

Emergency First Aid Response System in Forestry

Hyejeong Park, Kihun Nam

Department of Fire and Disaster Prevention Engineering, Changshin University,
South Korea
nkh0712@gmail.com

Abstract: Globally, the forest industry faces multiple challenges, such as relatively higher labor intensity and risks. Although the scope of the forest industry is getting smaller, the occupational accident rate of the forest industry is on the increase following the mining industry. Thus, this study aims to investigate the current practice of emergency first aid response and forestry work environment. Also, this study analyzed past accidents and suggested a direction to advance the system for the safe forest industry. In order to fill out gaps in safety and emergency management in Korean forestry, we reviewed relevant international documents and conducted a case study and field surveys at ten forestry workplaces. The results show that there is an absence of an emergency first aid response system and educational programs for securing the safety of forestry workers. When an accident occurs, a person who needs professional emergency medical treatment may not reach the closest medical center due to the limited accessibility to the accident scenes and first aid capacity. Thus, this study suggests renovating the current emergency first aid response system of the forestry to make a safe working environment in the forest industry and protect workers' lives.

Keywords: Emergency first aid, forest industry, forestry safety, occupational safety, occupational accidents

1. Introduction

South Korea has the fourth-largest forest, compared to the land area ratio of territories, among the Organization for Economic Co-operation and Development (OECD) member states (Korea Forest Service, 2020). While forest and other wooded lands cover approximately 62.6 % of the nation's total land area in South Korea, the rate of the forestry sector, including logging, in the entire national industry was only 0.1 %, according to a national survey between 2017 and 2020 (Statistics Korea, 2021). The survey shows that the accident and injury rate in Forestry is ranked second among the national industry with 1.24 per 10,000 of the average accident rates (the average of occupational accident rates: 0.53) and 1.66 of the average fatality rates (the average of occupational accident rates: 1.06) (KOSHA, 2021). Moreover, 94 % of accidents in the forest industry have been paid for by industrial insurance. These increasing accident and death risks rate resulted in impeding the development of the forest industry due to the necessary medical leave for recovery (Klen, 1989).

Some of the main reasons for forest industry accidents include a high degree of labor intensity, low salaries, increasing aging workers, a lack of safety management due to the downsized businesses, heavy machinery use, and geographical features referring to curvy and steep mountain ranges (Kim et al., 2013; Kim, 2016; Kim et al., 2017). As a result, fatal accidents have commonly occurred during logging in the workplace, and those accidents require quick and adequate first aid at the accident scene. However, an emergency medical system that considers the unique working environment has not been prepared yet. As a result, the workers entirely on the arrival of professional first responders arrive at the accident scene without appropriate first aid. This fact leads a victim not to be served with adequate first aid within the 'golden hours' due to a lack of emergency response capability and poor accessibility of professional first responders to an accident scene (Hu et al., 2020; Jeong et al., 2020).

The need for improving the working environment and accident response capacity has been proved by several researchers in other countries (Ghaffariyan, 2016; Bently et al., 2005; Patterson 2007), which have the largest forest industries. Despite the demand for the appropriate forest emergency response system, there is still less consideration of sufficient emergency workforce, emergency equipment, and applicable safety guidelines in the Forest industry, particularly in South Korea. Thus, this study aims to identify the current practices of safety guidelines, mainly focusing on emergency response in the Forest industry, and suggest directions for improving safety management that can enhance a capacity for emergency response to protect workers from hazards in forestry works. In order to learn the safety management and emergency response system, we conducted a review of relevant documents and regulations and a series of interviews with workers, particularly those who are working on logging.

2. Background

This section describes vicious cycles of accidents in the forest industry that cause chained sequential impacts and trends of forest accidents.

2.1. Forestry working environment

Regarding the relatively high rate of forest accidents and fatality rate, the current working environment shows some significant phenomena that cause vicious cycles of accidents in the forest industry. Fig. 1 illustrates the remarkable vicious cycles. With emerging urbanization and industrialization, the forestry workforce has been aged due to decreasing available young employers (Korea Forest Service, 2017). As of 2020, the rates of forestry workers are 90 % and 53 % over the age of 50 and 60, respectively (Korea Forest Service, 2017). Although the government has annually reduced the national budget for developing and conservating the forest industry, the industry is still entirely dependent on government support. However, there has not been an advanced work environment in the forest, and it has interrupted consistent productivity in a timber-producing sector (Kim, 2016). As a result, the forest and wood product industry has been becoming downsized. This result is also directly connected to increasing the risks of forest accidents due to investment decreases in safety management and insufficient professional workforce in the forest industry.

Most works are operated independently in wide areas. Although safety regulation requires group work with more than two workers to prevent unexpected accidents and respond quickly to an accident (Kim and Park, 2014; Nam et al., 2019;), the poor working environments made it likely impossible. Moreover, the business owners, who are responsible for workplace safety management, are often not capable of managing safety and potential accident risks since they are not specialized in managing workplace safety, and there are still limitations of workforce arrangement.

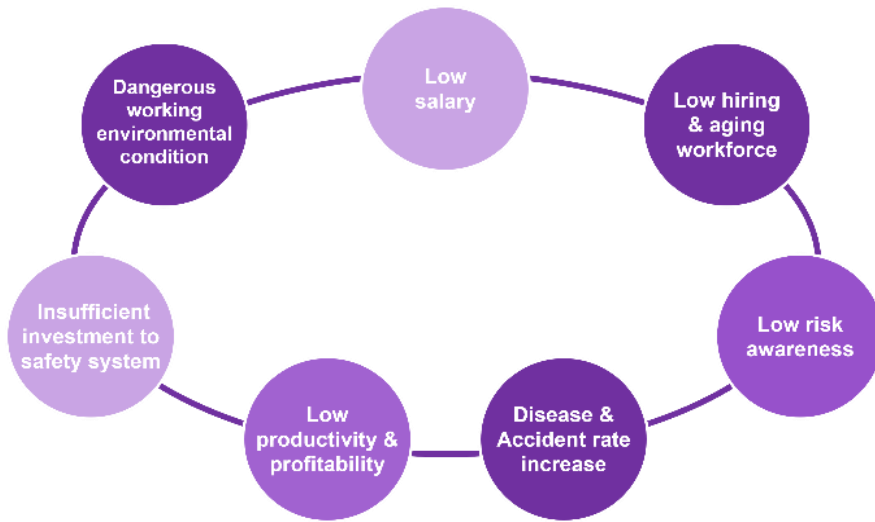


Fig. 1: Forestry accident vicious cycle

2.2. Accident trends in forest industry

Dangerous forestry working environment is clearly evidenced in accident statistical data reported by the Korea Occupational Safety and Health Agency (KOSHA). Relatively, injury rates in the forest industry have continued the decrease every year. However, compared to the average of other industry sectors, the injury rates are still higher, and it is ranked second following the mining industry (KOSHA, 2021). In occupational safety, the injury rate is defined as the number of injuries per 1,000,000 employee-hours worked, and the fatality rate means the number of deaths per 10,000 employee-hours worked. According to a data set released from the KOSHA (2021), the injury and fatality rates caused by accidents are outstandingly higher than those caused by diseases, as shown in Table 1. For example, the average injury rate between 2016 and 2020 shows accident-induced injury and fatality rates are approximately 33.4 and 5.24 times higher than disease-induced rates.

Table 1. Annual Injury and fatality rates caused by diseases and accidents between 2016-2020

Rate	Injury rates (Unit: per ten thousand)		Fatality rates (Unit: per ten thousand)	
	By diseases	By accidents	By diseases	By accidents
Year				
2016	0.05	1.50	0.43	0.96
2017	0.04	1.32	0.36	1.57
2018	0.03	1.13	0.33	1.11
2019	0.03	1.07	0.11	1.75
2020	0.03	0.99	0.10	1.58

Ave.	0.036	1.202	0.266	1.394
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(Source: KOSHA, 2021)

The statistical data implies that there have been severe occupational accidents and/or insufficient emergency first aid immediately after an accident at a workplace. This trend may continue to increase due to the working environment and a vicious cycle of forest industry accidents, as mentioned earlier. Therefore, it is also urgent to improve emergency first aid and medical system to protect workers' lives in the forest industry.

3. Methods

Currently, a safety management system provides various regulations, appropriate Personal Protective Equipment (PPE), and safety guidelines from a general perspective. However, this study only focuses on the improvement of emergency first aid and response in forestry work since forest industry-specified safety management regulations are still ongoing. In order to collect actual data regarding emergency first aid regulations for forestry workers to make a foundation for improving emergency first aid and response system in the context of South Korea, we conducted a review of relevant documents and guidelines focusing on educational programs in other countries, including the United States (US) and the United Kingdom (UK) and investigated the emergency management system in the forest aviation headquarters, that are mainly responsible for protecting forests nationwide, and the Forest Technical Training Center (FTTC) in South Korea. In the second part, this study conducted field surveys on ten forestry workplaces and unstructured interviews with workers in 2019 and investigated the actual process and system for emergency first aid and response. In the interviews, participants were randomly selected from the workplaces, and they were asked open-end questions regarding the emergency first aid system and their working environment. The results of the field survey and interviews were reviewed with the content analysis method. We also analyzed 60 cases of major occupational accidents in the forestry workplaces to estimate the required time for emergency first aid and transportation of a victim from a workplace to the closest hospital to get professional medical support.

4. Results

The results are presented in three parts: how other countries that have advanced safety and emergency management systems provides educational programs to the forestry workforce in the first part; an analysis of emergency first aid of major accidents in the forest industry and a process of emergency first aid; and the current status of emergency first aid practices at the workplaces.

4.1. Educational programs for emergency first aid and response in forestry

In general, educational programs for enhancing emergency first aid and response capacity are organized as a part of occupational safety education given after being hired regularly. Table 2 compares the current practices for education and safety works in the forest industry. A review on safety regulations regarding forestry works identified that four countries, the US (OSHA, 2004), the UK (HSE, 2013), Australia (SWA, 2019), and Japan (MHLW, 2021), that have the largest forestry have a well-organized system to reduce forest accident risks. They provide daily regular educational programs involving emergency first aid response. In addition, according to the regulations, forest businesses that are located in different areas make an agreement with the local response teams, such as fire departments, police, fire brigade, and hospitals equipping trauma centers in case of forest accidents.

Moreover, forestry workers are strictly requested to work with more than two people to respond to unexpected accidents that would lead to severe injuries immediately. Also, the law specified that forest businesses must stipulate at least one first aider well-educated with appropriate first aid kits at the forestry workplace. However, those specific guidelines in the forest industry have not yet been prepared in South Korea.

Table 2. Regulations for the forestry workers in safety and emergency management

	US	UK	Australia	Japan	South Korea
Safety and emergency educations before and during the working process	○	○	○	○	△
Pre-agreement with local emergency response teams and hospital	○	○	○	○	△
Working type	Group	Group	Group	Group/Solitary	Solitary
Existence of first-aiders at the workplace	○	○	○	○	X
Equipment of first-aid kit	○	○	○	○	X

Specifically, in the UK, the Health and Safety Executive (HSE) requires the forest businesses to hire first aiders depending on the size of their business since the forest industry is classified as a high-risk industry. The recruited first aiders are responsible for providing emergency educational programs with first aid training and different accidental situations, divided into first aid at work (FAW) and emergency first aid at work (EFAW), as shown in Table 3.

Table 3. Educational programs in the UK (HSE, 2013)

Educational programs	EFAW	FAW
Immediate and effective emergency first aid and response	○	○
Cardiopulmonary resuscitation (CPR)	○	○
Passing out (including convulsion)	○	○
Asphyxiation (choke)	○	○
Wounds and bleeding	○	○
Shocks	○	○
Mild injury	○	○
Prevention of cross-infection, accident records, and use of a healthcare toolkit (for first aid)	○	○
Fractures and sprains	-	○
First aid for injuries on pines, chest, and eyes	-	○
Burn injury	-	○
Toxication and hypersensitivity	-	○
Heart attack and brain stroke	-	○
Other diseases (epilepsy, asthma, and diabetes)	-	○

In the US, the Occupational Safety and Health Administration (OSHA) classifies and supervises forestry work, particularly all types of logging, as the most dangerous occupation according to the Occupational Safety and Health Standards involved in the code of federal regulation (CFR). The safety of logging is mainly controlled under four principles that are 1910.266: logging operation and, 910.266 App A: first aid kits (mandatory) (OSHA, 2001a), and 1910.266 App B: first aid and CPR training (mandatory) (OSHA, 2001c), and 1910.266 App C: Comparable ISO standards (non-mandatory) (OSHA, 2001b). Notably, 1910.266 App A offers necessary tools for arranging emergency first aid kits for two and three workers depending on the work area. In addition, 1910.266 App B provides a guideline for educational programs and training.

In South Korea, the Occupational Safety and Health Act covers safety and emergency issues occurring at the workplace. It demands workers to take safety education and training in hiring and during the work process. Since the Korean act does not include emergency first aid in their educational program, the workers are obliged to complete fragmented first aid training besides an official education. Moreover, the act requires that forest business owners must stipulate a safety manager who supervises the workplace and manages workplace safety. The FTTC also provides partial emergency first aid training in forestry work guidance.

In the case of the forest aviation headquarters, they support quick transportation using helicopters of victims from the accident place within golden hours. However, a reporting system to dispatch an aircraft is only allowed to local police, fire department,

local government, and hospital, not the workers. In addition, since it takes more than thirty minutes to be ready to dispatch a helicopter to an accident place, it is not easy to request the most efficient transportation in reality. Although there are several experts who are educated with emergency first aid skills, they are not available for accidents occurred in forestry workplaces, and the individual workers face challenges to perform emergency first aid in case of severe accidents.

4.2. Emergency first aid in major forestry accidents

This study analyzed sixty cases of major accidents that occurred in the forestry workplace between 2013 and 2017 in order to identify how long it takes to transport a victim from the workplace to the closest hospital. We also estimated the time with a web-based map and investigated the first aiders and transportation modes.

Table 4: Emergency first aid and response of major forest accidents

(a) required time to get to the closest medical centers		(b) Emergency first aider at a forest accident		(c) Used transportation to get to the closest medical centers	
Time (min)	Number of cases (N)	First aider	Number of cases (N)	Transportation	Number of cases (N)
< 30	22 (36.7 %)	Colleagues	22 (36.7 %)	Ambulance	39 (65 %)
30 ≤ T ≤ 60	22 (36.7 %)	Professional first aiders	30 (50 %)	Helicopter	1 (0.17 %)
60 ≤	12 (20 %)	Others	8 (13.3 %)	Private vehicle	2 (3.33%)
* Instantaneous death on the spot: 4				Others	18 (30 %)

Table 4 shows the investigated and estimated results: (a) required time to get to the closest medical centers; (b) emergency first aider at a forest accident scene; and (c) used transportation to get to the closest medical centers. The analysis indicates that more than 70 % of victims arrived at a hospital within 60 minutes using an ambulance dispatched from the local fire department. Since this estimation considered the distance from the workplace to a hospital, it may take more time from recognizing and reporting an accident to reach the accident scene located in the forest. Furthermore, most first-aiders were emergency medical technicians (EMTs) as soon as the accident occurred. It means that although most of the victims could have appropriate professional treatment, first aid that is most important in the traumatic injury could be delayed until the arrival of EMT. Thus, the analysis implies that the most critical emergency first aid will be implemented at the accident scene, and enhancing emergency first aid response capacity could be a key to reduce the fatality rate in the forest industry.

Based on our investigation, we rearranged a victim’s transfer process after an accident in the forest industry, as shown in Fig. 2. When an accident occurs in the forestry workplace, the emergency response usually follows this process that seems

pretty complicated. From accident recognition until arrival at a hospital, it could take a maximum of two to three hours. Then, of course, there is a helicopter to transport victims. Still, it is almost impossible to use it within accident golden hours, an hour after a traumatic injury, due to the complicated permission process and interests between the Ministry of Forest and the National Fire Agency.

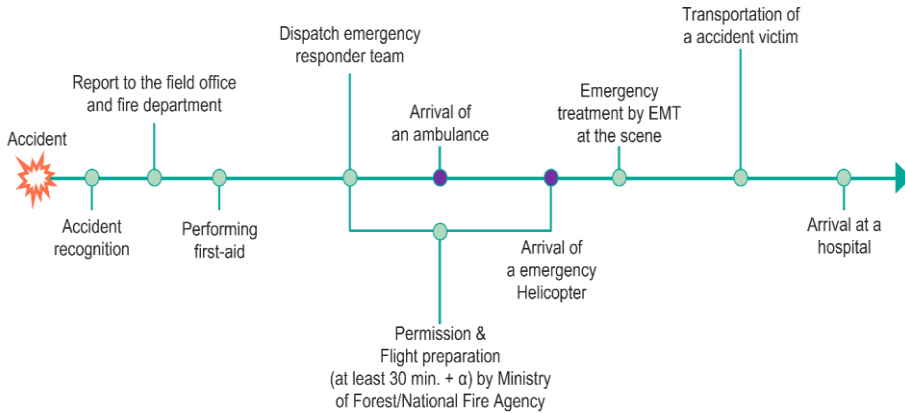


Fig. 2: A process to transfer a victim after an accident in the forest industry

4.3. The current practices of emergency first aid at the forestry workplaces

In order to examine the current status of emergency first aid at the actual workplaces, a series of field surveys were carried out at ten workplaces in the forest industry between March and December 2019. In addition, we also had unstructured interviews (Fig. 3) with 9 business owners and 62 workers while looking at their working environments (Fig. 4).

Unlike the national regulations, all the 9 owners combine their roles for managing the workplace environment and safety. Only one worker among the participants in the survey was educated on occupational safety and emergency first aid response. There were no qualified workers with emergency first aid specialized in severe accidents. The owners and 8 workers took educations for first aid twice a year, and 54 workers took a chance for first aid training once a year. In addition, the forest businesses equipped first aid kits containing plasters, bandages, some tools, and a type of ointment (Fig. 5).

According to our interviews with the firms' owners, they hire forestry workers under a temporary contract during logging season, specifically spring-autumn. Since their work intensity is considered to be high, applicants are relatively old generation, mainly over the age of 60, who have already experienced forestry for several years. The interviewees mentioned it is almost impossible to provide appropriate emergency first aid education/training to the temporary employees due to the time limitation. The

interviews with the workers argued that they are scared of unexpected accidents requiring immediate first aid or report to anyone since most works are set by solitary work in wide areas. The workers addressed that the option of forestry works must be more than two or three workers in their working environment.



Fig. 3: Interviews with the forestry workers



Fig. 4: A solitary work using a heavy machinery



Fig. 5: First aid kit equipped at the workplace

5. Discussion

Our study found that there is little knowledge available regarding South Korean forestry work safety and accidents due to the decrease of forestry enterprises. Forestry workers are the essential parts of the forestry sector, and the conditions of workers significantly impact their work efficiency. In recent statistical data, average accident rates in forestry have been decreased. However, the fatality rate and the severity of accidents tend to increase.

While the accident rate decreases could be related to improving forestry safety management and promoting several safety programs for forestry workers (Tremblay et al., 2018; Yanar et al., 2019), the fatality is associated with the working environment and their physical condition. Particularly, older workers easily tend to lose circumspection when their shifts are prolonged and exceeded in the scope of assigned works (Ghaffariyan, 2016). When an accident in the workplace occurs, the sick leave duration is increased depending on the victim's age (Lagerstrom et al., 2017). In South Korea, most forestry workers are over the age of 50s-60s who may have suffered a couple of diseases and/or physical problems. In addition, the inexperienced workers are recruited temporarily to fulfill vacancies that are emerged from forestry accidents and reduce the budget for the workforce. This fact impedes the continuity of safe forestry works by skilled workers and the prevention of potential economic loss.

The isolated working environment in forestry that does not have proper access routes interrupt immediate emergency first aid response by professional responders, such as rescuers or EMTs with an ambulance or rescue equipment. Also, sufficient emergency first aid kit and response capacity determine potential consequences of an accident, particularly victims' condition due to missing golden hours or secondary

infection on an injured part. The reason is that most injury types are associated with slips, falls, strains, sprains, fractures, dislocations, and amputation of a body part.

Therefore, this study identified that there is still a need for improving emergency first aid and safety system in the forest industry. In order to contribute to improving the current system, we developed a framework to support appropriate emergency first aid response, as shown in Fig. 6. It is divided into three parts: situational assessment, emergency first aid, and cooperation with EMT. This framework enables the forestry workers to assess a vital victim's physical condition and serve immediate first aid until the arrival of rescuers and EMTs. Their activity is controlled under a quick situational judgment and decisions related to a victim's condition require least first aid. Based on the assessment, the workers share the victim's information with cooperated medical centers and local fire departments to access the accident scene as fast as possible to allow the victim to get medical treatment. This process also helps rescuers and EMTs to make a better decision for adequate transportation, and consequently, an appropriate decision will be connected to saving a victim's life. Establishing applicable regulatory instruments and specific guidelines for forestry should be preceded to protect the forestry workers who will implement first aid and maintain their first aid skills. Forestry-specified emergency educational programs are also required to stipulate the forestry workers for the right position.

There is a couple of limitations that represent weaknesses within this study in data collection and application of the developed framework. Since there have not many revealed accident cases in the forestry and adequate accident archives, it was challenging to track major accidents' history from the beginning. Most victims have already quit work or died by forest accidents. Lessons learned from the past accident cases could help to develop better emergency plans and safety strategies. Moreover, applying the developed framework was not allowed at the actual workplaces due to lack of regulations and emergency first aid kits. In order to learn how the workers can implement appropriate emergency first aid, the framework must be tested. Fortunately, recently, the South Korean government has made many efforts by initiating a safety management program for forestry. We expect this positive movement with our study can help to improve the current emergency first aid response system, enhance the coping capacity of forestry workers, and reduce unnecessary potential accidents.

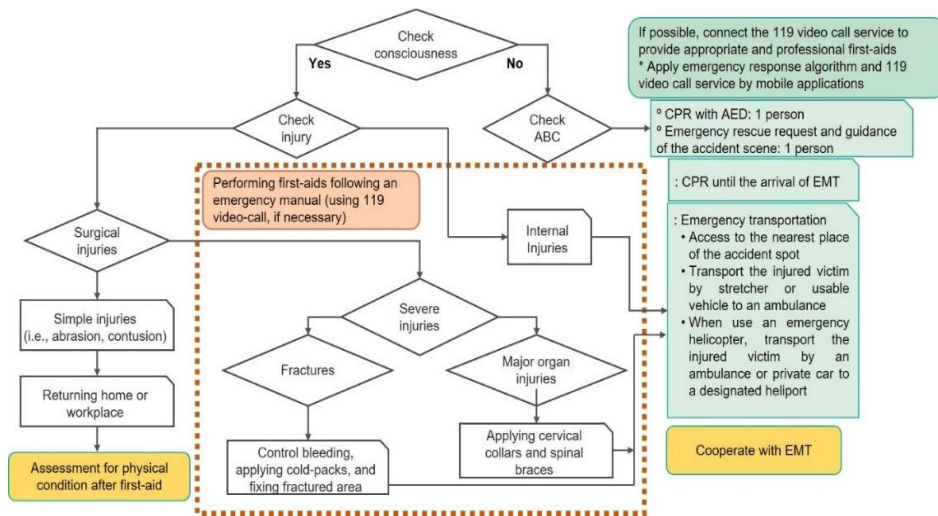


Fig. 6: A framework for effective emergency first aid response

6. Conclusions

Forestry and related operations (i.e., logging) are connected to a high risk of occupational accidents. This study investigated international and national emergency first aid response systems and major forestry accidents and conducted field surveys on forest enterprises to reduce potential severe accidents and protect forestry workers. In addition, we reviewed relevant regulations and guidelines to identify the limitations of the current emergency first aid response system, including educational programs and first aid equipment. We found that the forest enterprises, government, and forestry workers should work together to improve safety measures. As a result, we developed a framework for effective emergency first aid response in forestry that supports appropriate situational judgment, accident information sharing, first aid at an accident scene, and cooperation with EMT and medical staff. The framework is expected to reduce the severity of forestry accidents. In addition, it could be used in other industries, such as the farming and fishing industry that are relatively isolated from a boundary of the legal system.

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