al, 2015), including the forest product processing industry. Employees are exposed to many hazards for which most workers are not aware of their workplace which increases their risk of adverse health effects to physical injury and accidents (Adu et al., 2015). Unfortunately, most employers do not provide personal protective equipment or give much attention to the safety of processing machines (Jerie, 2012).

Based on these arguments, it is necessary to make efforts to increase worker awareness of the risk of accidents and illness with Behavior-Based Safety approach and Risk Management Education. Behavior-Based Safety is an approach that focuses on workers' behavior as the cause of most work-related injuries, illnesses and environmental degradation. Behavior-Based Safety is important because good systems do not ensure successful health, safety and environment management. Safety behavior must be 'lived' in the employees' daily activities (Jerie & Baldwin, 2017).

Behavior-Based Safety Approach and Risk Management Education was carried out on Gum Rosins and Turpentine Factory, an East Java regional forest product industry independent business unit, Indonesia.

Gum Rosin and Turpentine were products non-timber which were derived from the distillation sap of pine trees. Gum Rosins and Turpentine were widely known in the world market as raw material of pharmaceutical products, cosmetics, paint solvent, and other chemical products. Those are distributed to various domestic industry partners to export abroad (Asia, America and Europe). Their capacity of production approximately 18.000 tons/year. (Perhutani, 2015). Gum Rosins and Turpentine Factory goes through several stages starting from receiving raw materials in the form of pine resin, testing raw materials, screening raw materials, heating or cooking raw materials and testing the quality of processed products. The whole process uses oxalic acid as one of the ingredients to produce a high-quality products, but it is corrosive, toxic and causing, itching, burns until irritant contact dermatitis (Rosanti et al, 2018).

The high prevalence of irritant contact dermatitis in Gum Rosins and Turpentine Factory is due to low personal hygiene, lack of knowledge about the risks of chemicals used and lack of implementation of the safety management system (Rosanti et al., 2018). Gum Rosins and Turpentine as one of forest products non-timber have constituted a large part of the forest economy in Indonesia, but they got limited attention and even less in the way of measurement and research (Kusters & Belcher, 2004). Besides, Gum Rosins and Turpentine Factory had experienced a fire in the fuel storage warehouse in 2015. Fire can be caused due to a failure in the process of processing, storing or distributing combustible material (Yakub & Phuspa, 2019). So that was the reinforcing factor for the importance of the Behavior-Based Safety Approach and Risk Management Education.

Method :

The Behavior-Based Safety Approach was carried out in stages: Define, Observe, Intervene, and Test (DOIT). ***Define*** was determining the target that will be the object of research. Those were 56 workers who directly involved in gum rosins and turpentine process production and hence most affected by occupational safety and health hazards in the various sections they operated in. ***Observation*** was carried out twice, before and after an intervention to measure its effectiveness in changing safety culture cognition. ***Intervene***, in this case, was risk management education (training), pre-test, post-test and focused group discussion to the workers. ***Test***, measuring the significance of factors related to workers' safety culture used statistical test.

We developed an instrument to measure the safety culture of the Gum Rosins and Turpentine's Factory based on the literature review. The instruments in the form of questionnaires and observation guidelines consist of 55 question items covering knowledge (10 items), attitudes

(10 items), training (5 items), availability of safety facilities (5 items), communication style (5 items), motivation (5 items) items), supervision (5 items), penalty systems (5 items) and rewards (5 items) which had been tested for validity and reliability. A detailed descriptive study was undertaken on the effectiveness of the program. Direct field observations, interviews, questionnaires surveys, and focused group discussions were used as primary sources of data collection.

Results and Discussion:

The Gum Rosins and Turpentine Factory is located in Ponorogo Regency, East Java Province and employs 56 employees, which consists of 13 regular staff, 35 production workers, and 8 contract workers. The regular staff is in charge of running the administration, supervision, and laboratory. The production workers divided into several stages of work. Those are visual testing of gums, weighing, dissolving of gums with oxalic acid, separating of material from impurities, heating of sap, separation of gum rosins and turpentine, and packaging. While the contract workers are in charge of harvesting of pine resin and transportation to the factory.

In the ***Define*** phase, the determination of the intervention object with Behavior-Based Safety is carried out by analyzing the potential risk of accidents and occupational diseases using hazard identification and risk assessment form (**Fig.1**). As additional information, the gum rosins and turpentine factory does not have an occupational safety and health unit that records work-related accidents and diseases yet.

Fig 1. Table of Hazard Identification and Risk Assessment in Gum Rosins and Turpentine Production

Hazard Identification				Risk Assessment		
Work Activity	**Hazard**	**Which can cause/effect**	**Existing Risk Control**	**Likelihood**	**Severity**	**Risk**
Harvesting of pine sap	Biology (bugs or reptiles bite)	Itching or poisoning	-	Likely	Minimal	Medium
	Scrape tool	Injured hands even cut off	-	Likely	Minor	High
	Skin exposed to sap	Irritation	-	Likely	Minimal	Medium

Transportation of pine sap to the factory	non-ergonomic position	Dislocation or low back pain	Inclined plane	Moderate	Minimal	Low
	Sap container	Injury of being struck down	-	Unlikely	Minor	Medium
Unloading the pine sap	non-ergonomic position	Dislocation or low back pain	Inclined plane	Moderate	Minimal	Low
	Slippery floor	Fall accidentally	Boots	Moderate	Minimal	Low
Visual and laboratory testing of the sap	Skin exposed to sap	Irritation	-	Likely	Minimal	Medium
	Fumes	Sore eyes	-	Moderate	Minimal	Low
Sap dilution	Skin exposed to oxalic acid	Irritation	-	Likely	Minimal	Medium
	Fumes	Sore eyes	-	Moderate	Minimal	Low
Sap washing and filtering (with pressure vessel)	Engine heat	Skin burns, dehydration	-	Likely	Minimal	Medium
	Over-pressured	Explosion	Checking periodically	Unlikely	Major	High
Sap refinement (with pressure vessel)	Engine heat	Skin burns, dehydration	-	Likely	Minimal	Medium
	Over-pressured	Explosion	Checking periodically	Unlikely	Major	High
Sap distillation into gum rosins and turpentine (with pressure vessel)	Engine heat	Skin burns, dehydration	-	Likely	Minimal	Medium
	Over-pressured	Explosion	Checking periodically	Unlikely	Major	High
Packaging	Skin exposed to gum rosins and turpentine	Irritation	Gloves	Likely	Minimal	Medium
	Non-ergonomic position	Dislocation, low back pain, fall accidentally	-	Moderate	Minor	Medium

From the analysis above, we conclude that the Gum Rosins and Turpentine's Factory has not implemented a safety management system properly. Whereas the high health and safety risks are a requirement for the implementation of a safety management system (Jazayeri & Dadi, 2017). The safety management system aims to create a safety climate that is closely related with safety behavior (Lyu et al,

2018). Because all of regular staff, production staff and contract workers have potential risk low to high, then we include them all (56 participants) to the BBS approach and risk management education program.

Pre-intervention ***observation*** was done before the risk management education (training) program, using the safety culture instrument to measure the safe and unsafe behavior of the workers. The measurement results are used as a basis to sharpen the intervention program in the context of reducing the risk of accidents and complaints of occupational diseases (Jazayeri & Dadi, 2017). From 55 items of safety culture measurement, it was noted that the Gum Rosins and Turpentine Factory only got 33 points or 60%. **Fig. 2** below illustrates the lack of safety culture implementation in the production process of gum rosins and turpentine.

Fig 2. Process of unloading the pine sap into chamber

Intervention in this research is risk management education (training) for 3 weeks. We compiled the training curriculum of risk management material divided into 3 meetings in stages. Firstly, introduction of basic Occupational Safety and Health. Secondly, practicing the identification of hazards and potential risks. Lastly, strengthening the commitment of workers to carry out safety culture with focused group discussion and giving of grants in the form of personal protective equipment (PPE). We always do a pretest and posttest to measure participants' understanding of the material presented. Training that involves the participant's active role in joint exercise and dialogue (behavioral modeling) has proven to be more effective than other forms of method (Burke et al., 2006). Safety behavior can be changed due to predisposing factors, including increased knowledge (Hasanah et al, 2016).

(a) (b) (c)

Fig 3. (a) Participants work on the pretest questions; (b) material delivery situation; (c) focused group discussion

In the post-intervention ***observation*** was found that there was an increase in the score of implementing safety culture by 78%. Even though it seems that the real change is the desire of workers to use personal protective equipment (PPE) to maintain their safety and health while working (Fig. 4), the safety culture assessment results for workers did not show a significant improvement. This is different from the statement Hamdani et al (2018) that education in the form of training can change the behavior of workers using PPE. The use of PPE can be due to momentary enthusiasm, but without commitment from the company to support the creation of a good safety culture by providing safety facilities, it will not be effective.

(a) (b)

Fig 4. (a) Workers who channel pine resin into the chamber; and (b) workers who operate the forklift in the packaging section wear PPE

In the ***Test*** phase, we analyze data that has been taken at the time of observation up to

intervention to know whether the intervention can change the safety culture cognition of workers. Paired T-tests showed the score of safety culture cognition before intervention (60%) and after intervention (78%) with a P-value (0,000) <(α = 0.05) which means there was a difference, although the increase is not significant.

Then we carried out a contingency coefficient test and fisher's exact test to determine factors related to the safety culture of the gum rosins and turpentine's workers. The result show that dependent variable (safety culture) is relate to communication style (p-value 0,011), supervision (p-value 0,007), reward system (p-value 0,003) and punishment system (p-value 0,029). While other independent variables, such as knowledge, attitude, training, and motivation have an insignificant relationship with the safety culture of the objects. These results explain the previous findings about the insignificant improvement of safety culture. The intervention of the BBS approach with risk management education does not always succeed in bringing about changes in safety behavior.

Conclusion

The Behavior-Based Safety approach program and Risk Management education should be effective in increasing worker awareness to reduce health risks and accidents. However, its implementation depends on the company's commitment. The safety culture will be difficult to realize because the Behavior-Based Safety is a bottom-up approach, with top-down support.

The limitation in this work that can be the basis for further research is the lack of sample size so the results of this investigation cannot be generalized to other cases.

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