

Article

Risk Factors and Occupational Safety Failures in Forest Work in the Southeast Asian Region

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Abstract: Occupational safety is generally known to be low in forestry work. A similar situation may be found in Southeast Asian countries, where health and safety aspects are not commonly taken care of so rigorously. However, there is also a lack of primary data which could be suitable for evaluating such issues. The auditing reports of FCS certification are a source of useful information to evaluate and analyze health and safety concerns in forestry work. This paper addressed the coverage of available information, classified the risk factors uniformly from different certifying body criteria, compared occurrence of risk factors in groups and checked for dependencies in data. The key findings are that the main issues were those related to the organizations' failures to protect the workers and to the lack of awareness of safety. In turn, these may explain the high incidence of forestry-related work accidents in Southeast Asia.

Keywords: wood harvesting; accident risk; FSC; certification audit; incident rate; work safety; health and safety



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1. Introduction

Forestry work, which includes silviculture and logging, is commonly described as dangerous, difficult, and dirty (3D) [1,2]. The issues related to the dangerous nature of forestry work can be linked to the environment (rugged terrain, climatic conditions, biological agents, and exposure to noise, vibrations, and exhaust fumes) and to the tools and processed material: the use of sharp and/or power tools, heavy loads, and heavy machinery [3]. Difficulties are common to manual tree felling and processing work, which demand skills to control safety risks and physical conditions to tolerate workload [4,5]. The dirty component of the work can be seen when manual harvesting is compared to work in other industries, particularly in tropical countries, where the heat and rainy season makes working conditions sweaty and muddy [6].

In Malaysia and Thailand, for instance, forest work holds second place when the inter-industrial accident rate is considered [7,8]. In Thailand, the incident rate is about 21 cases per 1000 workers annually. Forestry work can be characterized as 3D in the whole of Southeast Asia (SEA) [9]. Additionally, in manual harvesting, the attitude towards safety is low, and safety actions are inadequately prioritized at the operators' and managers' levels [10]. Unfortunately, there are no available aggregated global statistics on accidents and fatality in forestry [11]. Country-specific studies, however, have described the situation; as examples, in South Korea and Romania the fatalities were found to be higher in forestry compared to other industries [12,13]. On the other hand, positive progress by lowering the accident frequency and severity can be seen when companies take initiative to promote health and safety (H&S) culture [14].

In SEA countries, the options used in timber harvesting vary from motor-manual to semi-mechanized; fully mechanized harvesting is seldomly used [15,16]. The common harvesting systems are those integrating motor-manual tree felling and processing with skidding by specialized machines or farm tractors adapted for forest operations. As shown by the latest statistics, fully mechanized harvesting is only seldomly used, although its share in operations is increasing, following the general trend in which forest companies are increasingly changing their options to mechanized harvesting due to shortage in labor and cost-effectiveness [17]. In SEA countries, the shortage in labor is typically characterized as the lack of professional workers and seasonal variation in labor availability; that is, skilled labor is not available in adequate amounts for year-round harvesting operations [18]. Other issues such as those related to the work technology and methods, non-use of personal protection equipment (PPE), out-of-date work equipment and lack of knowledge and experience are common problems in chainsaw work not only in Asia [19], but also in some European countries [20].

Forestry companies are increasingly considering forest certification systems when implementing their businesses [21]. Forest certification covers a wide area of elements related to sustainability, taking into account the economic, ecological, and social aspects of forest management [22]. The Forest Stewardship Council (FSC) standards, for instance, also cover the H&S issues [12]. With some exceptions, FSC certification is the most common certification system in SEA countries. Exceptions are Malaysia and Indonesia, where the most common is the Programme for the Endorsement of Forest Certification (PEFC) [23,24]. Gutierrez Garzon et al. [25] found that the FSC is much more detailed and prescriptive in nearly all aspects considered for forest certification. The certification is voluntary for landowners and forest companies, although lately it is starting to be rather mandatory in attempt to search for and keep a portfolio of forest products end-users. On the other hand, the H&S regulations and legislation differ between SEA countries. Typically, the H&S components of the FSC certification system are guided to follow the national laws and regulations of occupational safety and health (OSH) in forestry work [26]; if a given country has not established its own national laws, the certification will take into consideration the code of International Labor Office (ILO) for practicing OSH in forestry [27]. Nonetheless, it can be stated that adopting forest certification standards is important to develop or to extend the safety culture of a company [11].

To evaluate the risk factors and occupational safety issues, a potential study method could be that of investigating the reports on near miss incidents and undesired circumstances [28]. It can provide detailed information about hazardous behaviors, unsafe working methods, lack of personal protective equipment etc., which helps to understand risk factors and safety failures. In turn, this knowledge would help managing and lowering the accident rates. This is based on the domino theory of accident causation by Heinrich, which described five steps in the causal chain of events: social environment and ancestry, carelessness, unsafe act or condition, accident, and inquiry [29]. If this sequence is interrupted by eliminating at least one causal factor, the accident will not occur [30]. When an unsafe act or condition is observed by a FSC certification audit, accident prevention actions can be taken, and the domino effect can be stopped before it leads to accidents in the future.

As Robb et al. [18] have found, information of OSH regulations, accidents, and the use of PPE are not readily accessible in the SEA region. In addition, with the lack of a uniform regulatory framework in the SEA region, the national level data would be incomplete and incomparable. In this context, the FSC audit reports can be seen as suitable sources of valid data to study the most important risk factors of H&S in forestry work [13]. These audit reports are made by certifying bodies (CB), which have an accreditation approval from the Assurance Services International company, authorized by the FSC. The audit process itself is conducted by CB, which assesses the certification holders. The assessment of H&S is carried out based on several criteria, which, according to the FSC standard and depending on a given country implementing the current or former structure of principles [26], are linked to principle 2 (Workers' right and employment conditions) or to principle 4 (Community

relations and worker's right). The aim of the audit is to evaluate whether a certification holder has implemented the agreed requirements, which is called conformance [26]. In contrast, non-conformance or corrective actions required (CARs) are classified into groups in the CAR reports, namely major and minor CARs [26]. Additionally, observations are recorded, which can lead to a CAR later on. Minor CARs do not violate the core objectives of the standards; these unusual and non-systematic failures need to be corrected within 12 months. Major CARs violate the core elements or the central goal of the standard; typically, they stand for repeated or systematic non-conformances that have continued for a long time. The timeline given to correct major CARs is three months. As a part of the certification audit, CAR reports are available to the public.

This study uses the data from the FSC certification audit reports of the Southeast Asia region from which the H&S-related CARs were identified and classified into risk factor groups. The goal of the study was to investigate the risk factors and occupational safety failures that could later lead to occupational accidents in forestry work. The main objectives were that of examining the current occupational safety situation to identify the most common problems and of checking the dependencies in data in regard to country, certified area, level and type of nonconformities.

2. Materials and Methods

2.1. Data Sourcing and Categorization

This study was based on collecting secondary information. The data were collected from FSC's public dashboard, where the raw data are readily available for downloading [31]. The study addressed the period from 2017 to June 2022. All the available official audit reports were included for Cambodia, Indonesia, Laos, Malaysia, Thailand, and Vietnam, which indicated that there were FSC certificate holders in the six countries. Some of the SEA countries were excluded since no certificate holders were found for them. The standards on principles (1–10) and criteria were recategorized by FSC in 2019, and there was a transition period available during the revision period. The SEA countries were in different phases of implementing the new principles, which complicated data processing in this study. As such, the H&S criteria were recategorized under different principles. The study included five H&S-related risk factor groups: environmental, equipment-related, job-related, organizational, and personal (Table 1).

Table 1. Risk factor groups related to CAR of H&S issues issued in audit reports of FSC certifications.

Risk Factor	Description of Typical Characteristics
Environmental	Unsafe working conditions Improper weather conditions, extreme heat/cold, rain, dust Density of trees
Equipment-related	Use of inappropriate tool/machine Use of non-standard tool/machine Use of old machine Insufficient maintenance and repair Absence of machinery protectors Not using personal protective equipment Not using communication tools Insufficient PPE and/or first aid kit and/or fire extinguisher PPE and/or first aid kit and/or fire extinguisher are not available at working place
Job-related	Heavy physical workload Job structure spread over a large terrain, necessity of communication among workers Mobile objects (tree, logs) Long and heavy objects Various phases of work in the same field Limited visibility, obligation to complete work in a short time, limiting the choice of workers

Table 1. Cont.

Risk Factor	Description of Typical Characteristics
Organizational	Incorrect working system (laws and regulations, communication, written SOP, etc.)
	Insufficient number of workers
	Unsuitable selection of workers
	Insufficient training of workers
	Inadequate control
	Lack of warning signs
	Overtime hours
	Insufficient rest breaks
	Difficulties in supplying protective equipment
	Inadequate supervising, monitoring, and recording
Inadequate wages, welfare, and other benefits	
Personal	Carelessness
	Inexperience
	Insufficient knowledge on the job
	Unsuitability to the work
	Fatigue
	Tendency to act quickly
	Disorderly behavior
	Positioning in dangerous zones
Lack of motivation	

These groups were used when the minor and major CARs and observations were classified. This approach follows other studies from Romania and Turkey, where a similar grouping was used [13,32]. Table 1 describes the common situations and issues as they were collected from the auditing reports of CAR by the auditing teams. After downloading data from the FSC public dashboard, the data were sorted and categorized. Only valid FSC forest management certification holders were chosen, and the following information was extracted: certification code, certified area, country location, CARs (major and minor) and observations. The CARs and observations were picked from only safety related cases. Those descriptions were carefully read to be able to identify the root cause, i.e., carelessness, not wearing PPE, etc. These were categorized into risk factor groups. After this procedure, the data were ready for descriptive data analysis.

2.2. Data Analysis

The descriptive statistic part of the study was carried out in terms of absolute and relative frequencies on specific categories and countries. Dependencies in data were addressed by the means of correspondence analysis, a statistical technique designed for categorical data which takes as inputs contingency tables and plots multidimensional data in lower representation spaces that preserve much of the original variance; as such, it is particularly useful to infer and represent associations in data when the data come in a highly dimensional form [33–35]. Procedurally, the data on certified forest areas, level and type of CARs were structured into contingency tables at the country level. Absolute frequencies were used to count the forest areas on categories having as a baseline the classification given by FSC [36]. As such, categories of less than 10,000, 10,000 to 50,000, 50,000 to 100,000, 100,000 to 200,000 and 200,000 to 300,000 hectares were designed and named <10 k, <50 k, <100 k, <200 k and <300 k, respectively; then, the level (major-MAJ, minor-MIN, observations-OBS) and type (environmental-ENV, equipment-related-EQU, personal-PER, and organizational-ORG) of nonconformities were grouped. Distributions in data were particularly uneven, therefore Cambodia, Laos and Malaysia were grouped as countries in a group called KH-LA-MY; to Indonesia, Thailand and Vietnam were given codes of ID, TH and VN, respectively. The dimensionality of the data were of 4×5 for forest area (four countries/country group and five categories of forest areas), 4×3 for level of nonconformity and 4×4 for the type of nonconformity. The analyses

themselves were carried out at the level of these factor groups and they included a test for independence in data (χ^2 test for independence), development of symmetric biplots, characterization of contribution (proportion of the variance explained by dimensions) and quality of representation (eigen values), and interpretation of data. The selection of data representation dimensionality was also checked based on the degrees of freedom [33]. Procedures applied to the four contingency tables were extended by including all the data in a single analysis with the aim of mapping the data dependencies as a whole. There are several tools that can be used to run a correspondence analysis; in this study, Microsoft Excel[®] equipped with Real Statistics freeware add-in [37] was used, mainly because it supported other computation and statistical steps required by the study.

3. Results

3.1. FSC Certified Areas and Certifying Bodies

The certifying bodies (CBs) mapped by this study were seven in total, namely the Bureau Veritas (BV), Control Union Certifications (CU), GFA Certification GmbH (GFA), Preferred by Nature (NC), Soil Association (SA), Scientific Certification System (SCS), and SGS group (SGS). Detailed information about the number of certification holders classified based on country and CB is presented in Table 2. The highest number of certification holders were in Vietnam (51) and the lowest in Cambodia (1). The most common CB was GFA to be chosen as audit provider for certification holders (39 cases). In Indonesia, six of seven CBs have been called for auditing, and the median value of CBs was three per country. At the national level, a high number of certain certifying body audits was a consequence of local office and officer, i.e., BV in Thailand and GFA in Vietnam.

Table 2. Certification holders amounts presented between per countries.

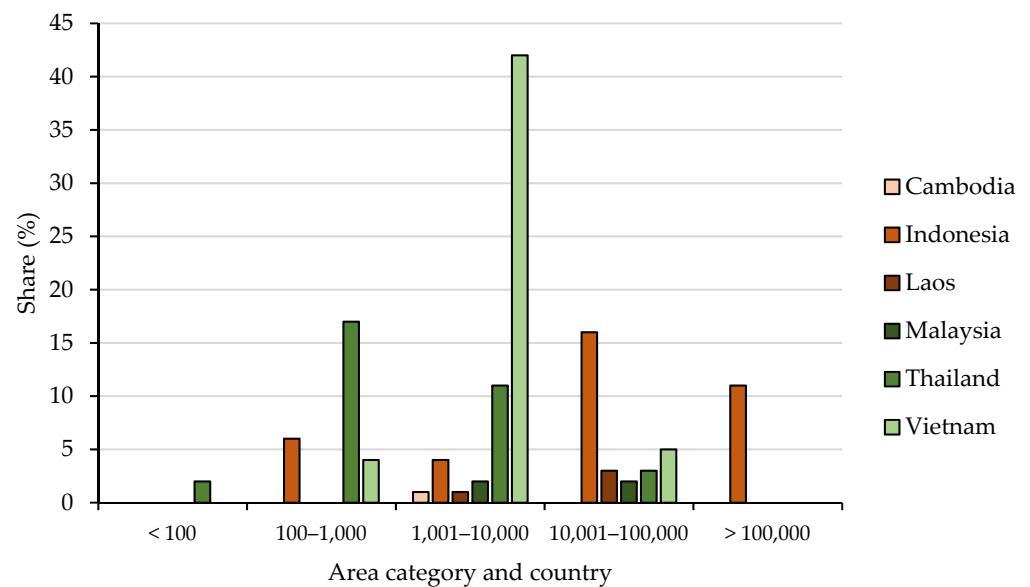
Country	BV	CU	GFA	NC	SA	SCS	SGS	Total
Cambodia			1					1
Indonesia	1	5		7	10	11	3	37
Laos			3	1				4
Malaysia		2				2		4
Thailand	13	11	2				7	33
Vietnam	2		33		6		10	51
Total	16	18	39	8	16	13	20	130

The FSC certification has been audited for about 3.65 million hectares in SEA (Table 3), of which the highest share (86.2%) was that of Indonesia, where the certified areas varied widely, from 148 to 298,710 hectares. In addition, the average size of the certified areas was also the highest among the countries, which may be because the companies/landowners commonly hold several thousand hectares under FSC certification in Indonesia. These companies are aware about the importance of H&S policy, although several organizational levels and wide and scattered forest areas may affect the outcome. The certified areas included both plantation and natural forests.

Table 3 does not give a comprehensive description about area size distribution, especially when countries hold large, certified areas. To understand more deeply country specific characters, Figure 1 presents the certified areas in size classes. Clearly, Indonesia had certification holders with the largest areas. In 11 cases the certified area was over 100,000 ha and in 16 cases between 10,001 and 100,000 ha. In Vietnam, the common land size was between 1001 and 10,000 ha (42 cases), while in Thailand the most common class was from 100 to 1000 ha.

Table 3. Total size of forested [38] and FSC certified areas in SEA countries.

Country	Total Forest Area, ha	Certificate Holders No.	Area Size, ha				Share %
			Min	Max	Average	Total	
Cambodia	58,714,510	1			7896	7896	0.2
Indonesia	92,133,200	37	148	298,710	85,073	3,147,695	86.2
Laos	16,595,500	4	3483	41,259	23,449	93,796	2.6
Malaysia	19,114,040	4	6476	23,344	14,289	57,154	1.6
Thailand	19,873,000	33	29	29,790	3514	115,946	3.2
Vietnam	14,643,090	51	780	20,282	4498	229,374	6.3
Total	221,073,340	130			23,120	3,651,860	100

**Figure 1.** Certified areas in different size classes (ha) per country.

3.2. CARs and H&S Related Issues

The CBs identified 324 CARs and observation cases in their audit reports related to H&S issues (Table 4). The ratio between major and minor CAR cases was generally one to two. The observation cases were mainly recorded in Indonesia. Countries such as Cambodia, Laos and Malaysia, which had fewer certificate holders and less certified areas, did not obtain many CARs or observations. Indonesia was the leading country based on total certified area, although it had relatively minor H&S related issues marked in the audit reports. Thailand and Vietnam had more major and minor CARs than expected compared to their certified area, though the number of certificate holders was high.

Table 4. Number of major and minor corrective actions required, and observations in the Southeast Asian countries.

Type Country	Major		Minor		Observations		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Cambodia	-	-	3	1.5	-	-	3	0.9
Indonesia	47	48.0	100	51.5	28	87.5	175	54.0
Laos	3	3.1	13	6.7	-	-	16	4.9
Malaysia	-	-	3	1.5	1	3.1	4	1.2
Thailand	18	18.4	15	7.7	2	6.3	35	10.8
Vietnam	30	30.6	60	30.9	1	3.1	91	28.1
Total	98	100	194	100	32	100	324	100

3.3. Main Risk Factors of Forest Work

In terms of risk factors, almost two thirds of the CARs and observations were connected to the organizational risk factor group, over one fourth to equipment, 7% to personal, and only 1% to environment (Figure 2). The data did not include any CAR or observation of the fifth risk factor group, namely job-related factors. The total number of H&S-issued cases was 368. It differed from the total amount presented in Table 4, which was 324. The reason for this was that 44 CARs were categorized into two risk factor groups by the audit teams. These audit teams were from different CBs and countries.

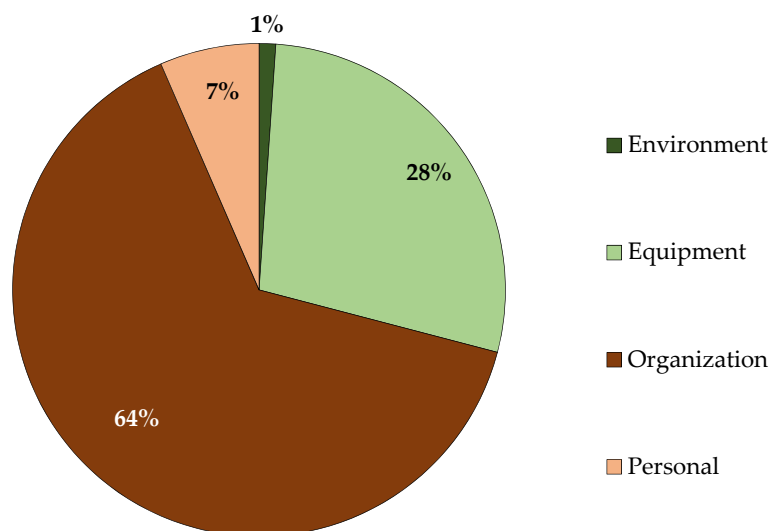


Figure 2. Health and safety related major and minor corrective actions required, and observations (n = 368) classified to four risk factor groups.

3.4. Risk Sub-Factor Groups of Forest Work

Table 5 gives more detailed information about risk factor groups. Each CAR and observation were more specifically categorized to subfactor groups, which were aggregated from the description of typical characteristics given in Table 1. For example, Figure 2 assigns one percent for the environment risk factor group. This one percent included four subgroup cases, of which one for unsafe working conditions, one related to the density of trees, and two cases for improper weather conditions (hot weather without provided drinking water supply). For equipment risk factors, the most common case was that workers did not use PPE (33%). For example, the following CARs were written down by auditors related to concerns about PPE:

1. Checking two harvesting teams, many harvesting team members did not wear appropriate PPE (hard hat and steel toe shoes), operated a chainsaw without face and ear protection, and did not wear steel toe shoes/boots: major CAR;
2. PPE was not worn during the hand slashing operation at the compartment. Slashing was being carried out using a long-handled slasher. The worker was wearing no PPE. In an interview with a silvicultural contractor, it was noted that the incorrect PPE as set out in the “ILO document Safety and Health in Forestry Work” was being worn during brushing and cutting operations. The operator had ordinary rubber boots, a normal hat, no safety trousers and no visor: minor CAR;
3. Only one set of PPEs for chainsaw operators (suitable with ILO Code Practice on H&S in Forestry) was presented in the office. No evidence was provided on how many sets were available, while there were at least four chainsaw operators in the harvesting team. At the interview with harvesting team members, they did not use PPE in accordance with ILO code practice requirements in practice: major CAR;

4. Workers carrying logs and assisting on the harvesting site were wearing shoes without steel cups/toes and did not wear protection equipment for the shoulders when carrying logs: minor CAR.

Table 5. Amount (*n*) and share (%) of the major and minor CARs and observations in different risk factor groups.

Risk Factor	Subfactor	<i>n</i>	%
Environment	Unsafe working condition	1	25.0
	Insufficient weather conditions, extreme heat, rain, dust	2	50.0
	Density of trees	1	25.0
	Total	4	100
Equipment	Use of inappropriate tool/machine	10	9.7
	Use of non-standard tool/machine	13	12.6
	Use of old machine	2	1.9
	Insufficient maintenance and repair	11	10.7
	Absence of machinery protectors	3	2.9
	Not using PPE	34	33.0
	Not using communication tools	1	1.0
	Insufficient PPE and/or first aid kit and/or fire extinguisher	19	18.4
	PPE and/or first aid kit and/or fire extinguisher are not available at working place	10	9.7
	Total	103	100
Organization	Incorrect working system (laws and regulations, communication, written SOP, etc.)	64	27.0
	Unsuitable selection of workers	3	1.3
	Insufficient training of workers	26	11.0
	Inadequate control	47	19.8
	Lack of warning signs	4	1.7
	Difficulties in supplying protective equipment	37	15.6
	Inadequate supervising, monitoring, and recording	39	16.5
	Inadequate wages, welfare, and other benefits	17	7.2
	Total	237	100
	Personal	Carelessness	5
Inexperience		5	20.8
Insufficient knowledge on the job		10	41.7
Positioning in dangerous zones		4	16.7
Total		24	100

At the organization level, the highest number (27%) of CARs was classified as an incorrect working system concerning law and regulations, communication, written standard operating procedure (SOP), etc. Here are some typical notes of CARs written on audit reports:

- a. During audit at the office, there was an ILO code of practice OSH available in forestry work. However, during verification, the OSH procedure auditor found that there was no applicable ILO code of practice in their OSH procedure for workers who support forest activities. This may impact the effectiveness of OSH control. So, it was raised as a major CAR.
- b. SOP for OSH, handling of work accidents explained that if there is a work accident, they must provide first aid to the accident, but the procedure/aid program was not explained. Furthermore, no evidence was provided related to the training of workers: major CAR;
- c. Auditors reviewed the 2019 and 2020 accident record and found that there were no serious or fatal accidents. There were 12 light accidents in 2019, 9 light accidents and 1 medium accident in 2020. The auditor reviewed two samples of accidents from 2020

(chainsaw operator's assistant and mechanic) and found that the organization had kept a record of accidents, including the victim data, including the name, gender, age, job, impact (dead, permanent disability, temporary not able to work, light wound), accident factor (location of wound, source of accident, type of accident, physical condition), loss estimate (material, day of work), and cause of accident. The chainsaw operator's assistant injured his left leg (swollen and hurt) due to being hit by logs already cut that were suddenly broken into two. Additionally, the auditor found that both employees were brought to the hospital immediately to receive treatment after they obtained their first-aid kit. Details of all costs for treatment of both employees were reviewed and it was found that these were submitted to the social insurance. Based on interviews with managers, staff and workers, the organization was found to have revised their SOP on harvesting, induction training and safety briefing before workers arrived at the work area. However, the documentation of training of the revised SOP for harvesting had not been documented: minor CAR;

- d. The organization had SOP on H&S, which identifies appropriate safety equipment for each job category. It also includes the procedure of H&S equipment provision. The procedures clearly stated that the minimum standard of PPE for harvesting unit staff is helmet, rubber boots, cloth gloves, earplugs, long socks and a mask. Safety trousers and earmuffs were not mentioned in the organization's procedures as required by the ILO Code of Practice for H&S in Forestry Work (chapter 7). Based on those findings, the auditors concluded to issue a minor CAR.

Insufficient knowledge on the job was clearly the highest (41.7%) personal risk factor. Below are some common findings selected as examples from audit reports:

- I. The chainsaw operator and his support worker in the organization were both situated one next to the other and it was detected that the stumps were not in line (missing felling hinge and kerf) with the requirements of the national regulations and ILO-code of practice: major CAR;
- II. The tree stumps observed did not comply with good practice in terms of cutting technique and, thus, safety requirements: minor CAR;
- III. The cutting technique observed in the field was not in compliance with best practices. This nonconformity was already identified during the main audit (minor CAR 2018-04). As the former minor CAR could not be closed due to the observation made during the first surveillance audit, the former minor CAR was upgraded to a major CAR.

Organization and personal risk factor groups did not include any written notes from some subfactor groups, which are listed in Table 1. These subfactor groups are not listed in Table 5, although these absent cases are noted in the discussion section.

Country-level analysis revealed that Indonesia and Vietnam have some CARs and observations that were concentrated in some subfactor groups. Not using PPE, as a subfactor, accounted for 34 cases, of which 21 were from Vietnam. Furthermore, the number of cases of difficulties in supplying protective equipment subfactor group was the most common (14 of 48) in the organization risk factor group in Vietnam. Additionally, in the personal risk factor group, two thirds of all cases (16) were reported in Vietnam. In total, 54% of cases of CARs and observations were detected in Indonesia (Table 4). There were some subfactor groups in the organization risk factor group, which were above the average: inadequate control was reported 39 times out of a total of 47 cases (83%), and inadequate wages, welfare, and other benefits were reported 14 times out of 17 cases (82%).

3.5. Sources of CARs and Observations

The sources of data for major and minor CARs and observations were site visits, interviews, and document reviews (Figure 3). Both site visits and document reviews included more than one third of the total amount. The share of interviews was 17%. In some cases (10%), the audit report mentioned more than one source. Both minor and major CARs included all four types of data source. Additionally, any CB and country did not stand out from other in terms of source.

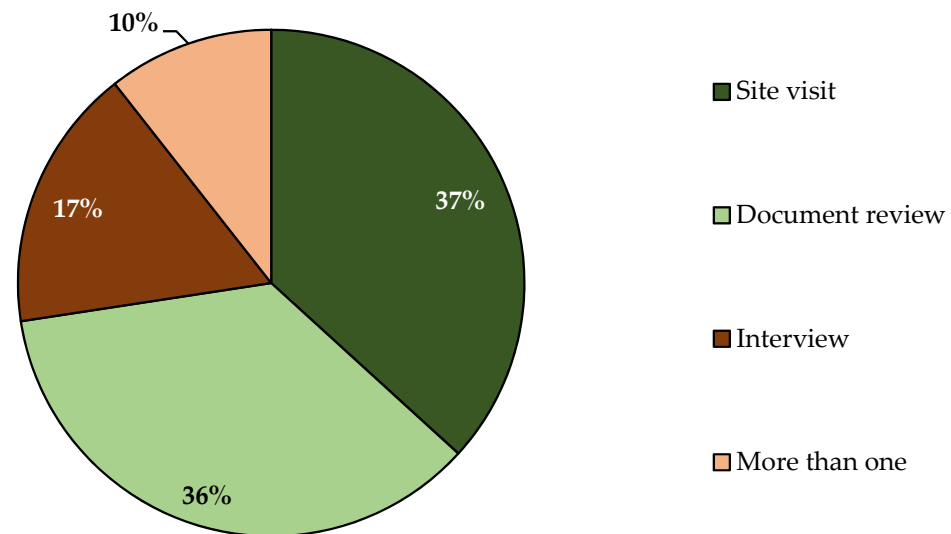


Figure 3. Sources of CAR and observation identifications.

3.6. Dependencies in Data

As a prerequisite of the correspondence analysis, the results of χ^2 tests for independence indicated that there are dependencies in data represented as rows and columns. These dependencies were significant for all the subsamples shown in Figure 4, which stand for the contingency tables associating the countries to forest area, level and type of nonconformities. Significance of dependencies was also evaluated by taking the square root of the trace; in all cases this number was more than 0.2, and it can be interpreted as the correlation between the data stored in rows and columns of a contingency table [32]. Figure 4 shows the main results of the correspondence analysis, along with the main metrics used for interpretation. Bidimensional solutions were retained for all four correspondence analyses since these accounted for 95.4 to 100% of the explained variance (Figure 4c,f,i). By eigen values (Figure 4b,e,h), only the size of the certified forest area seemed to indicate an association closer to an exclusive one, which was shaped by the first dimension (Figure 4b). In the rest of the cases, the eigen values were low, indicating other types of dependencies.

Indonesia was mostly associated to certified forest areas higher than 100,000 hectares (Figure 4a). From this point of view, it stood apart from the rest of the countries, as separated by the first dimension, explaining 76% of the variance (Figure 4a). Thailand and Vietnam seemed to have a higher frequency in certified areas less than 10,000 hectares, while the group formed from Cambodia, Laos and Malaysia was more associated with forest areas between 10 and 50 thousand hectares. All of the countries were placed well apart from the center of gravity (origin of the plot).

Figure 4d shows the results of correspondence analysis by considering the level of nonconformity. There was a clear separation between Indonesia and the rest of the countries made by the first dimension, explaining 62% of the variance. Vietnam, for instance, was more associated to minor observations, while Thailand was more associated to major ones. Similar interpretations apply to Figure 4g, where Vietnam seemed to be more associated with observations made on equipment, and where the organizational issues were well separated from the rest by the first dimension, explaining 87% of the variance.

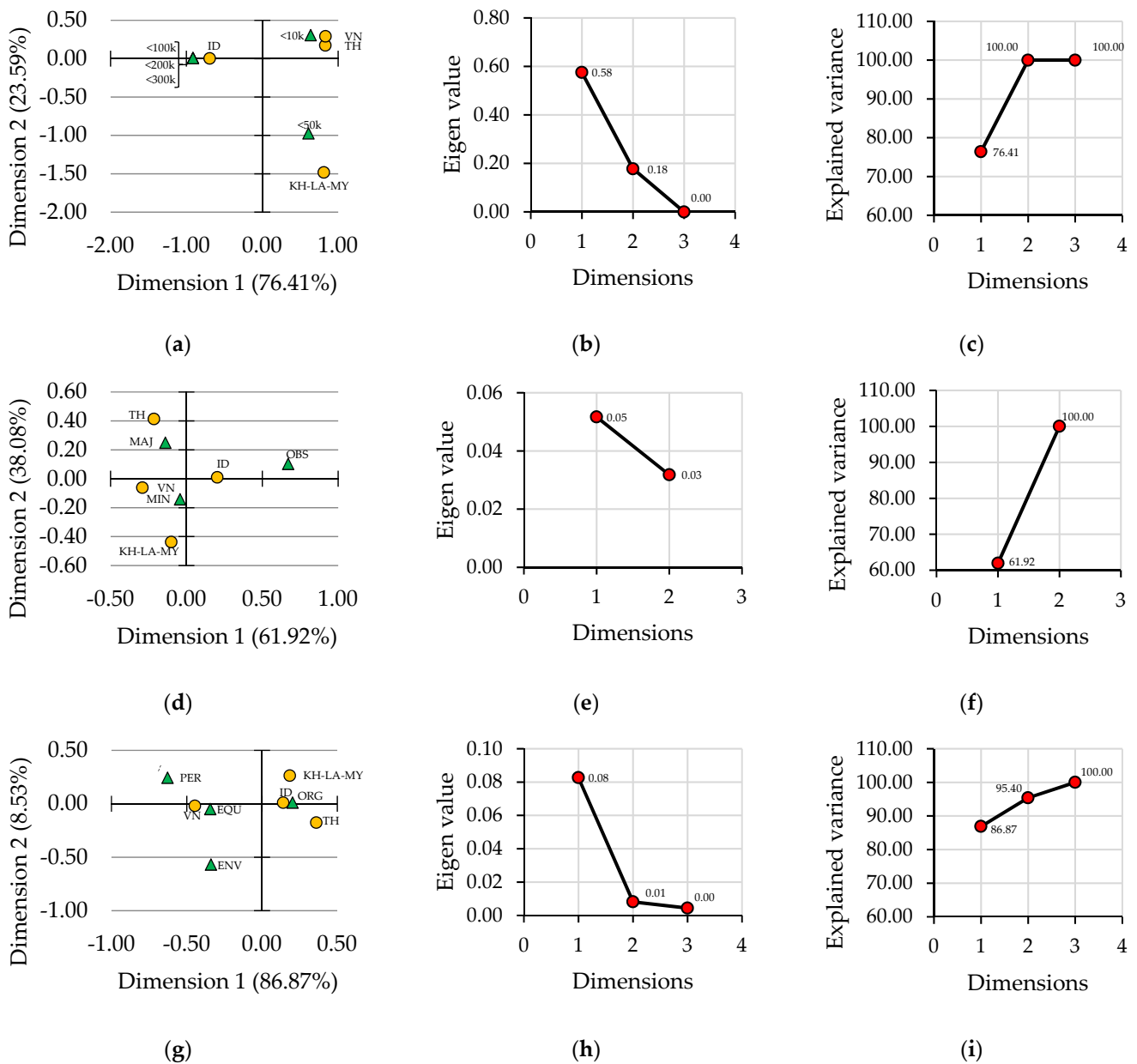


Figure 4. Results of correspondence analysis: (a–c) from left to right-combined plot of countries versus certified forest areas, eigen values versus dimensions and explained variance; (d–f) from left to right-combined plot of countries versus level of nonconformities, eigen values versus dimensions and explained variance; (g–i) from left to right-combined plot of countries versus types of nonconformities, eigen values versus dimensions and explained variance.

Figure 5 describes the results of the correspondence analysis based on the aggregation in data describing the column profiles. While it should be interpreted with caution due to data aggregation, it still provides some important hints on how the data was associated, mainly by setting apart Indonesia from the rest of the countries by the first dimension, which was coupled with the size of certified areas. Additionally, organization-related issues, and minor observations seemed to be close to the average profile of the data. The second dimension separated the group from Cambodia, Laos and Malaysia from the rest of the countries. This dimension appeared to mostly distinguish between major and minor observations, as well as between organizational–personal and equipment–environment issues.

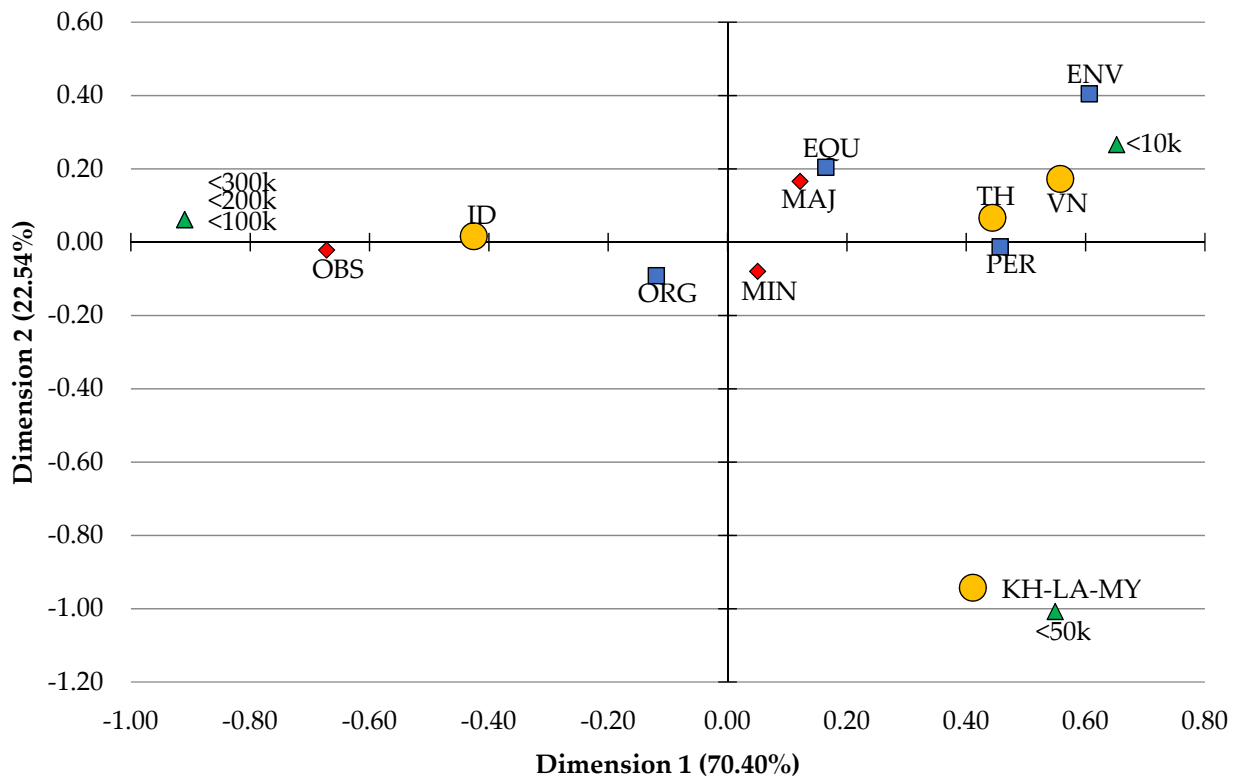


Figure 5. Biplot of Correspondence Analysis based on all factors and country groups.

4. Discussion

This paper aimed at giving more detailed information by considering a wider scope over forestry work in the SEA region. Data from FSC certification audit reports turned out to be a fruitful source to investigate the current situation on OSH. However, one should bear in mind that while the CB and their audit teams follow the same certification criteria, each audit has various particularities affecting decision making.

No job-related factors were found, as presented and described in Table 1. The group includes, for example, ergonomics-related sub-factors such as heavy physical workload, or handling long and heavy objects, and subfactors, which need to be assessed from a subjective point of view, such as limited visibility or time. Moreover, audit reports did not include any CARs or observations which could be categorized in subgroups of organization or personal risk factor groups: insufficient number of workers, overtime hours, insufficient rest breaks, unsuitability to the work, fatigue, tendency to act quickly, disorderly behavior and lack of motivation. Reasons for lacking these CARs can be the limited time of visit, when the auditing team has to go through all ten principles of FSC criteria and create a complete report in three days. Some of the abovementioned subfactors need more time from the auditor to be discovered, including by having more in-depth interviews with workers. A similar lack of CARs was detected in Romania, where job-related and environment risk factor groups did not receive any CARs [13]. The study stated that the reason could be that auditors were mostly carrying out punctual observations in the field and they focused on PPE, knowledge and experience of the workers, or on the tree felling technique. These are easily and objectively observed facts of forestry work, and the same phenomenon can be an explanation for this study as well. Accordingly, studies dedicated to operational safety, ergonomic condition and exposure to environment- and technology-related factors could clarify such effects in the area, providing additional information for a comprehensive evaluation of CARs. In addition, the results of such studies could be paired to key information on the dynamics in weather conditions to guide the organizations in properly setting up their activities.

The study covered 130 certification holders, audited by seven CB in six countries of SEA for a forest area of about 3.65 million hectares. Forestry work can include similar tasks and techniques all around the SEA region, where mechanized harvesting is taking its first steps. The size classes of certified areas, as well as some results of the correspondence analysis, slightly indicate that countries in medium classes with a high number of certificate holders, such as Vietnam and Thailand, have more CARs than Indonesia, where the certified area size is greater, but the number of certificate holders is at about the same level. This can indicate that a bigger scale forest industry company can more effectively tackle H&S issues and it can implement OSH-related improvements. The CAR reports included H&S issues at nurseries, weeding controls, harvesting sites and workshops, especially with the PPEs. Labor-intensive methods are prevailing, and the OSH culture is not self-evident. The results of the risk factor groups clearly indicate the high share of PPE-related problems at the equipment, personal, and organizational levels. Most of CARs and observations were organization risk factors, which seemed to also affect, to a high extent, the existing dependencies in data, since this category was close to the mean data profile. It seems that companies have to first more carefully follow laws and regulations and create written SOPs, secondly to strengthen internal control at the manager level to improve supervising and monitoring, and thirdly to provide PPE and train their workers to use it in an adequate way. The personal risk factor results mainly indicated the background of workers, who had no vocational school education; it may stand also for the workers' personal attitudes, which may result in unprofessionalism and negligence. This category stood particularly apart for Vietnam. Nevertheless, these shortages could be mitigated, if organizations would improve their H&S culture and implement more precisely safety awareness to forestry work by training [14]. Similar conclusions were drawn by a study on chainsaw use in Asia, where a holistic approach was recommended to improve H&S in forestry work [19]. This paper points out these H&S shortages with a more closely defined and wider spectrum in forestry. The findings were also similar to those found in Romania, where H&S-related major CARs were those of not using PPE in the equipment risk factor, insufficient knowledge of the job in personal risk factor, and inadequate control and difficulties in supplying PPE in the organizational risk factor groups [13], which were backed up by the results of some dedicated studies carried out in the past [20,39].

FSC certification has been noticed to be a possible game changer in reducing injuries and improving OSH by compelling certificate holders to develop a proactive safety culture [40]. The FSC certification audits are an effective tool to stop the domino theory of accident causation by preventive actions. Based on this study, there were several hot spots of H&S issues which need careful and rigid reviewing for improving OSH in the SEA region. In future, the mechanization of forest work will reduce accident rates, mainly by decreasing the share of chainsaw work in the SEA region, as proved by statistics to have occurred in other parts of the world [1,40–43]. Before such developments will be in question, proactive safety actions are needed to be carried out. Education is a key factor to enhance safety perception, which leads to engaging in safety procedures, lowering accident rates, and increasing the job satisfaction [44]. However, its implementation needs periodic assessments so as to be able to tailor the contents to the findings of practice [45].

There are some limitations of this study which need to be addressed. First of all, the results of this paper are based on data recorded by FSC certification audits. At such, they do not reveal causes behind the major and minor CARs, nor do they guarantee the uniformity of practice in assessments, which may also be shaped by the auditors' subjective views. To reach a better outcome in implementing the safety culture to organizations, it is also important to understand national cultural values, which influence people's attitudes and behavior. It would be beneficial to implement interdisciplinary studies on the relationship between OSH and national cultural values, so as to see whether the lack of safety awareness is linked to inadequate training or to people's life philosophy, which affects their work safety attitudes. Given the level of mechanization and climate of the area, specialty studies should be implemented to evaluate and adapt the difficulty of tasks to the workers. Secondly, the

findings of this study may stand as a minimum limit found in terms of non-conformity. As a fact, workers may be more compelled to comply to some safety guidelines or regulations when audits are pending in a given area, on which the certification outcome may depend. For instance, the study of [20] was based on rather non-scheduled assessments, and it revealed serious issues related to the procedures used, as well as in the wearing of personal protective equipment.

5. Conclusions

This paper gives an overview on the H&S issues in the SEA region based on FSC certification audit reports. Previous studies proved that occupational safety failures are common in forestry work. In this study, similar risk factors were found in the studied region. One needs to take into consideration that FSC certification is not yet very common in SEA. If the amount of certificate holders and certified forest areas are to increase in the future, then certification could have a positive effect on the OSH. The study clearly pointed out the frequency of CARs related to motor-manual harvesting but, surprisingly, audit reports included cases from other forestry work as well. The organization level risk factors were found to be strikingly common in audit reports in SEA during the last five years. The results of this study can be used by certificate holders, policy makers, and stakeholders to support their decision making in an attempt to mitigate or even eliminate risk factors so as to reduce the hazardousness of forestry work.

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