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EVALUATION OF THE RISKS IN WOOD HARVESTING ACTIVITIES BY THE PRELIMINARY HAZARD ANALYSIS (PHA)

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Abstract-The first step of the wood harvesting process is the harvesting that include cutting-felling, pruning, peeling, and bucking. These activities involve a variety of hazards, because of in the work environment, done and machines used. Forestry operations are among the most difficult and risky. Taking the necessary precautions is crucial to ensure occupational health and safety in forest operations before the operations is done that identification and classification of hazards posed by these activities. In this study, it is aimed to determine the hazards that the trees cutting-felling, pruning and bucking activities carry in terms of occupational health and safety and evaluate them according to the preliminary hazard analysis (PHA) method. Preliminary hazard analysis method has been chosen as the risk analysis methods because of the necessity of documentation is less in the study, the ability to be done by an expert, the medium level of experience and the application of each sector. The hazards of these activities have are revealed by the literature survey and the field studies in the wood harvesting area in the Black Sea, Central Anatolia and Mediterranean regions of the Turkey. Twenty-nine hazardous situations were identified in the study, of which 12 were high risk, 9 were serious and 8 were intermediate risk. It is not possible that the working environment and all hazards in the forests that are living ecosystems and work material is heavy are completely removed. Intervening according to the importance classes of the hazards to minimize and the level of the risk to decrease should be taken precautions that determined in the study.

Key Words- Risk analysis, PHA method, Wood harvesting, Forestry activities.

1. INTRODUCTION

Forestry activities are considered in the 3D class according to the International Labor Organization (ILO) due to being dirty, difficult and dangerous [1]. These activities are located in the fourth risk class from the 5 risk group "Communiqué on the List of Risk Groups Related to Occupational Health and Safety" published in Turkey [2]. The wood production process is comprised of harvesting, extraction and transportation. The first step of the wood production process is the harvesting that include cutting-felling, pruning, peeling, and bucking. These works are among the most dangerous and risky works in terms of occupational health and safety due to the working conditions, the equipment used and the heavy workmanship. According to TS 18001 risk is the combination of the likelihood of a hazardous event or exposure to occur, and the

severity of the injury or health impairment that may be caused by the event or exposure [3]. The Risk assessment is, in short, a process involving the estimation of the size of the risk and the identification of whether the risk is on an acceptable level. The main aim of the risk assessment is to reduce all kinds of danger, risks and arising from working conditions and to decrease a level that does not affect human health [4].

Although the wood harvesting activities are an activity that has much more work accidents and occupational diseases, there is not much the records of the accident in the Social Security Institution (SSI). This is due to the fact that until the recently the wood harvesting activities have been made through tender to the forest villagers or the forest villages development cooperatives in accordance with the relevant regulations of the forest law [5]. Seasonal wood workers do not have a health insurance system for wood harvesting works that they do. For this reason, there are no accurate records of occupational accidents, occupational diseases, or near miss events. The data needed for risk analysis were obtained from workplace records, the cards of used machines, field observations, the opinions of experienced wood employees and employers [6].

Serious forestry operation accidents occur worldwide at the rate of 4–10 per year [7]. Establishing and controlling the hazards of forestry activities for various reasons will reduce the risk of occupational accidents and diseases. There are various studies on the area of different activities in the forestry sector with the literature review and the field studies for determination of possible hazards and risk analysis. [1, 8-16]

Preliminary hazard analysis (PHA) is one of the most widespread methods for use in identification and qualitative or semi-qualitative risk analysis [17]. Its objective is to identify and categories hazards, hazardous situations and hazardous events that can cause harm to persons, facilities and systems [18, 19]. Aydos [20] defined the PHA as a hazard or risk inventory to be drawn up at the beginning of the activity to be undertaken and in consideration of general hazard groups. Thus, it may be possible to remove the risks or reduce them to acceptable levels by setting preventive control measures. The identified hazards are put in order through the risk assessment selection diagram and the precautions to be taken are determined according to priority sequence. Ericson [21] emphasized that implementing this method before starting is functional in terms of ensuring a safe working environment and avoiding economic, ergonomic or environmental damage that may occur. The PHA method has a methodology that uses design and hazard information to strengthen the identification of hazard and causal factors (Figure 1).

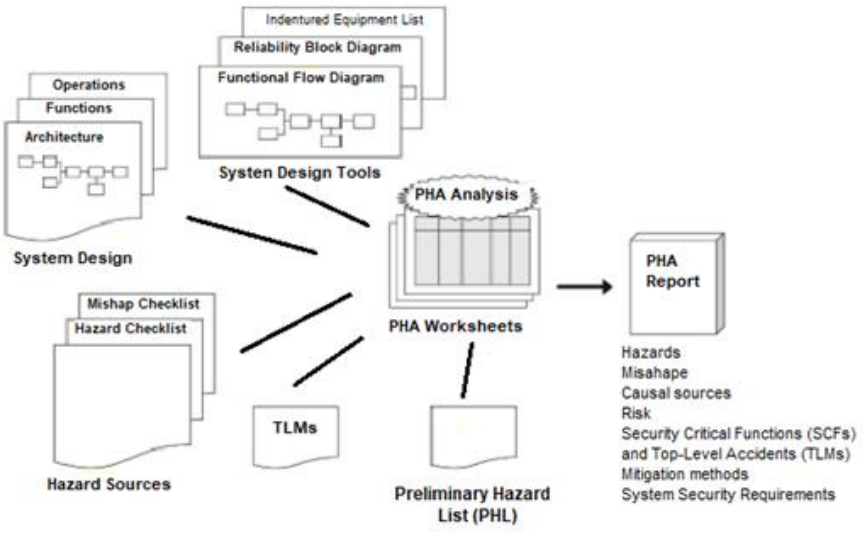

Figure 1. The PHA methodology

Taking the necessary precautions is crucial to ensure occupational health and safety in forest operations before the operations is done that identification and classification of hazards posed by these activities. In this study, it is aimed to determine the hazards of wood harvesting activities and classify them according to importance levels by using preliminary hazard analysis method.

2. MATERIALS AND METHOD

The field studies were carried out in the harvesting area of Bolu-Elmalık, Eskişehir-Değirmendere and Antalya-Düzlerçamı in Turkey. The studies were made in summer season of 2017 (Figure 2).

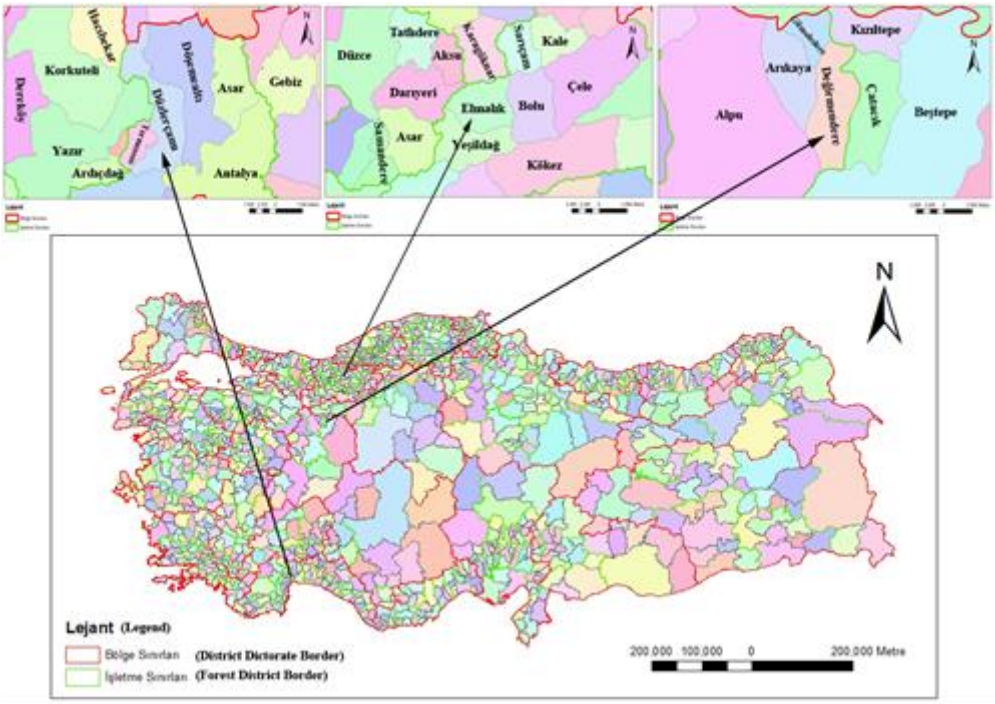

Figure 2. Map of the study areas

All of the cutting-felling, pruning, and bucking operations in the harvesting units were made with a medium sized chainsaw. These operations were carried out by seasonal chainsaw operator and forest workers. Within the scope of the study, total of 6 days were left in the harvesting units. During these days, the field observations were made to identify possible hazards that could arise from the work organization, because of the chainsaws used and the environment conditions. Taking into consideration the literature review and field observations, 29 possible hazards for cutting-felling, pruning, and bucking were identified.

The risk matrix method is used to determine the risk levels for the risks envisaged in the survey and to prioritize the control measures to be taken. Thus, it has been decided which risks need to be examined in more detail and whether the risks are acceptable or unacceptable (Table 1 and Table 2).

Table 1. Severity category ranks

Severity category	Rank	Description
Catastrophic	1	Major injury or death of personnel, irreversible environmental impact, 10 milyon $ < damage
Critical	2	Permanent disability, occupational disease in which at least 3 workers are hospitalized, significant environmental impact or $ 1 million - $ 10 million damage
Major	3	1 or more working days loss, moderate environmental impact, 100 thousand $ to 1 million $ damage
Minor	4	No loss of working day, minimum environmental impact $ 100 thousand > damage.

Table 2. Occurrency ranks [22].

Occurrency Category	Rank	Description
Frequent	A	Once per month or more often
Probable	B	Once per year
Occasional	C	Once per 10 years
Remote	D	Once per 100 years
Improbable	E	Once per 1000 years or more seldom

The risk scores of the potential hazards were classified according to the risk assessment matrix calculated by mathematical multiplication of the probability and severity values (Table 3).

Table 3. Risk assessment matrix [23].

Frequency of Occurrence	Severity			
	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	1A	2A	3A	4A
Probable (B)	1B	2B	3B	4B
Occasional (C)	1C	2C	3C	4C
Remote (D)	1D	2D	3D	4D
Improbable (E)	1E	2E	3E	4E

3. RESULTS AND DISCUSSION

Risk analysis was performed by preliminary hazard analysis method considering the results of field observations and literature review (Table 4).

Table 4. Risk analysis results

Hazard Class	Hazard	Risk	Rank	Degree
Work- sourced	Tree hanging	Fracture and death of the employee due to tree crushing	1B	Catastrophic
Work- sourced	Falling branches	Crush, broken and fatal work accident	1B	Catastrophic
Work- sourced	Falling branches	Crush, broken and fatal work accident	1B	Catastrophic
Work- sourced	Trunk under the tension	Death or injury	1C	Catastrophic
Work- sourced	Falling branches	Crush, broken and fatal work accident	1B	Catastrophic
Work- sourced	Trunk under the tension	Death or injury	1C	Catastrophic
Machine	Rotating or attaching chain saw	Death or injury	2B	Catastrophic
Machine	Recoil of chain saw	Death or injury	2B	Catastrophic
Chemical	Fuel-oil replenishment	Fire, environmental pollution, allergy	1C	Catastrophic
Worker-sourced	Incorrect determination of falling direction	Death or injury	1C	Catastrophic
Worker-sourced	Body injury	Death or injury	2B	Catastrophic
Worker-sourced	Walking over the overturned trunk	Injury	2A	Catastrophic
Worker-sourced	Uneducated	Death or injury	1B	Catastrophic
Worker-sourced	Non-use of PPE	Death, injury, occupational disease	1B	Catastrophic
Organizational	Working alone	Death or injury	2B	Catastrophic
Machine	Noise	Temporary or permanent hearing loss	3A	Critical
Study area	Rainfall	Death or injury	2C	Critical
Study area	Thunderbolt	Electric shock, tree or branch fall, forest fire	1D	Critical
Study area	Rough ground	Slipping, falling, hanging	3B	Critical
Organizational	Hygiene	Disease transmission, fatigue, distraction	3A	Critical
Work-sourced	Decayed trees	Crush, broken and fatal work accident	2C	Critical
Work-sourced	Inclined or double body	Uncontrolled actuation of the tree during harvesting in work-related accidents	2C	Critical
Worker-sourced	Attaching to electrical lines	Death or injury	1D	Critical
Worker-sourced	Incorrect posture	Musculoskeletal system disorders	3B	Critical
Machine	Vibration	Occupational disease	3C	Marginal
Machine	Chain breakage	Right hand and various parts of the body to injury	3D	Marginal

Machine	Incorrect transport of chain saw	Death or injury	2D	Marginal
Biological	Wild animals or insects	Death or injury, allergy	2D	Marginal
Psychological	Fatigue	Carelessness, unemployment resulting in loss of concentration	3C	Marginal
Organizational	Nutrition	Work accident due to carelessness, fatigue	3C	Marginal
Organizational	Visitors	Death or injury	2D	Marginal
Work sourced	Sun	Sunburn, excessive fluid loss, fatigue	3C	Marginal

According to the results of the preliminary hazard analyses made, the distribution of possible hazards to the groups of hazardous sources has been determined (Table 5).

Table 5. Distribution of hazard groups

Group of Hazard	**Number of Hazard**	**Risk Degree**		
		Catastrophic	Critical	Marginal
Worker sourced	7	5	2	-
Work-sourced	5	3	2	-
Machine	6	2	1	3
Study area	4	-	3	1
Organizational	4	1	1	2
Chemical	1	1	-	-
Biological	1	-	-	1
Psychological	1	-	-	1

It was determined that on the logging operations areas 39.28% of the hazards identified were high, 32.15% were serious and 28.57% were in the middle risk class (Figure 3).

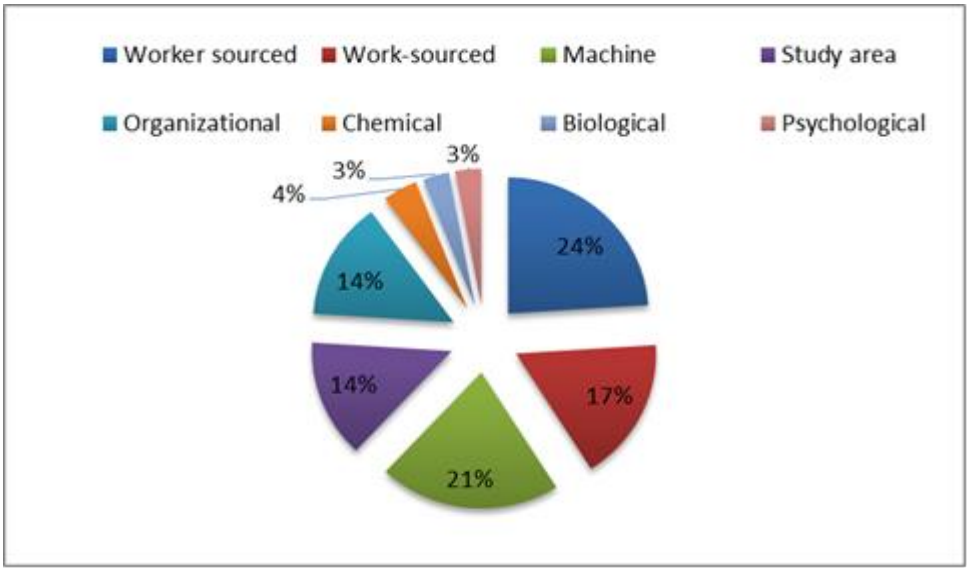

Figure 3. Percentage of hazard groups

As a result of the study, the most dangerous hazards during the logging off are found as workers' mistakes, improper use of chainsaws and difficulties of occupational. Similar to studies in Europe and New Zealand, it was found that the cutting and felling stage are the most risky of harvesting's stages [24, 25]. In addition, it was determined that the mistakes made by the loggers during their

work due to carelessness, inadequacy of work training or not using protective equipment which constitute the significant risks.

4. CONCLUSION AND RECOMMENDATION

In this study, the hazards of the logging off in terms of occupational health and safety were determined and evaluated by preliminary hazard analysis method. In the study, 28 hazardous situations were determined and detected as 11 high risk, 9 severe risk and 8 intermediate risk.
It has been found that the cutting-felling is the stage in which the accident rate is highest in the forestry sector. As some of the most dangerous situations may stand out attached trees, uneducated workers, and no personal protective equipment.

- At least two-person teams should employed in terms of danger of wild animals, assistance in case of injury, and help in heavy work.
- Warning signs should affixed or cut-off area to prevent entering the logging operation area by persons outside.
- For logging operation areas should suitably use to the physical conditions such as sun, rain, floor structure.
- In harvesting, the employee should be only forest workers and loggers which educated by suitable institutions.
- It should use to personal protective equipment appropriate for the logging off.
- Chainsaws which periodically repaired and to be getting equipment should use.
- Noise and vibration levels of chainsaw should measure periodically and if the exposure is above the limit values, they should not use.

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