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Effectiveness of the Implementation of Occupational and Safety Health Management System (OSHMS) on Pine Resin Harvesting

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Abstract

Work in the forestry sector, especially pine resin harvesting, is classified as heavy work and a high risk of accidents and occupational health because the pine resin harvesting activities are carried out on varying topography, using various heavy tools and hazardous chemicals. Hence, the occupational and safety health management system (OSHMS) is an essential sector. Some studies about pine resin tapping focused on productivity, socio-economics, and resin quality; however, there needs to be more research about OSHMS in pine resin harvesting. Therefore, the effectiveness of implementing OSHMS is essential to analyze, finding out its impact on the rate of work accidents and employee health in forest product harvesting activities. The objectives of this study are a) to identify the sociodemographics of forest employees, b) to clarify the pine resin harvesting activities and identify the hazard risk, and c) to clarify the effectiveness of the implementation of OSHMS on pine resin harvesting activities. The research was conducted in the state forest company (SFC) in Central Java Province. Interview techniques, literature studies from OSH documents, and field observations carried out to collect sociodemographics of forest employees are dominated by old employees, low education levels, and a working system based on family; this situation impacts the implementation of OSHMS and pine resin harvesting. The SFC provides SOP and training about the technical application of pine resin harvesting, but some employees did not follow the procedure. The impact of disobeying employees, the hazard risk, and accidents also improve. The recommendations for the company are to increase the time spent training the workers and to implement the OSHMS standard. Personal protective equipments have to check routines, and the employees must know the mechanism if there is an accident and how to solve it.

Keywords: *effectiveness, health, occupational safety, harvesting, pine resin*

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Introduction

Pine resin is an important non-timber forest product in Indonesia. Indonesia is third in average pine resin production, after China and Brazil, equaling 90,000 tons annually (Yovi & Amanda, 2020; Lukmandaru et al., 2021). The total area of pine forests is estimated to be 877,330 ha and located between 200 m and 2,000 m altitude (Wardah & Chumaidi, 2023). Pine resin is used as a raw material to manufacture gum rosin, soap, adhesives, paints, and cosmetic ingredients. Another processed pine resin that is also in demand by the industry is turpentine oil. Gum rosin and its derivatives are widely used as raw materials for the paper industry, ceramics, plastics, paints, batik, soap, printing inks, pharmaceuticals, cosmetics, glues, coatings, vehicle tires, as well as for the food industry (Imanuddin et al., 2020).

Trends of rising accident rates in Indonesia include about 82,000 accidents, a high incidence of occupational diseases 179 cases, and early retirement among forestry employees because of accidents (MoL, 2021). Limited, if any, training, poor safety practices, and long working days all contribute to unsafe work conditions. Employees may also be exposed to adverse or extreme weather. Repetitive tasks and working over extended periods in one position are significant sources of overuse and musculoskeletal injuries. An indicator of overuse is employee harvesting many times in one day.

Much forestry work involves manual labor, such as using potentially dangerous tools and bearing a heavy physical load. So, the forest industry is categorized as high-risk and dangerous, including pine resin harvesting (Gandaseca & Yoshimura, 2001; Yovi & Yamada, 2019).

Sundberg and Silversides (1988) state that the energy needs for forestry work are generally larger than those of other sectors. Different activities require additional energy, such as cutting down trees, delimbing and bucking, peeling bark, and shouldering/skidding logs.

Wilmsen et al. (2015) explain that activities in the forestry sector are particularly vulnerable to health problems and accidents. Permatasari et al. (2024) said that knowledge and caution in behavior toward heat exposure differ between indoor and outdoor workers. It is also conveyed by Yovi and Nurrochmat (2009) and Yovi et al. (2022) that work in the forest area has various obstacles, such as a complex work

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environment, heavy physical work (which often exceeds the capacity limits of forest workers), and a high-risk of work accidents. Garland et al. (2020) said that the forestry sector remains one of the most dangerous industrial sectors in most countries. They stated that around the world, there is often a tendency to underestimate the increase in the number of accidents, the occurrence of occupational diseases, and early retirement in forestry workers, even though they are one of the most critical inputs towards the continuity of the production process. Therefore, the protective aspect of the occupational and safety health (OSH) for forest workers is fundamental for governments, forest worker organizations, and forestry companies. Yovi et al. (2023) also said that the heat-related knowledge, risk perception, and precautionary behavior among Indonesian forestry workers and farmers and the implications for occupational health promotion in the face of climate change impacts. Yovi et al. (2022) explain the current weakness in the safety climate among workers and supervisor levels.

Facts show that exemplary implementation of the occupational and safety health management system (OSHMS) in the forestry sector is necessary (Alli, 2008; ILO, 2024). Evaluation of the OSHMS at the company level needs to be carried out to support the realization of a better OSHMS in the forestry sector. In addition, it is also a prerequisite for solid management of the environmental use of natural resources. The OSHMS at the company level can be evaluated by analyzing the employees' OSH conditions. OSHMS is part of the company's overall management system required to develop, implement, achieve, assess, and maintain OSH obligations in controlling risks related to working activities to create a safe, efficient, and productive workplace.

In the forest management certification, the FSC standard also regulates the OSHMS, which is harvesting forest products. According to Özden et al. (2011), harvesting forest products, as the first production activity in the forest, is the cause of the highest occupational accidents in the forestry sector. Pine resin harvesting is classified as heavy work and a high risk of accidents. Because the pine resin harvesting activities are carried out on varying topography, various tools or equipment and hazardous chemicals are used. Some studies about pine resin tapping were conducted by Budiaman and Heryana (2013), Setyawan et al. (2020), Yovi and Amanda (2020), Çağlar (2021), Mujetahid et al. (2021), and Tarno et al. (2022) have researched pine resin harvesting, focusing on productivity, socio-economics, and resin quality; however, there is minimal research about OSHMS in pine resin harvesting. Therefore, the effectiveness of implementing OSHMS is essential to analyze, finding out its impact on the rate of work accidents and employee health in forest product harvesting activities. The objectives of this study are a) to identify the socio-demographics of forest employees, b) to clarify the pine resin harvesting activities and identify the hazard risk, and c) to clarify the effectiveness of the implementation of OSHMS on pine resin harvesting activities.

Methods

The research was conducted in the state forest company (SFC). The total area of the research location is 6,422.29 ha. The research location is about 43,71% of the area, which is a wavy slope (1525%); somewhat steep (2540%) is about 4.45% of the area. The rainfall at the location average is 3,500 mm year^{-1}. The average pine resin production is about 11.5 ton year^{-1}. The research was conducted from 2020 to 2021 in Java during August and December.

The study's methods were interviews and field observation about the implementation of OSHMS, the sociodemographics of employees, harvesting activities, the level of hazard risk, and the kind of accidents at the activities. Interviews using questionnaires were conducted with 77 employees from a total of 150 pine resin tappers. The employees were selected based on the representation of each compartment in the research location. Most of the interviews with the employees were conducted in the forest areas during their tapping.

Furthermore, an in-depth interview was carried out with key informants in the office and forest area, such as two persons from the board management, three forestry assistants, three forest ranger staff, two persons from the division of production, six foremen, and two persons from the OSHMS organization. The data collected are the employee's condition, the harvesting site's condition, the implementation of OSHMS, and the hazard risk assessment. The impact of OSH, constraints, work accidents, and occupational health problems were collected. Sociodemographics of forest workers analysis uses the Chi-square test with the term significance level (α) of 0.01. This level was chosen because of the statistically highly significant, or less than one in a thousand, chance of being wrong.

Risk is defined as the combination of the likelihood of occurrence of a work-related hazardous event or exposure(s) and the severity of injury and health problems that the event or exposure can cause. Hazard risk is evaluated using risk assessment matrices, as shown in Table 1 and Table 2. The

Table 1 Hazard risk assessment level

Likelihood of commonly-occurred Accidents			Severity of commonly-occurred accidents		
Rating	Likelihood	Definition	Rating	Severity	Definition
1	Inconceivable	Has never occurred	1	Negligible	First aid, minor abrasions, cuts
2	Unlikely	Has not been known to occur after many years	2	Minor	Outpatient, medical leave not more than 4 days
3	Possible	Might occur sometimes in future	3	Serious	Hospitalized, medical leave 5 days or more
4	Likely	Chances to occur and not unusual	4	Major	Permanent disability, single fatality
5	Most likely	Happen extremely	5	Crisis	Numerous fatalities

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Table 2 Evaluation of risk

Likelihood (L)	Hazard saverity (S)				
	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	8	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Risk value	Risk level	Evaluation
1–6	Low risk	May be acceptable, but keep revisiting whether risks can be mitigated.
7–12	Medium risk	Tasks may only proceed with management authorization after consultation with the expert and assessment team. If possible the task should be redefined to take into account the hazards or should further reduce the risk before commencement of the task.
15–25	High risk	the work should not proceed, the task should be retranslated, or appropriate control measures should be taken to reduce the risk prior to commencement of work.

data was analyzed qualitatively, descriptively, and quantitatively based on the objectives.

Results and Discussion

Socio-demographic of pine resin harvesting workers

Employee characteristics are essential in implementing OSH and selecting pine resin tapping methods. Influential characteristics of employees are age, gender, education level, work experiences, and the number of trees tapped. Age is one variable that affects a worker's productivity in doing their job. The old workforce generally has weak and limited physical energy, while the young workforce has strong physical abilities.

Figure 1 explains that the largest industries in Indonesia are agriculture, forestry, and fishery, which employ about 30% of the workforce. The average age of pine resin tappers is 53, the youngest being 39, the oldest being 67, and dominated by people more than 65 years old. According to the national statistics, most workers are 35–39 and 30–34, as shown in Figure 2. This means that older people dominate the age of employees in this industry. Septiana et al. (2020) showed that age and productivity have a positive relation. Older employees increasingly have more substantial specifications, experience, considerations, work ethics, and commitments. In addition, a person of productive age (15–65 years old) will be more motivated to work to meet the needs of their family than employees over 65.

On the other hand, older people will be more aware of the implementation of OSHMS. Based on Chi-square statistical tests, Table 3 shows that the national level and pine resin workers' ages are significantly different. The *p*-value of age is less than 0.01.

Figure 3 shows that the number of trees tapped by each worker varies between 200–2,000. This number is based on the employees they have in the family because the employee of pine resin harvesting is based on family members.

Figure 4 explains that the gender ratio of employees engaged in pine resin harvesting activities is predominantly male (91%), and the proportion of women is meager (9%) compared to other industries. The dominance of the males may have resulted from the nature of tasks in the forest industry that are physically demanding for females. Based on statistical tests, using Chi-square, it is shown in Table 3 that the national level and pine resin workers' gender are significantly different. The *p*-value of gender is less than 0.01. Cohen and Tappin (2014), Bee and Sijapati-Basnett (2017), and Haryati et al. (2022) reported that gender inequality could affect a person's productivity level. However, this is the proportion of employees, and many women work because they are family members (wives and children) engaged in the tapping activities. Tapping resin activities is a physical and demanding workload, making it heavier for women. In general, the productivity rate of men is higher than women (Asher & Sijapati-Basnett, 2016). This means that if the family members are mostly men, productivity will be higher, and pine resin harvesting will be completed faster.

As shown in Figure 5, 97% of employees have only completed elementary school, and only 3% have completed junior high school. In contrast, 37% of the country's workers have only graduated from elementary school, while more than 60% have at least a junior high school education. This ratio indicates that tapping pine resin is a livelihood that is possible with an elementary school education. Based on statistical tests using Chi-square, it is shown in Table 3 that the national level and pine resin workers' education levels are significantly different. The *p*-value of education is less than 0.001.

Figure 6 shows that 39% of forest employees have 5–10 years of experience, and 35% have more than ten years of experience. This result shows that most forest employees are advanced in harvesting pine resin. The average work experience is 23 years.

Socio-demographics is very important and related to

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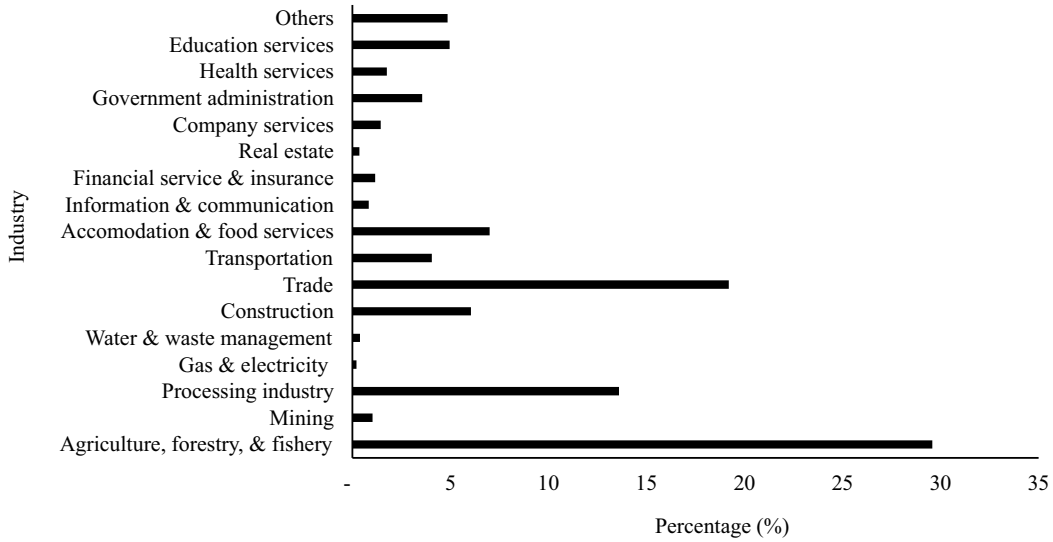

Figure 1 Data of workers based on industries in Indonesia.

Figure2 Characteristic age of pine resin harvesting employee.

Table 3 Chi-square test of pine resin employees and national employees

Chategories	DF	Asymp. Sig	α	Result
Age	6	0.000000000000000002	0.001	Significant
Education	1	0.000000000000000000	0.001	Significant
Gender	1	0.000000029394661797	0.001	Significant

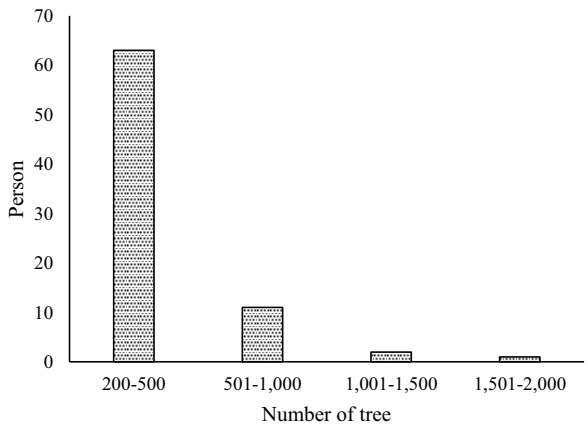

Figure 3 Characteristic number of tree of pine resin harvesting employee.

Figure 4 Characteristic gender of pine resin harvesting and national employee.

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OSHMS implementation in pine resin harvesting activities because human factors, such as unskilled and young employees, must be investigated to ensure the safety of forest employees. Untrained employees are at a very high risk of accidents and health problems because they have yet to learn how to harvest pine resin. Young employees have a good physique but often need more emotional control to achieve significant results and are at greater risk of lack of attention and accidents.

Technical application of pine resin harvesting The distances from home to the work sites vary, with the farthest being 9 km. Some workers go to the forest area by motorcycle, and some go walking or biking. The number of tapping trees in each area ranges from 200 to 2,000. The method used in SFC is the quare method, which some countries call hugues or French method (Cunningham, 2012; Woesono et al., 2022).

The following presents the pine resin tapping procedure, as seen in Figure 7. Pine resin harvesting starts by cleaning around the tree using a machete and preparing the tools (sharpening the tools for making quares). The employees prepare the tools they use themselves. Then, clean the bark. This is conducted to reduce impurities that enter the resin product.

The second step is barking 20 cm from the ground (Figure 8). The first quare is a rectangular–shaped wound 1.5 cm thick and wide, about 4 cm, and has a height of 10 cm. The tools for barking are *kedukul*, *petel*, drill, and wooden ladder. Based on the SOP, the maximum total barking is 210 cm, but many workers bark until 250 cm because the workers want to get much more resin. When the barking is high, employees use simple stairs to reach higher heights of barking and tapping. This operation is dangerous in the steep land forest area. Then, install a zinc gutter under the quare and a resin container as a shell with a distance of 5 cm below the quare. In this case, 52 accidents are slipping or falling down the stairs. Based on the interview with the workers, the accident is the three most severe accidents in the location.

Furthermore, tapping mals consisting of 12 quares linked vertically, the shape of which is 4 cm wide and 60 cm high. It consists of 12 boxes with 5 cm height manufactured, after

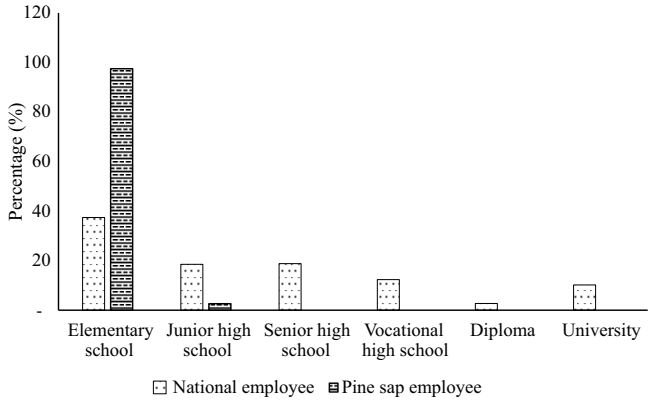

Figure 5 Characteristic level of education of pine resin harvesting and national employee.

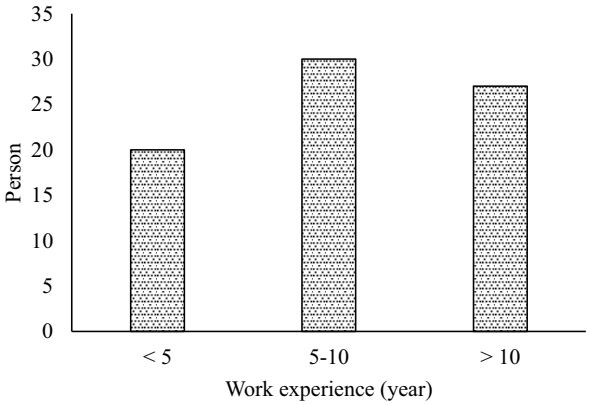

Figure 6 Characteristic work experiences of pine resin harvesting employees.

Figure 7 Wound and tapping.

Figure 8 Step of pine resin harvesting.

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which the tapping mals are sprayed with sulfuric acid liquid (SAL) as a stimulant to increase resin productivity. Stimulant spraying was applied to the freshly wounded tissue with a spray bottle with a nozzle (2 to 3 ml wound^{-1}). Stimulants are chosen to increase pine resin production (Lukmandaru et al., 2021). On the other hand, the sprayed chemical stimulants are dangerous for the skin and eyes, and this process is a high risk without any personal protective equipment (ATSDR, 1998; Hwang et al., 2022). After five days of quare (tapping mals after 12 boxes) renewal with 4 to 5 slashes, each renewal activity is followed by a stimulant spraying with the same dose.

After three times of quare renewals, resin collection was carried out. There are four steps to resin collection. The first step is scraping the resin still attached to the quare. A metal was fixed in the wound to minimize contamination in the exuded resin by foreign materials and rainwater. The second step is to collect resin on metal to coconut shells for each wound. The resin was accommodated into the dried coconut shell. The third step is to collect resin from each shell in the bucket. The bucket can load 60 kg of resin.

The last step of the collection is the resin bucket transported to the final collection and placed by carrying it on the shoulders. Transportation of the resin bucket is done manually by employees, which is also risky. This process is dangerous because the topography is a high slope (15–25%), and the worker brings heavy resin. During the rainy season, the land is a wet and slippery workplace. As pine resin harvesting occurs in such a hazardous environment, it is essential to understand what risk employees will tolerate during the three wound periods. The foreman weighed the resin bucket using a hanging scale at the resin collection place. After being weighed, the resin is put into the resin container at the resin collection place. The tapping circle is wound three times, and one is collected. A worker repeats this procedure for 200 to 2,000 trees.

As pine forest harvesting takes place in such a hazardous environment, it is essential to understand what level of risk will be tolerated by employees during three wound periods: the first wound period was tapping on days 1 through 6, the second wound on days 7 through 12, and the third wound on days 13 through 18 was at a slightly higher position. They prepare the tools they use by themselves. The tapping cycle is three times wounding and one collecting.

Due to various factors, the survey results show that pine resin tapping does not follow the standard operation and procedure for pine resin tapping work in production forests. These factors include the high emotions of young people who like challenges, the desire to earn income quickly, the availability of tools, and minimizing the usual expenses. The points that do not follow the method such as: a) the process of making quare. Which is made to increase resin productivity without regard to tree health or the long-term negative impact on the tree. The scales used are not under the procedure, the height of the quare exceeds the maximum limit of 250 cm recommended in the process; b) the company has yet to consider replacing damaged facilities and infrastructure, such as personal protective equipment (PPE), forest roads, and some tools to tap the pine resin; and c) mix stimulant ingredients using water to dilute the solution and lower its levels; employees also do not wear the recommended self-protective equipment, such as gloves, masks, and mouth coverings, when performing pine resin tapping activities. This increases the impact risk of chemical use on the worker's body, where SAL is usually not stored in a safe place and misused by others.

The impact of disobeying the SOP is that it causes accidents and disease problems for the workers. Yovi and Yamada (2019) said that improving the working techniques is the proper strategy to overcome the hazard based on the accident types. A worker can tap 200300 pine trees in a day, yielding one time the resin collection (about 120 kg) for 15 days. However, the investment of time or the tenacity of the worker also determines whether the results are obtained. Pine trees can begin to be tapped at 1011 years; from the sample data, the oldest tree tapped is 77 years.

OSHMS implementation in pine resin harvesting activities The SFC has various work procedures related to OSHMS implementation. Some are occupational safety, occupational health, hazard identification, OSH risk assessment, OSH investigation, first aid in accidents, internal audit OSH, and occupational accident compensation.

The company also has an OSH supervisory committee (OSHSC) team, which is fully responsible for its implementation. The company's decree Number 560/75/2019 explains that the OSHSC team comprises the chairman, vice chairman, secretary, treasurer, and 16 members. The OSHSC's tasks are preparing the PPE, monitoring and controlling OSHMS, and training the employee.

The company also provides pine resin workers with training for the first time. The training consists of the SOP for pine resin harvesting and the basic rules of OSHMS training conducted in 1 day in the field. The limited time, limited training material, and participants-only workers are the constraints in the OSHMS implementation. Workers do not have enough time to understand the material and concepts of OSHMS and SOP. Training is one of the administrative hazard control measures to minimize accidents and health problems (NIOSH, 2024). Limited knowledge of OSHMS, SOP, and the mechanism if there is an accident and how to solve it can impact the improvement of accidents and health problems for employees. Yovi et al. (2023) also said that knowledge has an immediate and significant impact on individuals' attitudes toward risk and is a robust predictor. On the other hand, the employees of pine resin harvesting are based on family; if the workers are only head of the family and don't transfer the knowledge to the members, the family members don't know the concept of the OSHMS and the SOP. A lack of understanding of the concept of hazard control potentially increases hazards (Yovi & Yamada, 2019).

Based on the interview, Figure 9 explains that almost all tappers have had work accidents. Many work accidents experienced include being exposed to SAL, slipping on slippery roads, and falling down the stairs. Tappers affected by SAL are usually due to not using PPE such as masks, gloves, and glasses. They consider PPE to be troublesome and hinder their work. The tappers say the pine forest floor is slippery, especially in the rainy season. Based on the administered questionnaires, types of hazard risks identified

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include getting chemical stimulants (itchy hand skin, eye pain, etc.), slipping, falling, being bitten by a snake, being bitten by a fallen tree, falling from the stairs when tapping, and death because of slipping. However, in this case, they do not have a system for recording, reporting, and monitoring occupational accidents and diseases, and dangerous occurrences may be used to measure compliance. In addition, some risks of work accidents can cause death, such as being bitten by a snake, being hit by a fallen tree, coughing after inhaling acidic liquid, and accidentally drinking SAL. There are 14 kinds of accident categories. The three highest of accidents are slipping on slippery roads (59 cases), being exposed to SAL (52 cases), and slipping or falling downstairs (52 cases). We categorize accidents into three types: low, medium, and high. Based on the administrative questionnaire and risk evaluation show that the most dangerous or high-risk accident is coughing after inhaling acidic liquid; there are 2 cases. This shows that most accidents are physical hazards. These cases, similar in some industries that result in accidents, are dominated by physical hazard and chemical hazards (Rout & Sikdar, 2017; Musungwa & Kowe, 2022). Based on the evaluation result, the company and workers must be aware of the type of solution to each level of risk.

The company provides employees with employee rights related to OSH through employee insurance, health checks, and PPE. Confirmation to employees by interview that most of them are unaware of any employee or health insurance facilities provided by the company, even though in the event of a work accident, the company will fully reimburse the costs incurred. As noted above, employees do not use PPE properly, so the risk of OSH arises when using SAL stimulant material applications.

The implementation of OSHMS was running, but there were some obstacles to it. Some of them are workers' low awareness of the importance of OSHMS and the number of PPEs needed to meet their needs. A large area with many workers is not proportional to preparing the PPE for all the workers. The budget for PPE procurement also does not cover existing needs; the available field officers also need to follow the extent of their working area. The small number of officers in a large working area makes it challenging to monitor around the clock, and the facilities provided are also less than the officers need. Another problem is there is no regeneration of workers; most of the workers are over the age of 30 years and even up to 70 years, while the resources with productive age prefer to work in the city or find other jobs such as construction or factory so it would be a good thing if it is increasing with time, large area, and the reduction of the workability.

PPE is still an issue that SFC needs to take seriously. SFC provides PPEs for tappers only at the beginning of the tapping process and never re-procures for those who have suffered damage or loss. PPE is the least position-effective action in the hierarchy of hazard control (NIOSH, 2024). That means PPE is still necessary to control hazard risks and minimize accidents and health problems. Therefore, using PPE as the first hazard control attempt is appropriate because PPE alone cannot be relied upon to control hazards (Yovi & Yamada, 2019; NIOSH, 2024). Most tappers use only rubber-based shoes, long shirts, and trousers. Only a few tappers use gloves when spraying SAL because they think it is unpleasant. Few use masks and goggles to protect their eyes and airways. Some replace them by using a cloth to cover the face. SFC once provided PPE that followed the standard for workers, such as shoes, hats, masks, and gloves, but the workers felt uncomfortable using them for work. The PPE used by workers is not standard because the PPE can not minimize exposure to hazards.

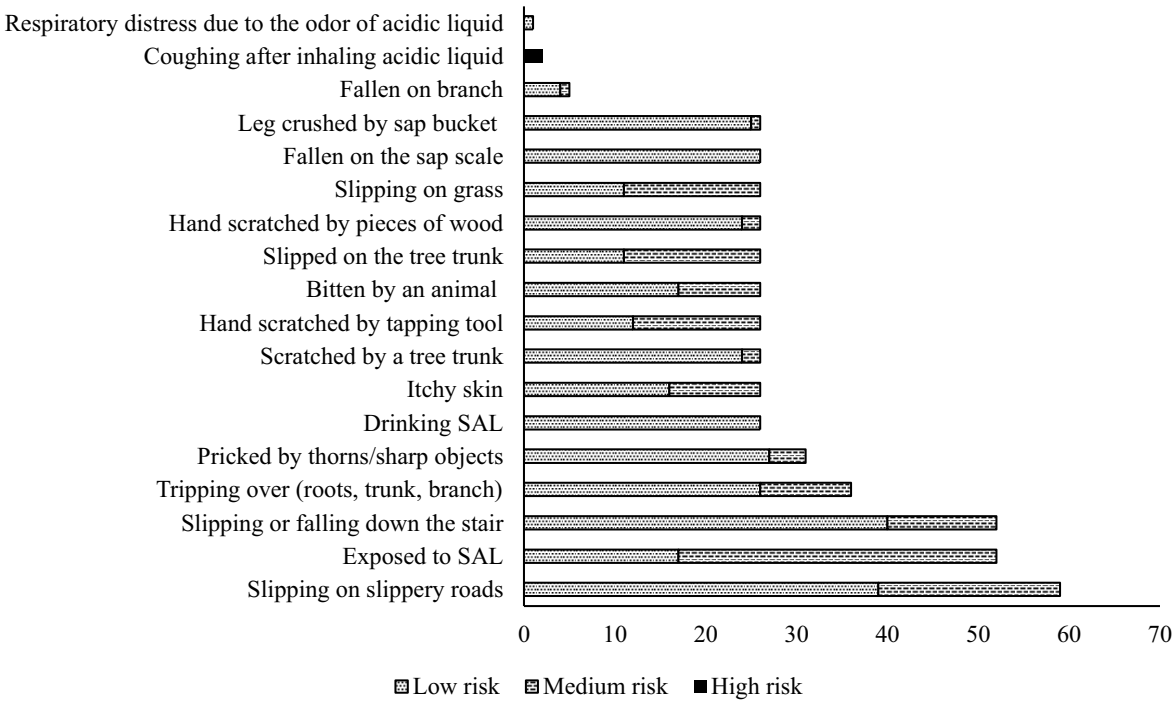

Figure 9 Step of pine resin harvesting.

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On the other hand, the PPE, like shoes and gloves, makes the workers uncomfortable. Gloves are made of too thick, so they are awkward to wear in tropical areas. The workers felt uncomfortable because their movements were not fast enough. They think that the PPE will be troublesome and hinder their work. SFC currently provides shoes and raincoats for workers as PPE as a reward for diligent workers who can meet work targets. Controlling exposures to hazards in the workplace is vital to protecting workers, and PPE is the least effective action in the hierarchy of hazard control (Yovi & Yamada, 2019; Ajslev et al., 2022; NIOSH, 2024).

Based on observation and interviews, the implementation of OSHMS still needs to improve in the field. Initially, there were sanctions for violators of OSHMS implementation. However, the sanctions imposed are reprimands for tappers who disobey OSH and do not meet work targets. Sanctions against violations can be in the form of reprimands, taking or removal of work areas, and termination of work, but as of now, the sanctions carried out are still in the form of reprimands because there are fewer and fewer human resources with large production targets. In addition, for tappers who have yet to be able to meet the target or stop tapping without notice, usually, a foreman will visit their home to ask questions and discuss.

The signs in the forest usually warn of the danger of forest fires, landslide areas, fallen trees, and others. However, most signs are also invisible to tappers. Warnings and appeals specifically for tappers have yet to be created.

Companies provide labor and health insurance to employees, but they have yet to be widely known to the employee. Some work accidents that tappers have experienced are usually only treated traditionally. However, if anyone must be taken for treatment to the health center or hospital, it will usually be financed by SFC; this is insurance provided by SFC. The procedure is to use personal money first, then the treatment receipt is reported to the foreman and continued until the branch level, and then it will be exchanged for the costs that have been incurred. However, some tappers only feel this; others claim to be financed only half of the overall cost. Every tapper who becomes a member will get health insurance in the form of insurance whose premium payment is made by the company with a total of IDR60,000 person^{-1} year^{-1}. Insurance claims must include a doctor's certificate and a photocopy of the identity card. Insurance cards are held mainly by SFC. However, insurance is only for employees who participate in these activities, not their families. OSHMS audits are carried out annually through internal and external audits, which are then reported to the labor office. Actions taken after the audit in the form of improvement of deficiencies are included in the facilities and infrastructure. SFC carries out health checks for its employees, but there is no exact time for its implementation. For the first time, the company offers training about SOPs, how to tap pine resin, and safety occupational and health systems; however, the training is only for workers for a limited time.

The board management says that SFC has implemented OSHMS but still needs conformity between implementation in the field and procedures (SOP) owned by the company. Table 4 shows the SOP of pine resin harvesting and its implementation. There are many different procedures for the SOP and implementation by companies or workers. Some of the procedures didn't follow by workers are: The number of quares in a tree often exceeds the requirement to increase the yield of resin, Quare renewal is done with a different number of repetitions by each tapper, and a quare height that exceeds the maximum limit, Resin collection by all tappers is done at least once every 18 days, Tappers mostly do not use PPE that should be used when spraying stimulants and Some tapper storage the stimulants at the forest area. The company didn't follow some procedures, such as only the shells and zinc (gutters) continuing to be re-procured, and other lost or damaged infrastructure was borne by the tappers.

On the other hand, board members said the allocation of funds for OSHMS is insignificant. The impact of OSHMS implementation on pine resin harvesting has yet to be recorded and is still weak, resulting in the potential risk of work accidents and health for employees in the field. Ranger staff and some foremen say that the implementation of pine resin harvesting activities by SFC has been carried out for a long time, but there are still many challenges and obstacles in the field. Employees and staff use different PPE and dangerous technical harvesting activities in the field, like using simple stairs in the stip land forest area. Lack of education and training about OSHMS and SOP of pine resin harvesting is one of the problems with implemented OSHMS. That information is confirmed on-site for pine resin harvesting. From the above, there is a gap between the concept and implementation of OSHMS.

The research finding indicated that sociodemographics of pine resin harvesting have a relationship between productivity and implementation of OSHMS. Most workers are old and have long experience (23 years), but the employees are also their families (husbands, wives, and children). Concerning OSHMS, older people will have a higher awareness of its implementation, but young people are motivated to get much more income than those concerned with OSHMS. Related to the technical application of pine resin harvesting activities, some employees didn't follow the SOP because of low education and limited training from the company. Some hazard risks in pine resin harvesting findings are the high emotions of young people who like challenges, the desire to earn income quickly, the availability of tools, and minimizing the usual expenses. Hazard risk from internal factors (employee and company) can be minimized when employees and company are aware.

OSHMS in harvesting is deeply intertwined with sociodemographic factors and hazard implementation strategies. Harvesting is a high-risk occupation, and the effectiveness of safety measures significantly depends on integrating these elements. Sociodemographic factors such as age, gender, education level, experience, and cultural background are critical in how workers understand, accept, and implement safety protocols. Younger or less experienced workers may not fully understand the risk involved in forest harvesting, which increases the need for more intensive training. Workers' education levels affect their comprehension of safety instructions. Manzo et al. (2023) and García-Mainar and Montuenga (2024) confirmed this situation that several sociodemographic and occupational

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Table 4 The SOP of pine resin harvesting by the tappers

The SOP		Implementation		
		Yes	No	
1	Planning			
	Cleaniung area	√		By Foreman and the tappers
	The first quare is made as an open tapping with a width of 4 cm, a height of 10 cm, a depth of 1.5 cm, and a maximum height of 20 cm from the ground.	√		
	Controlling the number of quares in a tree based on the circumference of the tree		√	The number of quares in a tree often exceeds the requirement to increase the yield of resin
2	Preparation the tools and equipment			
	Procurement of exhausted and damaged tapping facilities and infrastructure by the Company		√	Only the shells and zinc (gutters) continue to be re-procured. Other lost or damaged infrastructure is borne by the tappers.
3	Barking and tapping			
	The first quare is made as an open tapping with a width of 4 cm, a height of 10 cm, a depth of 1.5 cm, and a maximum height of 20 cm from the ground.	√		
	The tapping gutter is installed under the quare by clipping it to the bark of the tree.	√		
	The resin collection container is installed approximately 5 cm below the gutter.	√		
	Quare renewal is done every 5 days (with stimulant) and every 3 days (without stimulant) by adding quare with a maximum height of 5 mm and depth of 1.5 cm. The maximum height of the quare is 250 cm		√	Quare renewal is done with a different number of repetitions by each tapper and a quare height that exceeds the maximum limit.
	Tapping gutter and resin collection container raised every quare increase in height		√	Tapping gutter and resin collection container are raised when the quare increases in height every 30 cm.
4	Pine resin harvesting			
	Pine resin harvesting is carried out a maximum of once every 10 days		√	Resin collection by all tappers is done at least once every 14 days.
	Cleaning resin from dirt and water before resin collection		√	No filtering is done by tappers because tappers consider it too troublesome
	Scraping off the resin attached to the quare	√		
5	Stimulant use			
	Stimulants that can be used should be based on the recommendations of the Research and Development Center.	√		
	The use of stimulants is done after wound renewal with an interval of 1 spray every 5 days.		√	The use of stimulants by tappers is carried out with different time spans
	Mixing of stimulants with other ingredients is not permitted without instructions from the manufacturer of the stimulant liquid being used.		√	Tappers mix their own stimulants with water accordingly
	The use of stimulants must use gloves, masks, mouth covers, and long clothing		√	Tappers mostly do not use PPE that should be used when spraying stimulants.
	Cleaning of tools used in stimulant spraying, such as sprayer and SAL bottle.	√		
	Storage of stimulants with good air circulation, protected from sunlight, protected from fire, and tightly closed		√	Some tapper storage the stimulants at the forest area.

characteristics were associated with higher perceptions of safety culture, including older age and having a higher level of education.

On the other hand, the SFC has to provide a standard OSHMS based on the regulations. An effective OSHMS can improve the employees' and company's productivity when the company and employees feel safe and convenient during pine resin harvesting.

Conclusion

Sociodemographics of forest employees are dominated by old employees, low education levels, and a working system based on family; this situation impacts the implementation of OSHMS and pine resin harvesting. The SFC provides SOP and training about the technical application of pine resin harvesting, but some employees need to follow the procedure. The impact of disobeying

employees, the hazard risk, and accidents also improve. The SFC has implemented OSHMS but still needs conformity between implementation in the field and procedures (SOP) owned by the company. In addition, the impact of OSHMS implementation on pine resin harvesting has yet to be recorded. It is still weak, resulting in the potential risk of work accidents and health for employees in the field. The recommendations for the company are to increase the time spent training the workers and to implement the OSHMS standard. PPEs have to check routines, and the employees must know the mechanism if there is an accident and how to solve it. The company and workers need more extended training with complete material about the SOP and OSHMS.

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