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Logging Safety Practices of Chainsaw Workers in the Indonesian State Forest Concession

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ABSTRACT

The forestry industry outside Java continues to rely on chainsaw-based logging in natural forests, a technique that involves significant safety risks due to the size of harvested trees, machine hazards, and challenging environmental conditions. These risks highlight the need for skilled operators and effective Occupational Safety and Health (OSH) systems. This study was conducted at two Indonesian State Forest Concessions in East Kalimantan and examined OSH implementation among chainsaw operators. Data were collected through questionnaires with both qualitative and quantitative components, field observations, interviews, and analysis of company documents, including work plans and safety procedures. The results showed that operator awareness of OSH was very high (85.94%), and support and guidance from managers and foremen also strongly influenced compliance (75.97% and 76.81%, respectively). However, barriers remained (49.46%), particularly in the form of incomplete Personal Protective Equipment (PPE), operator discomfort when using certain PPE, and the absence of structured training. These shortcomings indicate a gap between policy and practice. Addressing these issues requires companies not only to provide complete and comfortable PPE but also to enhance training and actively enforce safety protocols. Strengthening these measures would improve both worker safety and the overall sustainability of forest operations.

1. INTRODUCTION

Logging is considered one of the most dangerous jobs in the forestry sector because workers deal with chainsaws, heavy equipment, steep terrain, and unpredictable environments. The ILO (2025), notes that forestry, along with agriculture, mining, and construction, has the highest rates of work-related fatalities worldwide. These risks are made worse by human errors, fatigue, and weak safety practices. As Suhartana & Yuniawati (2011) explain, even when workers understand safety rules, a lack of proper PPE (Personal Protective Equipment) and limited supervision still puts them at risk. This shows why strong OSH (Occupational Safety and Health) practices, including proper PPE use and supervision, are essential for protecting workers and supporting productivity. Proper OSH implementation, including PPE use, ensures worker safety and productivity.

OSH encompasses various job aspects, including workers, tools, tasks, and the environment (Irmawati *et al*., 2019). Apiliani *et al*. (2022) define OSH as protecting physical and mental well-being of workers, improving work output, and fostering a safe work culture. Logging, especially with chainsaws, has high risks, necessitating regular evaluation and improvement of OSH implementation (Grünberg *et al*., 2023). Human resources play a key role in OSH effectiveness, as ability and willingness of workers to follow OSH procedures directly affect logging safety and productivity (Widodo & Yandi, 2022; Kaakkurivaara *et al*., 2022). The objectives of the study are to assess how logging workers apply OSH

principles and identify the factors influencing OSH compliance, providing valuable insights for improving Standard Operating Procedures (SOPs) in logging activities.

Chainsaw operators were chosen as the focus of this study because they face the highest level of risk in logging activities. Their work involves direct interaction with chainsaws, heavy timber, and hazardous environments, making them more vulnerable to accidents compared to other forestry workers. Since chainsaw use is central to the logging process, the operators' awareness, behavior, and compliance with OSH procedures directly determine the overall safety and productivity of operations (Ferhat *et al*., 2024; Yovi *et al*., 2023). Studying this group therefore provides critical insights for evaluating the effectiveness of OSH implementation and for improving SOPs in logging activities.

2. METHODS

2.1. Study Sites

This research was conducted at two locations within the Indonesian State Forest Concessions in Berau Regency, East Kalimantan: Forest Management Unit (FMU) A and FMU B, covering areas of respectively 106,020 ha and 138,210 ha (Figure 1). The fieldwork of this study was carried out from May 30 to June 30, 2022. The two FMUs were purposively chosen because they are large natural forest concessions in East Kalimantan where chainsaw logging is still widely used. They have long histories of forest operations, high production levels, and active logging permits, making them good examples for studying how OSH is applied in real forestry practices. Both FMUs are natural forests predominantly composed of *Dipterocarp* species. Forest operations at these sites began in 1961, with current logging permits valid until 2038. In 2022, the average annual timber production was 125,155 m³ for FMU A and 71,230 m³ for FMU B.

Figure 1. Map of study sites: FMU A and FMU B.

2.2. Data Collection

Respondents in this study were chainsaw operators, selected using a census-based approach, meaning all chainsaw operators were included. Interviews with field supervisors and company representatives provided additional information. The collected data aimed to offer comprehensive insights into OSH implementation.

The tools used in this study included interview guides, questionnaires, voice recorders, cameras, and stationery. The questionnaire used in this study was validated through expert review by forestry academics and OSH practitioners to ensure that the items reflected the key aspects of logging activities and occupational safety. A pilot test was also conducted with a small group of respondents, and the results showed good reliability with Cronbach's Alpha values above 0.70. In addition, the consistency of responses was strengthened through triangulation with interviews, field

observations, and supporting documents. Therefore, the questionnaires were considered valid and reliable for assessing OSH implementation in forestry operations. Data materials included interview results, Likert scale responses, and documents such as the Forest Utilization Business Work Plan (RKUPH) 2022-2031, Annual Work Plan for Forest Utilization (RKTPH) 2022, SOPs for logging and OSH, maps, and other supporting documents. Primary data comes from logging operators, supervisors, and related companies, focusing on respondent identities, OSH implementation, influencing factors, obstacles, and field observations. Secondary data includes research location descriptions, logging activities, OSH guidelines, worker numbers, accident records, and other supporting documents.

2.3. Data Analysis

The analysis involved two methods: qualitative and quantitative studies. The first method analyzes environmental conditions, factors motivating OSH implementation, and compliance with OSH SOPs, aiming to align field practices with SOPs to reduce accidents. Data from primary and secondary sources were used to interpret findings and address the research objectives. Another method used was a Likert Scale with 1-5 levels (Strongly Disagree to Strongly Agree, respectively), and respondents answered questions on OSH implementation and motivational factors (Muhdi *et al*., 2020). Responses were measured based on conditions and perceptions to quantify awareness and adherence to OSH principles. Microsoft software assisted with data processing and analysis.

To calculate the interpretation results, the highest (X) and lowest (Y) Likert scores were determined using X = the lowest Likert score multiplied by number of respondents, and Y = the highest Likert score multiplied by number of respondents. To interpret results, the percentage Index Formula, Mean Score, and the Interval for each class were calculated respectively using Equation (1) to (3):

$$\text{Index \%} = \frac{\text{Total Score}}{Y} \times 100\% \quad (1)$$

$$\text{Mean Score} = \frac{(\text{Total Score})/Y}{\text{Number of questions}} \times 100\% \quad (2)$$

$$\text{Interval} = \frac{\text{Max index} - \text{Min index}}{\text{Number of classes}} \quad (3)$$

3. RESULT

3.1. Characteristics of Forest Workers

FMU A has 11 chainsaw operators, five from one of its subcontractor and six from another subcontractor, as cooperation partners. FMU B has five operators from its cooperation partner. These total of 16 operators vary in characteristics work directly with chainsaws and felling tasks (Table 1). The educational background of chainsaw operators in this study is relatively low, with half of them having completed only elementary school (8 workers) and the other half junior high school (8 workers). None had senior high school or university education. Formal training in occupational safety was also limited, and most operators relied on practical experience rather than structured OSH instruction. The long work experience of many operators –more than half with over 20 years of service– contributed to their ability to perform logging tasks safely, but this experience did not always translate into full compliance with OSH standards, especially in relation to the proper use of PPE.

The nature of chainsaw work itself, which involves direct exposure to high-risk activities such as tree felling and chainsaw handling, increased operator awareness of workplace hazards. This is reflected in the high overall awareness score (85.94%). However, the heavy workload, physical demands, and reliance on habit sometimes reduced strict compliance with established OSH procedures, particularly when PPE was uncomfortable or perceived as slowing down productivity.

Differences between subcontractors also influenced operator compliance. While all subcontractors required workers to follow OSH rules, the consistency of supervision, provision of safety equipment, and intensity of guidance varied (Yovi *et al*., 2021). This variation shaped the degree to which workers internalized and applied OSH standards in daily operations. Operators under subcontractors with stronger OSH support demonstrated better compliance compared to those with weaker oversight.

Table 1. Characteristics of forest workers based on age, education, and work experience

Characteristic	Classification	#Worker
Age (year)	18 - 25	-
	26 - 30	-
	31 - 35	1
	36 - 40	3
	41 - 45	3
	46 - 50	2
	51 - 55	2
	56 - 60	4
	> 60	1
Work Experience (year)	< 1	-
	1 - 5	1
	6 - 10	-
	11 - 15	3
	16 - 20	3
	> 20	9
Education	Elementary School	8
	Junior High School	8
	Senior High School	-
	Bachelor	-

Age and physical condition further affected OSH awareness and compliance. Most operators were middle-aged to older (36–60 years), with only one younger operator (31–35 years) and one above 60. Older workers often relied on their long experience and showed confidence in hazard recognition, but physical decline –such as reduced stamina and slower reflexes– sometimes limited their ability to fully implement OSH measures. Conversely, younger operators, though fewer in number, had higher physical capacity but less experience, requiring more training and supervision to ensure safe practices.

3.2. Responses of Chainsaw Operator on Safety Issues

3.2.1. Safety Awareness

The calculation using the five-point Likert Scale shows that the mean score for chainsaw operators' awareness of OSH, particularly PPE use, is 85.94%, indicating a "very high" level of awareness (Table 2). Operators recognize the importance of PPE for safety during logging activities and feel safe using it, aware of the high risks involved (Yovi *et al*., 2023). This supports the research objective on OSH implementation at FMUs A and B. All operators demonstrate strong awareness of PPE use in the field. PPE is crucial in logging to protect workers from hazards and accidents. Key PPE includes safety shoes, clothing, gloves, helmets, goggles, and earmuffs, each designed to protect against specific risks associated with chainsaw logging (ILO, 1998; 2025; Grünberg *et al*., 2023).

Among 16 chainsaw operators, they all responded to questionnaires. The results was summarized as the following: the highest score (Y) = 5 x 16 = 80; the lowest score (X) = 1 x 16 = 16, index formula = (71/80) x 100% = 88.75%, and mean score = 343.75/4 = 85.94%. The condition and availability of PPE at FMUs A and B are not yet adequate. Although SOPs require complete PPE in line with ILO standards, in practice only helmets are consistently provided, while other equipment such as gloves, ear protectors, and safety shoes are either missing or not supplied in proper safety-grade quality (FAO, ILO & United Nations, 2023). For example, some shoes and clothing used by operators are ordinary rather than certified protective gear, making them less effective and uncomfortable in rough terrain. The limited provision and substandard quality of PPE, combined with the absence of regular training or supervision, cause operators to use PPE selectively, relying only on what is available or comfortable (Yovi *et al*., 2021). This shows that the PPE provided is neither fully sufficient in quantity nor compliant with safety standards, leading to gaps in OSH implementation.

Table 2. Likert scale calculation of the level of awareness of chainsaw operators in OSH at FMUs A and B

Question	Respond	#Worker	*Likert Scale*	Total Score	Index Formula
Wearing personal protective equipment prevents future health problems	SS	10	50	71	88.75
	S	4	16		
	N	1	3		
	TS	1	2		
	STS	0	0		
Personal protective equipment prevents exposure to hazards around me while working	SS	9	45	73	91.25
	S	7	28		
	N	0	0		
	TS	0	0		
	STS	0	0		
I feel safe from work-related diseases when using personal protective equipment	SS	2	10	60	75
	S	10	40		
	N	2	6		
	TS	2	4		
	STS	0	0		
I benefit from using personal protective equipment.	SS	8	40	71	88.75
	S	7	28		
	N	1	3		
	TS	0	0		
	STS	0	0		

Note. SS: Strongly Agree; S: Agree; N: Neutral; TS: Disagree; STS: Strongly Disagree

Management plays a key role in ensuring effective OSH implementation, but in practice their efforts are still limited. At FMUs A and B, management has prepared SOPs in line with international standards, yet operators do not fully comply because PPE is incomplete and not provided at proper standards. Only helmets are consistently supplied, while other essential PPE such as gloves, ear protectors, and safety shoes are lacking. In addition, management has not given formal training or regular socialization of OSH procedures, relying only on banners, so operators depend more on personal experience. This shows that management role has not been proactive, and stronger commitment is needed through complete PPE provision, structured training, and closer supervision to improve OSH practices in the field.

The SOP for Reduce Impact Logging (RIL) at those concessions specifies PPE elements in line with ILO, 1998; 2025; Grünberg *et al*., 2023) standards, including safety shoes, clothing, gloves, helmets, face masks, and ear protectors. These are intended to ensure operator safety and health. However, in practice, chainsaw operators only use helmets, trousers, long shirts, and shoes, with some not wearing gloves. Some PPE, like shoes and clothing, are not made from standard safety materials. While operators understand the importance of OSH and PPE for reducing risks, they often consider certain PPE unnecessary or impractical for logging activities (Yovi *et al*., 2023).

Chainsaw operators consider helmets the most important PPE, with all operators agreeing on their necessity to protect against injuries from falling branches or roots (Figure 2). Additionally, 13 out of 16 operators believe shoes are essential to prevent foot slips and injuries due to thorns, roots, or branches. Some operators also find gloves, pants, and long shirts crucial to safety and comfort, although some dislike gloves for hindering grip. However, 10 out of 16 operators view ear protectors, and 6 out of 16 see glasses as unnecessary. Some also consider gloves and long clothes uncomfortable and unsafe. The limited use of PPE stems from insufficient company-provided facilities and failure to meet PPE standards. The company only provides helmets, violating legal requirements that mandate complete PPE provision for workers. As a result, both incomplete PPE use and inadequate provision demonstrate that OSH has not been adequately implemented at FMUs A and B.

The fact that companies at FMUs A and B only provide helmets reflects deeper structural issues in OSH implementation. Providing helmets may be seen as the easiest and least costly way to fulfill minimum safety requirements, while other PPE items such as safety shoes, gloves, and ear protectors require greater investment and monitoring. Weak enforcement of regulations and limited oversight also contribute, as companies face little pressure or

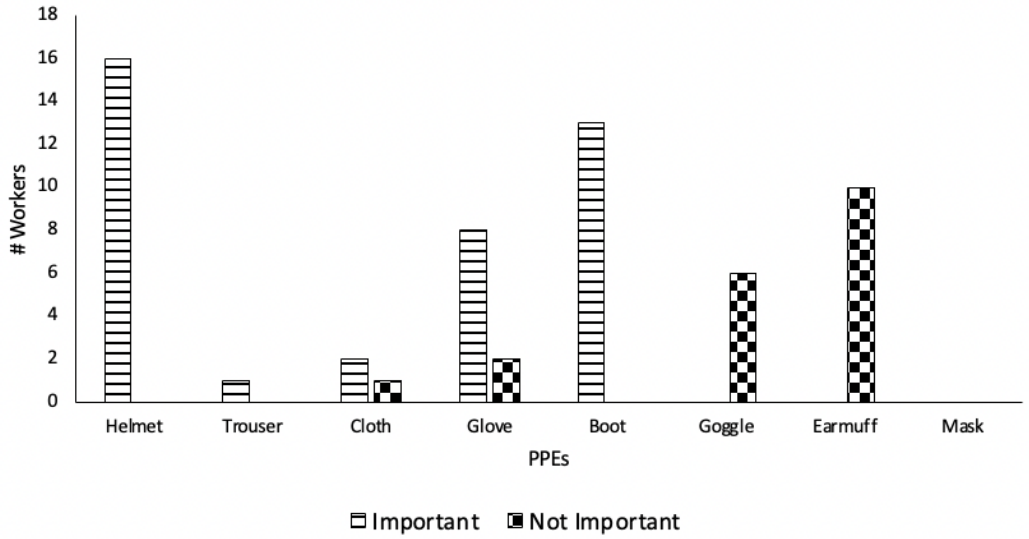

Figure 2. Operator perception diagram on the use of each PPE element

sanction for failing to provide complete and standard-compliant PPE. In addition, the absence of structured OSH training and socialization indicates that management prioritizes operational efficiency over worker safety, leaving operators to rely on personal judgment. These factors show that the problem is not only about worker awareness but also about systemic weaknesses in company commitment, regulatory enforcement, and supervision, which together hinder proper OSH implementation.

Despite upholding OSH principles, both FMUs have not fully implemented proper PPE use. Both FMUs follow OSH guidelines outlined in their RIL and OSH SOPs, alongside a felling SOP for logging activities. However, these SOPs have not been communicated or socialized to chainsaw operators, who rely on their experience and knowledge, which similar found in study by Muhdi *et al*. (2020). The OSH SOP requires equipment preparation and direct socialization of procedures, but to date, only banners have been used for awareness, with no formal socialization or training provided to operators.

3.3. Driven Factors on Safety

Table 3 shows summary of the Likert score for guidance factors in implementing OSH at two FMUs. The calculation resulted in a mean score of 76.81% for the influence of instruction factor on OSH implementation, particularly PPE use, classifying it as "influential." This supports the research on factors affecting OSH implementation by chainsaw operators at both FMUs. The instruction factor, such as daily morning assemblies where foremen check operators' PPE and equipment, plays a key role. Operators appreciate reminders and verbal warnings, which influence their consistent PPE use. However, most operators oppose penalties like fines to increase PPE awareness, preferring instruction through banners, coworkers, and managerial reminders.

The Likert scale calculation resulted in a mean score of 75.97%, indicating an "influential" classification (Table 3). This supports the research on the factors influencing OSH implementation by chainsaw operators at both FMUs. Support factors include guidance from managers and foremen, routine reminders on safety, ensuring operator safety during logging, and providing replacement PPE, such as helmets. Operators are also allowed to rest if they are unwell or weather conditions are poor. However, a key support gap is the lack of OSH training for operators, as they have not received training on safety or logging techniques, which commonly a safety issue in Asia region (Robb *et al*., 2022).

The gap between the high support factor score (±76%) and the lower safety challenge score (49.46%) shows that while companies provide basic support, such as reminders, rest allowances, and helmets, these efforts are not enough to address practical barriers faced by operators. Many workers find PPE uncomfortable, hard to access, or interfering with

their work, and these daily obstacles reduce compliance despite management encouragement. Moreover, the absence of proper training and weak role modelling from supervisors create a disconnect between formal support and actual safety practices in the field. This explains why strong structural support does not automatically translate into effective OSH outcomes, as real challenges in comfort, availability, and workplace culture remain unresolved.

Table 3. Likert score of guidance factors in implementing OSH at two Indonesian State Forest Concessions.

Question	Respond	#Worker	Likert Scale	Total Score	Index Formula
Where I work, employees, supervisors, and management work together to ensure the safest working conditions	SS	5	25	68	85
	S	10	40		
	N	1	3		
	TS	0	0		
	STS	0	0		
Employees are always notified if they are not following good safety practices.	SS	3	15	56	70
	S	9	36		
	N	0	0		
	TS	2	4		
	STS	1	1		
Worker safety is a huge priority with the management where I work	SS	7	35	71	88.75
	S	9	36		
	N	0	0		
	TS	0	0		
	STS	0	0		
I feel free to report safety violations at my workplace.	SS	2	10	51	63.75
	S	6	24		
	N	3	9		
	TS	3	6		
	STS	2	2		
My supervisor is very concerned about my safety	SS	4	20	66	82.5
	S	11	44		
	N	0	0		
	TS	1	2		
	STS	0	0		
My employer ensures I can do my job safely	SS	4	20	66	82.5
	S	11	44		
	N	0	0		
	TS	1	2		
	STS	0	0		
My supervisor provides adequate training to perform my job safely	SS	3	15	48	60
	S	4	16		
	N	1	3		
	TS	6	12		
	STS	2	2		
I have access to all personal protective equipment (PPE) needed to complete my job safely	SS	1	5	58	72.5
	S	12	48		
	N	0	0		
	TS	2	4		
	STS	1	1		
My boss won't give me a hard time if I quit my job because of unsafe conditions	SS	2	10	60	75
	S	11	44		
	N	0	0		
	TS	3	6		
	STS	0	0		

Note. SS: Strongly Agree; S: Agree; N: Neutral; TS: Disagree; STS: Strongly Disagree. Highest score (Y) = 5 x 16 = 80, Lowest score (X) = 1 x 16 = 16, Index formula = (68/80) x 100% = 85%, Mean Score = 683.75/9 = 75.97%

Managers and supervisors play an important role in ensuring the safety of chainsaw operators by providing guidance, giving routine reminders about OSH, monitoring safe work practices during logging, and supplying replacement PPE such as helmets. They also support operators by allowing rest when workers are unwell or when weather conditions are unsafe. However, their role remains limited because they have not provided formal OSH training or technical logging training to operators. This gap reduces the effectiveness of safety management in the field, as operators rely mostly on personal experience rather than structured safety knowledge.

3.3.1. Safety Challenges

Table 4 shows data and calculations reflect the feedback of chainsaw operators on factors inhibiting PPE use in implementing OSH principles. The Likert Scale calculation reveals a mean score of 49.46% for general obstacle factors affecting OSH implementation, classified as "low." Key obstacles include incomplete PPE availability and operator discomfort with full PPE use. The company only provides helmets, while operators must supply other PPE like shoes, gloves, and clothing based on their preferences and comfort. This results in non-compliance with the full PPE standards in the SOP. Operators are comfortable with some PPE, but find others uncomfortable and unnecessary for their tasks, leading to inconsistent use.

Operators find some PPE, such as safety clothing, protective glasses, ear protectors, and masks, uncomfortable and disruptive to their work. Safety clothing feels tight, restricting breathing, while glasses fog up in hot, humid conditions, impairing vision. Ear protectors hinder hearing, making operators unable to detect falling trees or warnings, and masks interfere with breathing during physically demanding tasks. These discomforts may increase the risk of accidents (Yovi & Yamada, 2019; Kaakkurivaara *et al*., 2022). According to Indonesia's PPE regulation, the selection of PPE should align with the type of hazard, worker needs, and comfort, suggesting the need to evaluate PPE used by operators.

Companies can evaluate the effectiveness of PPE by monitoring accident records, conducting operator feedback surveys, and carrying out field observations to assess whether the equipment truly protects workers without hindering their performance. Since some PPE causes discomfort –such as glasses that fog, ear protectors that block warnings, or masks that restrict breathing– evaluation should also focus on usability and comfort alongside safety standards. This means companies need to test PPE under actual logging conditions, ensure it meets hazard-specific requirements, and adjust procurement to provide equipment that both complies with regulations and is practical for operators to use effectively (Ferhat *et al*., 2024).

3.4. Controlling the Risk of Work Accident Hazards

While both FMUs reported zero occupational accidents between January 2021 and June 2022, this finding should be interpreted with caution. Underreporting of accidents and occupational illnesses is a known issue in the forestry sector (Robb *et al*., 2022), and reliance solely on company records may mask the true extent of risks. Minor incidents such as slips, scratches, and thorn injuries were acknowledged by operators, alongside cases of fatigue, back pain, respiratory problems, and hearing loss, which suggest that ergonomic and health challenges persist but are not systematically recorded. This raises the possibility that the absence of fatal accidents may reflect a mix of basic safety practices, chance, and underreporting rather than fully effective risk controls.

In addition, while PPE use is recognized as the lowest level of risk control, the implementation of higher-order controls –such as elimination of hazards, substitution of safer tools, engineering solutions (e.g., improved chainsaw ergonomics, anti-vibration systems), and, administrative measures (e.g., work-rest cycles, training, supervision)– was not evident in the field. This reliance on PPE alone shows a gap in applying the hierarchy of controls as recommended in recent studies on logging safety and operator ergonomics (Garland, 2018; Wempe *et al*., 2019; Yuniawati *et al*., 2025).

Therefore, strengthening OSH in FMUs requires (1) integrating ergonomic assessments into work planning, (2) enforcing higher-order controls beyond PPE, (3) improving monitoring systems to reduce underreporting, and (4) adopting preventive measures for chronic health issues such as fatigue, musculoskeletal disorders, and hearing loss. Including these measures would align FMU practices with international standards for sustainable and safe forest operations.

Table 4. Likert score of barrier factors in the implementation of OSH FMUs of the Indonesian State Forest Concessions.

Question	Respond	#Worker	*Likert Scale*	Total Score	Index Formula
Wearing personal protective equipment is uncomfortable	SS	0	0	36	45
	S	3	12		
	N	1	3		
	TS	9	18		
	STS	3	3		
Personal protective equipment interferes with my ability to do my job	SS	0	0	37	46.25
	S	3	12		
	N	2	6		
	TS	8	16		
	STS	3	3		
Personal equipment is not always available to me	SS	0	0	45	56.25
	S	6	24		
	N	3	9		
	TS	5	10		
	STS	2	2		
My coworkers would make fun of me for wearing PPE	SS	0	0	24	30
	S	0	0		
	N	1	3		
	TS	6	12		
	STS	9	9		
My supervisor rarely wears protective gear when needed.	SS	0	0	34	42.5
	S	1	4		
	N	3	9		
	TS	9	18		
	STS	3	3		
My supervisor is aware of my compliance with personal protective equipment guidelines	SS	5	25	68	85
	S	10	40		
	N	1	3		
	TS	0	0		
	STS	0	0		
I need to develop the habit of wearing personal protective equipment, which is problematic	SS	5	25	60	75
	S	6	24		
	N	2	6		
	TS	2	4		
	STS	1	1		
Wearing PPE is too much of a hassle for me.	SS	0	0	41	51.25
	S	4	16		
	N	3	9		
	TS	7	14		
	STS	2	2		

Note. SS: Strongly Agree; S: Agree; N: Neutral; TS: Disagree; STS: Strongly Disagree. Highest score (*Y*) = 5 x 16 = 80; Lowest score (*X*) = 1 x 16 = 16; Index formula = (36/80) x 100% = 45%; Mean Score Value = 346.25/7 = 49.46%

The company can increase the awareness and compliance of machine saw operators with the risk control hierarchy by providing regular training and socialization on its five levels –elimination, substitution, engineering, administrative control, and PPE– so that operators understand PPE is only the last line of defense. Practical demonstrations and safety talks before logging activities can help operators connect these concepts with their daily work. In addition, management should integrate risk control into routine supervision, highlight real cases of minor injuries or health complaints, and show how higher-level controls can prevent them. Clear communication, continuous reminders, and involving operators in discussions about safer work practices will strengthen awareness and encourage compliance with the hierarchy of risk control (Ferhat *et al*., 2024).

4. CONCLUSION

Although awareness of OSH implementation among chainsaw operators was very high (85.94%), this awareness did not automatically translate into consistent practice in the field. This gap appears to stem more from managerial shortcomings –such as lack of training, incomplete PPE provision, and weak SOP socialization– than from operator culture alone. The weakest aspects of OSH implementation identified in both FMUs were insufficient PPE provision, inadequate replacement facilities, and the absence of structured OSH training. These findings indicate that risk control and OSH enforcement are hindered more by systemic managerial factors than by operator resistance.

To address these gaps, recommendations should move beyond general statements. Practical steps include conducting regular and compulsory OSH training, ensuring the provision and replacement of certified PPE suited for tropical logging conditions, improving SOP socialization, and establishing participatory monitoring systems where workers can report hazards and unsafe practices without fear of reprisal. Strengthening these elements would help FMUs move from reliance on PPE alone toward a more comprehensive application of the hierarchy of controls.

For future research, a narrower focus is suggested to generate more actionable knowledge, such as examining the ergonomic design and usability of PPE under tropical forest logging conditions, assessing the long-term health impacts of chainsaw operations (e.g., musculoskeletal strain, hearing loss, and respiratory issues), and evaluating how different managerial approaches influence OSH compliance. Expanding comparative studies across multiple FMUs and harvesting activities (felling, skidding, transport) would also provide broader insights into best practices for safe and sustainable logging.

CONFLICT OF INTEREST

The authors declare that there is no significant competing financial, professional, or personal interests that might have affected the performance.

AUTHORS' CONTRIBUTION

All authors declare that they are participating actively in research and article writing and partly responsible for the content of writing, including in the preparation and writing of concepts, designs, analysis, or revision of the article. The role(s) of authors H, R, N: Conceptualization, Methodology. S: Data curation and analysis, S, H: Writing-Original draft preparation. H: Writing-Reviewing and Editing.

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REFERENCES

Apriliani, C., Fitria, F., Deli, F., Samuel, M.H.M., Sulistiyani, S., Risnawati, T., Lukman, H., Muhammad, R.A., Dame, E.S., Chrisha, M.K., Arina, N.R., Lamria, S., & Firdaus, F. (2022). *Keselamatan dan Kesehatan Kerja*. PT Global Eksekutif Teknologi, Padang. ISBN 978-623-99632-5-5.

FAO, ILO & United Nations. 2023. Occupational safety and health in the future of forestry work. *Forestry Working Paper*, ***37***. Rome. https://doi.org/10.4060/cc6723en

Ferhat, A., Nurdiansyah, B., Suswatiningsih, T.E., & Bimantio, M.P. (2024). The implementation of occupational health and safety (OHS) program on employee working conditions in the harvesting unit of PT Sewangi Sejati Luhur. *OPSI*, ***17***(1), 135-145. https://doi.org/10.31315/opsi.v17i1.11997

Garland, J.J. (2018). Accident reporting and analysis in forestry: Guidance on increasing the safety of forest work. *Forestry Working Paper,* ***2***. Rome, FAO.

Grünberg, J., Ghaffariyan, M.R., Jourgholami, M., Labelle, E.R., Kaakkurivaara, N., Robert, R.C.G., & Kühmaier, M. (2023). Criteria for assessing the sustainability of logging operations—A systematic review. *Current Forestry Reports,* ***9***, 350–369.

https://doi.org/10.1007/s40725-023-00198-x

ILO (International Labour Organization). (1998). *Kode praktis ILO: Keselamatan dan Kesehatan Kerja di Kehutanan*. (Translated by Yanri, Z., Yusuf, M., & Ernawati, A.W.). ILO, Jenewa.

ILO (International Labour Organization). (2025). *Keselamatan dan Kesehatan Kerja di Sektor Kehutanan*. ILO office, Jakarta.

Irmawati, I., Kresnowati, L., Susanto, E., & Nurfalah, T.I. (2019). Kesehatan dan keselamatan kerja (K3) di bagian filing. *Jurnal Manajemen Informasi Kesehatan Indonesia*. ***7*(1)**, 34-38. https://doi.org/10.33560/jmiki.v7i1.215

Kaakkurivaara, T., Borz, S.A., & Kaakkurivaara, N. (2022). Risk factors and occupational safety failures in forest work in the Southeast Asian Region. *Forests*, ***13***(12), 2034. https://doi.org/10.3390/f13122034

Muhdi, M., Hanafiah, D.S., Lubis, W.R., Telaumbanua, A.A., & Atika, D. (2020). Chainsaw operators' perception on occupational health and safety (OHS) in industrial plantation forest, North Sumatra, Indonesia. *Proceedings of the 3rd International Conference on Community Research and Service Engagements (IC2RSE 2019), December 4, 2019, North Sumatra, Indonesia.* EAI. https://doi.org/10.4108/eai.4-12-2019.2293807

Robb, W., Zemánek, T., & Kaakkurivaara, N. (2022). An analysis of chainsaw operator safety between Asian and European countries. *Croatian Journal of Forest Engineering (CROJFE),* ***43***(2), 373-389. https://doi.org/10.5552/crojfe.2022.1539

Suhartana, S., & Yuniawati, Y. (2011). Tingkat pemahaman keselamatan dan kesehatan kerja pada kegiatan pemanenan kayu jati di KPH Cianjur. *Jurnal Penelitian Hasil Hutan,* ***29***(1), 46–56.

Wempe, A.M., Keefe, R.F., Newman, S.M., & Paveglio, T.B. (2019). Intent to adopt location sharing for logging safety applications. *Safety,* ***5***(1), 7. https://doi.org/10.3390/safety5010007

Widodo, D.S., & Yandi, A. (2022). Model kinerja karyawan: Kompetensi, kompensasi dan motivasi, (literature review MSDM). *Jurnal Ilmu Multidisiplin*, ***1***(1), 1–14. https://doi.org/10.38035/jim.v1i1.1

Yovi, E.Y., & Yamada, Y. (2019). Addressing occupational ergonomics issues in Indonesian forestry: Laborers, operators, or equivalent workers. *Croatian Journal of Forest Engineering (CROJFE),* ***40***(2), 351-363. https://doi.org/10.5552/crojfe.2019.558

Yovi, E.Y., Abbas, D., & Takahashi, T. (2021). Safety climate and risk perception of forestry workers: a case study of motor-manual tree felling in Indonesia. *International Journal of Occupational Safety and Ergonomics*, ***28***(4), 2193–2201. https://doi.org/10.1080/10803548.2021.1986306

Yovi, E.Y., Nastiti, A., & Kuncahyo, B. (2023). Heat-related knowledge, risk perception, and precautionary behavior among indonesian forestry workers and farmers: Implications for occupational health promotion in the face of climate change impacts. *Forests*, ***14***(7), 1455. https://doi.org/10.3390/f14071455

Yuniawati, Y., Septina, A. D., Ningrum, M. H., & Andini, S. (2025). Indonesian timber harvesting workers' knowledge of occupational safety and health. *New Zealand Journal of Forestry Science*, ***55***, 1. https://doi.org/10.33494/nzjfs552025x305x