

Article

Suggestions for Improving South Korea's Fall Accidents Prevention Technology in the Construction Industry: Focused on Analyzing Laws and Programs of the United States

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Abstract: Since the enactment of the Occupational Safety and Health Act in 1981, the Korea Occupational Safety and Health Agency has endeavored to prevent fall accidents in the construction industry. However, many fatalities still occur in the South Korean construction industry. Meanwhile, the United States improved various systems and conducted studies to prevent fall accidents, significantly reducing such occurrences in the construction industry. The objective of this study is to present improvements to South Korea's fall prevention technology by analyzing the laws and programs of the United States. To achieve this, this study has analyzed the United States' fall prevention technology and derived improvements applicable in South Korea through an expert opinion survey. This study suggests to (1) set the height standard of a fall accident to 2 m, (2) adopt an active fall prevention system, (3) create a map of fallen fatalities, and (4) employ safety experts to support foreign workers. In the future, the results of this study are expected to be used as basic data for policies and programs related to fall accidents in the construction industry.

Keywords: South Korean construction industry; fall accident; fall prevention technique; improvement measures; cases analysis of the United States



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1. Introduction

Fall accidents are major high-frequency accidents that can occur anywhere at a construction site [1]. Even if workers fall from a low place such as 1 m high during work, it often leads to serious disasters including death [2]. That is, a fall accident is the most serious hazard in the construction industry [3]. To systematically prevent fall accidents, large amounts of effort and funds are being invested in construction safety education at Korean construction sites—for example, construction safety training, high elevation work management guidelines, and the use of fall prevention protective equipment [1].

However, the incidence rate of industrial accidents in South Korea is steadily increasing, and construction accidents account for more than one-third of all industrial accidents [4]. According to the Korea Occupational Safety and Health Agency (KOSHA)'s industrial accident status and analysis from 2009 to 2017, fall accidents accounted for 47.7% to 52.1% of the deaths every year in the construction industry [5].

In the United States, where the safety management field is well-developed, construction accidents have steadily decreased due to the implementation of proper safety policies to prevent industrial accidents. In the United States, private and public institutions cooperate with each other to implement customized safety policies, such as providing and promoting safety information reflecting the conditions of the construction site and implementing educational programs [6].

In the case of the Occupational Safety and Health Agency (OSHA) in the United States, various accident prevention activities suitable for the size of the construction site are being carried out, and this has resulted in a reduction of 50% of the deaths and 40% of the number of industrial accidents and occupational diseases [7]. This shows that to maximize the effectiveness of industrial accident prevention measures, it is important to consider workplace conditions and customize safety measures for each type of accident.

In other words, there should be an approach to investigate and analyze industrial accident prevention techniques in the United States and introduce them into applicable situations in South Korea. Therefore, the objective of this study is to present improvements to South Korea's fall prevention technology by analyzing the laws and programs of the United States. To achieve this, research is conducted as follows:

- (1) Compare construction safety management systems in the United States and South Korea
- (2) Analyze previous literature related to fall accident prevention.
- (3) Investigate the current status and studies on fall accidents in South Korea.
- (4) Investigate the laws and programs of the United States.
- (5) Conduct an expert opinion survey.
- (6) Present improvements to the South Korean fall accident prevention technique.

2. Preliminary Study

2.1. Construction Safety Management Systems in the United States and South Korea

OSHA is in charge of matters related to workplace safety and health in the United States, and the enforcement rule for implementing the Occupational Safety and Health Act (OSHAct) is called the Code of Federal Regulation (CFR). CFR contains all general and permanent regulations published in the Federal Register, and the Labor (CFR Title 29) section contains the construction industry safety standards (29 CFR 1926). 29 CFR 1926 consists of 26 sections from Subpart A to Subpart Z.

South Korea is also making various efforts to prevent safety accidents in the construction industry under the supervision of KOSHA. In Korea, the Occupational Safety and Health Acts were enacted on 31 December 1981 and have laws, enforcement decrees, and enforcement regulations. They are composed of a method of entrusting detailed information to subordinate laws. The enforcement regulations on the laws stipulate the general information for enforcing the Occupational Safety and Health Act and its enforcement decree. The enforcement regulations related to the standards stipulate safety and health measures to be taken by employers. Additionally, the enforcement regulations on the restriction of employment for hazardous and dangerous work stipulate the information related to the qualifications, licenses, and experience necessary for hazardous or dangerous work. Currently, in South Korea, the provisions related to fall accident prevention are established in the regulations on standards, and fall prevention safety facilities are set in terms of safety railings, ladders, walk plates, openings, safety belts, roofs, and scaffolding.

The Ministry of Employment and Labor in South Korea conducted inspections on 753 construction sites that were at high risk of major accidents such as fire, explosion, and suffocation in winter, from 19 November to 7 December 2018 [8]. As a result, 690 (91.6%) sites were detected in violations of the laws, and safety management officers and corporations at 346 sites that neglected the risk of accidents, such as not installing safety railings in places where there is a risk of falling, were criminally charged. In total, 77 sites were ordered to stop where there was an urgent risk of accidents, such as working from a high place without installing walk plates. Additionally, a fine (\$1.52 million) was imposed on 607 sites that did not have worker safety training and medical examinations, and they were immediately ordered to improve. Therefore, there is a need for research to suggest improvement measures to increase the compliance rate by investigating whether or not the system related to fall accident prevention is actually observed.

In the OSHA regulations, there are six rules related to fall prevention: general requirement of scaffolding, duty to have fall protection, fall protection systems criteria and

practices, scaffold training requirements, fall protection of steel erection, and ladders. On the OSHA website, the statistics of the field inspection results for one year from October 2017 to September 2018 are posted [9]. The total number of inspections in the entire construction industry was 11,966, and the number of violations detected during the inspection was 29,759, and the total penalty amounted to about \$85.71 million. The number of violations against the regulations related to fall accidents was 15,399, which corresponds to 51.7% of the total number of violations, and the fine for negligence is about \$52.31 million, which is 61% of the total number of penalties in the construction industry.

The United States imposes fines for violations, but South Korea not only imposes fines—it also criminally prosecutes the safety management officers and corporations at the sites. Additionally, the United States accounts for only 51.7% of the total number of violations, but in South Korea, 91.6% of the violations were detected at the sites, accounting for a high percentage in the construction industry. In addition, as in the United States, the number of foreign workers is increasing in South Korea, and as the number of foreign workers at construction sites increases, the rate of foreign accidents increases proportionally [10]. Since the United States has a similar environment to Korea in various aspects, a case study of the United States is needed to prevent safety accidents at construction sites.

2.2. Literature Review for Fall Accidents

Fall accidents have recorded high injury and mortality rates at construction sites in many countries [11]. Accordingly, studies are regularly conducted in many countries to analyze the cause and risk of a fall and suggest various preventive measures. Chi et al. developed a coding system to easily indicate the cause and location of a fall and classify the fall in terms of company size, and they suggested various solutions for nine causes of fall accidents. The paper stated that prevention measures include handrails, guardrails, surface-opening protections, crawling boards, planks, strong-roofing materials, fall arrest systems, travel restraint systems, and fall containment systems [12]. Masoud et al. used unmanned aerial systems (UAS) as a fall prevention system and emphasized the importance of monitoring places (openings and corners) having a high risk of falls. However, the paper explained that legal problems and technical limitations must be overcome in order to introduce UAS to the construction site [13].

Kang et al. investigated fall accidents that occurred in the United States between 1997 and 2012 and examined the frequency and trend of the fall accidents. The study analyzed that the percentage of fall accidents from four major accident types, such as fall, struck by, caught in or between, and electrocution, was increased substantially [14]. Al-Bayati and York provided details about the trends of fatal injuries among Hispanic workers in the United States and analyzed that the fall fatalities among Hispanic workers are significantly higher on general contractors' sites. The paper indicated a need for different interventions of industry professionals and government agencies to improve overall site safety [15].

Amotz et al. stated that the role of safety supervisors is important for workers to safely perform aerial work at construction sites and that safety supervisors should gain training and experience through virtual reality (VR) and augmented reality (AR) [16]. In addition, Tsai stated that if the situation at the construction site was monitored using image recognition technology, the site manager could grasp the site situation more easily [17]. The study showed that a site could be monitored using video, and risks can be identified using image recognition technology. The recordings can be used as basic data to revitalize safety education and training in the construction industry and improve fall accident prevention techniques.

The current research on the prevention of fall accidents focuses on safety management plans using sensors, AR, and VR by introducing smart technology. However, due to data loss and technical problems, innovative measures for preventing fall accidents are insufficient. It is expected that continuous support and research and development (R&D) can compensate for these problems, and if UAS and image recognition technology are used in construction sites, fall accidents in the construction industry may be prevented.

2.3. Fall Accidents in South Korea

Since the enactment of the Occupational Safety and Health Act in 1981, KOSHA has made efforts to revise the law and implement policies to prevent fall accidents in the construction industry [18]. In the three-year plan for the advancement of industrial safety by the Ministry of Employment and Labor (1997–1999), the eradication of disastrous construction accidents, such as falls and collapses, was selected as one of the eight key promotion tasks and was promoted in earnest [19]. Various policies such as technical guidance and business support were established in the 1st to 4th Industrial Accident Prevention Five-Year Plans (2000–2019) to prepare countermeasures for fall accidents [20]. However, despite continuous efforts to reduce such fall accidents, deaths from fall accidents in the construction industry still account for a high proportion.

Despite the trend of gradually decreasing industrial accidents, the number of deaths from industrial accidents was 969 in 2016 and 964 in 2017, and the economic loss due to the accidents amounted to about 21 trillion won. As shown in Table 1, the number of deaths in the construction industry declined until 2013; however, it increased again after 2014. Fatal accidents caused by falls account for about 50% of the deaths in the construction industry. In addition, fall accidents accounted for 32.1% of the total number (20,998) of injuries in the construction industry in 2009.

Table 1. The number of deaths and fall deaths in the South Korean construction industry.

Item	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total deaths	606	611	621	496	567	486	493	554	579
Fall deaths	292	302	311	248	266	256	257	281	276
Fall deaths (%)	48.2	49.4	50.1	50.0	46.9	52.7	52.1	50.7	47.7

To solve this problem, South Korea has conducted several studies on fall accident prevention at construction sites. Hong et al. introduced the use of image processing at construction sites in South Korea to identify potential risk factors, record them as images, and signal the manager to prevent fall accidents due to cognitive mistakes [21]. Lee et al. studied quick emergency measures by periodically receiving worker location information in dangerous situations and alerting the manager through a smart module and monitoring system in order to create a safe working environment at the construction site [22]. In that study, it was shown that this system could reduce fall accidents and injuries.

Kim and Ahn conducted expert workshops to apply the United Kingdom's fall disaster impact network in consideration of the situation in South Korea [23]. As a result, the factors identified to have the most direct influence on fall disasters were situational awareness, risk perception, equipment, and facilities. A 10-step risk reduction method was suggested to prevent fall accidents. Ryu classified topics on fall disasters occurring at construction sites and analyzed the hazard factors according to each topic [24]. It was found that most fall accidents were caused by insufficient field management and safety education in small-scale workplaces, defects in personal safety equipment, and inadequate wearing conditions. In that paper, it was suggested that a safety education policy was necessary to prevent this.

Although studies on the causes of fall accidents are conducted in many countries, only unsafe factors of facilities and equipment are being studied in South Korea. Therefore, an analysis of the complex causes of fall accidents in South Korea is required. In this study, after comparing and analyzing the causes and prevention techniques of fall accidents in South Korea and the United States, we suggest improvements suitable for the South Korean situation.

3. Fall Accident Prevention Techniques in the United States

3.1. Fall Accident Status in the United States

Samantha et al. showed the United States' construction fatality trend from 2007 to 2018 [25]. The number of deaths increased by about 33%, from 7,810,000 in 2011 to

10,380,000 in 2018. Samantha et al. showed the number of deaths and rate of deaths in the United States construction industry. It decreased from 2007 to 2011, but from 2011 to 2016, it rose to 36,500. However, it has been on a decreasing trend since 2017, and the rate of deaths was down to 28,000 in 2018. The increase in fatal accidents after 2011 is believed to be due to an increase in the number of construction sites and workers when the global economy began to recover.

Samantha et al. showed the causes of fall accidents represented as a roof, ladder, and scaffold [25]. The number of deaths from falling off the roof was 92 in 2011, but it increased by 35% to 124 in 2016 and decreased by 8% to 114 in 2018. The number of ladder-related fatalities increased 48% from 70 cases in 2011 to 104 cases in 2016 and decreased to 15% with 88 cases in 2018. The number of cases of falling off the scaffold was 38 in 2011; this increased to 58% with 60 cases in 2016 but went down to 23% with 46 cases in 2018.

3.2. Revision of Laws and Standards

OSHA establishes and continually revises industrial safety rules and standards to prevent and reduce industrial accidents. Representative examples include the revision of vertical fall prevention standards in Washington state, OSHA's fall prevention standards, scaffold safety standards, and safety standards for steel structures. The contents of each case are shown in Table 2.

Table 2. Revised laws and standards related to fall accidents. Abbreviations: Occupational Safety and Health Agency (OSHA) and Code of Federal Regulation (CFR).

Year	Laws	Details
1991	Washington Administration Code 265-155	- Personal protective equipment and fall prevention plans shall be submitted for those who work at 6 ft or higher [26] - 20% reduction in falls [27]
1995	OSHA 29 CFR Part 1926 Subpart M	- Fall prevention standards have been strengthened for steep roof workers at a height of 6 ft or higher [28] - In 2 years, falling hazards decreased by 11% [29]
1996	OSHA 29 CFR Part 1926 Subpart L	- Revision to the maximum load of scaffolding, height–width ratio, and fall protection [28] - Serious accidents decreased by 33% [29]
2002	OSHA 29 CFR Part 1926 Subpart R	- Fall prevention standards have been strengthened for those who work at 15 ft or higher [28] - Fall prevention devices shall be required to be worn by workers working at 15 ft–30 ft height [28] - Deaths decreased by 22.2%, serious accidents decreased by 53.7% [29]

In 1991, the Washington Administration Code 265–155 required personal protective equipment when working 6 ft or higher and required a fall prevention plan to be submitted [26], which reduced fall accidents by 20% [27]. In 1995, OSHA 29 CFR Part 1926 Subpart M strengthened the drop-prevention criteria, which considered workers to stay a minimum of 6 ft from the edge of steep roofs that were 6 ft or more in height [28], reducing the risk of falling by 11% in two years [29]. In 1996, OSHA 29 CFR Part 1926 Subpart L modified the maximum scaffold load to 25–75 lbs/ft about heavy-duty, up to 20–60 feet high, and a height and width of 5 ft [28]. This had reduced the number of serious accidents by 33%. [29]. In 2002, OSHA 29 CFR Part 1926 Subpart R required a personal fall arrest

system, positioning device system, or fall restraint system, and workers must wear the equipment necessary to be able to be tied off when working at the height of 15 ft–30 ft [28], resulting in a 22.2% reduction in deaths and 53.7% reduction in serious accidents [29]. In each case, specific fall height standards were presented for each task, and after the revision, fall accidents were reduced.

3.3. Strengthening Management Supervision

The United States is also implementing policies to strengthen on-site management and supervision, such as national focus programs, regional focus programs, intensive supervision at specific sites, and severe violator enforcement programs on industrial sites. The contents of each case are shown in Table 3. The National Emphasis Program (NEP) stipulates that investigators must be selected for each risk factor such as falls, cuts, lead poisoning, crystalline silica, shipbuilding, and oil refining. The Local/Regional Emphasis Program (LEP/REP) calculates corporate risks, occupational accidents, and mortality rates in the region and specifies that risk factors that threaten the safety and health of workers should be managed in each region. The Enhanced Enforcement Program (EEP) describes a program that targets workplaces that have repeatedly violated the law. The Severe Violator Enforcement Program (SVEP) is divided into four categories: death and disaster standards, non-death/disaster standards related to high-emphasis, safety/disaster standards (pre-safety management), and serious standards for the risk of potential spills of highly hazardous chemicals. It is specified to establish standards and manage the site.

Table 3. Reinforcement of supervision and management. Abbreviations: National Emphasis Program (NEP), Local/Regional Emphasis Program (LEP/REP), Enhanced Enforcement Program (EEP), and Severe Violator Enforcement Program (SVEP).

Program	Details
NEP	- Investigation supervisors were selected according to specific risk factors such as falls, cuts, lead poisoning, crystal silica, shipbuilding, oil refining, etc.
LEP/REP	- Calculates business risk, industrial accidents, and death rates in the corresponding region - Hazardous risk factors that threaten the safety and health of workers shall be managed in the region
EEP	- Enforcement program implemented for workplaces that repeatedly violate the law
SVEP	Includes the following four criteria: - Fatality and Catastrophe criterion - Non-fatality/Catastrophe criterion related to high-emphasis - Non-fatality/Catastrophe criterion for hazards due to the potential release of a highly hazardous chemical (process safety management) - Egregious criterion

3.4. On-Site Safety Management Support

In order to systematically support the autonomous safety management of private institutions, the United States is trying to prevent fall accidents by implementing programs such as the Voluntary Prevention Program (VPP) and the Strategic Partner Program (SPP). In addition, to support on-site safety management, it appoints safety and health regulations compliance officers (CSHO) and coordinators within diverse workforces having limited English-speaking proficiency, so they can comply with various OSHA regulations and standards. The contents of each case are shown in Table 4.

Table 4. On-site safety management support. Abbreviations: Voluntary Prevention Program (VPP), Strategic Partner Program (SPP), and safety and health regulations compliance officers (CSHO).

Program	Details
VPP	- Securing the safety and health of construction sites based on success cases - In 2017, VPP participants showed a 58% lower accident rate and 73% lower serious-accident rate
SPP	- A strategic partnership aimed at solving safety and health problems at workplaces - The hazardous risk factors of the workplaces shall be checked by the employer - Participants can learn practical skills to solve problems
CSHO	- Performs the task of checking regulatory compliance and case issues if it exists
Diverse Workforce/Limited English Proficiency Coordinators	- Coordinator support is provided for workers who have difficulty communicating in English - Education, training, and regulatory compliance support data is provided on the OSHA website for non-English speaking workers

The VPP provides support to secure the safety and health of construction sites based on success stories [28]. The SPP constitutes a strategic partnership for solving workplace safety and health issues, supports employers to directly identify risk factors at workplaces, and allows participants to learn practical skills for solving problems. The CSHO has been responsible for identifying compliance issues and case issues. Diverse Workforce/Limited English Proficiency Coordinators support workers who have difficulty communicating in English. In addition, the OSHA website provides education, training, and compliance support data for non-English speaking workers.

3.5. Education and Training

In addition to various OSHA standards and guides designed for fall prevention, disaster prevention videos (V-Tools) and an annual fatality map are produced so that the general public can also visualize the information provided. The National Institute for Occupational Safety and Health (NIOSH) ladder safety application (APP) for smartphones has been developed to provide visual and audio signals to prevent fall accidents related to new construction and mobile ladders, and it includes reference materials for safe ladder use, ladder calculation, inspection, and usage as well as safety guidelines. The contents of each case are shown in Table 5.

Table 5. Education and training in the United States. Abbreviations: National Institute for Occupational Safety and Health (NIOSH), ladder safety application (APP), and disaster prevention videos (V-Tools).

Program	Details
V-Tools [28]	- Clear explanation to identify, reduce, and eliminate risks with 2–4 min videos
Fatality Map [28]	- Access to information on fatal accidents - Provided for all deaths and death cases caused by falls in the construction industry - The provided content includes the date of the disaster, city names, state names, employer, accident description, data source, and accident investigation report link
NIOSH Ladder Safety APP [30]	- Safety guide with smartphone APP provides instructions for safely using ladder to prevent ladder-related fall accidents

V-Tools explain the identification, reduction, and elimination of risks [28]. Fatality maps provide fatal accident information regarding all deaths from falls in the construction

industry [28]. The content provided includes the disaster date, city name, state name, employer, accident details, data source, and links to report accident investigations. The NIOSH Ladder Safety APP provides safety guides for ladder-related fall accidents [31].

3.6. Analysis Results of the United States Cases

In order to prevent fall accidents in the construction industry, the United States continues to make efforts through laws and programs centered on OSHA. Accordingly, fall accident prevention techniques in the United States were investigated and categorized into (1) laws and standards, (2) reinforcement of supervision, (3) field safety management support, and (4) education and training. In the case of amendments to laws and standards, standards for fall prevention devices, safety management plans, and fall protection equipment for fall accidents are continuously strengthened. In most of the revised cases, a clear criterion for fall height was presented. In the case of management and supervision, the laws specify standards related to serious industrial accidents or impose more serious sanctions on workplaces that violate the law.

The United States implements the VPP and SPP to support on-site safety management. Through these programs, construction companies are engaged in autonomous safety management. In particular, by cultivating and arranging experts for various workforces, including workers with limited English-speaking proficiency, the management delivers clear information to workers who speak various languages. Through the national-level fall prevention campaign, the fall accident fatality map, which is used for education and training, is continuously updated. In addition, creating applications for smartphones can help in preventing ladder-related risks.

4. Suggestions for Improvements

4.1. Expert Survey

Prior to the suggestion of improvement measures for South Korean fall accident prevention techniques, 11 safety experts working in industries, universities, and research institutes were selected and surveyed in order to receive opinions from various groups. The survey targets included one person in charge of safety research at the corporation (9.09%), three safety researchers (27.27%), two professors (18.18%), and five industrial safety experts (45.46%).

The prevention techniques related to fall accidents in the United States could be divided into revision and improvement of laws and standards, strengthening supervision and support for on-site safety management, fall accident prevention campaigns, and education and training. Focusing on these four items, an opinion survey was conducted on the effectiveness of introducing a fall accident improvement plan. The survey is a representative opinion survey on the (1) revision of standards for fall height, (2) introduction of an active fall prevention system, (3) introduction of a fall accident guidance system, and (4) expansion of safety experts supporting foreign workers. The scope was limited to the subject. Opinions were collected based on three criteria: (1) the possibility of the application of the United States laws to South Korea, (2) effectiveness of the improvement, and (3) problems when applying the improvements to the South Korean fall accident prevention method.

4.2. Analysis of Survey Results and Improvements

(1) Improving the height standard of fall accidents in South Korea

In South Korea, on 6 July 2011, when the rules on occupational safety and health standards were completely revised, the 2 m height standard was deleted in “Prevention of Falls” and “Protective Measures for Openings.” However, regulations to prevent fall accidents, such as the protective equipment provisions, safety belt attachment facilities, and construction of a working platform, were maintained for places with a height of 2 m or more. In other words, in the current rules, the standard for a fall height of 2 m is mixed, so there is confusion when complying with the regulations.

However, the United States has continually revised its fall height laws. In OSHA, the probability of death from a fall accident is less than 5% (considered as a reasonable risk), and a specific height of 6 ft (1.83 m) is suggested [32]. Experts from universities and the industry have determined that clear standards for accidents, as in the United States, are effective for legal compliance. Therefore, in this study, to increase the uniformity of the fall height standard in the “Rules on Occupational Safety and Health Standards” and achieve more rational compliance with the standards, a fall accident height standard of 2 m or more is proposed.

(2) Active fall prevention system

In the United States, the active fall prevention system standard is operated by laws and institutions. The area of activity is restricted through safety equipment, such as safety harnesses and safety hooks, restricted access to danger points, and fall accidents are prevented with a fall prevention system [33]. In order to limit workers’ activities and fall height, experts argued that it was necessary to introduce an active fall prevention system from the United States in South Korea. In addition, it was judged that the effect would be excellent in South Korea, which uses a passive system, because workers are protected by blocking the cause of the fall accident. However, in the industry, problems were cited about the decrease in work efficiency and lack of will of workers, and the need for research and on-site efforts was raised. Prior to the introduction of the active fall prevention system, experts pointed out the decrease in work efficiency and negative perceptions of workers as problems to using the system. Accordingly, in order to provide a period of adaptation to workers, a fall prevention system with a relatively free range of motion should be introduced first [34]. After the adaptation period, it is believed that an effective active fall prevention system can be introduced if workers’ awareness of safety is improved and their resistance to activity restrictions is reduced.

(3) Fatality map of fall accidents

In South Korea, only information on the disaster outline of a fall accident, the cause of the accident, and disaster prevention measures are provided through the Occupational Safety and Health Agency’s website. However, in the case of the United States, the fall accident statistics provided by the Bureau of Labor Statistics (BLS) are displayed on a map and used in the national fall prevention campaign. When a pinpoint on the map is clicked, high-quality information, such as the date of disaster occurrence, location, employer, industry and data source of the location, is provided, raising safety awareness about the fall accident [35].

The experts said that providing information that can be used for safety education through the fall and death accident guidance system could raise workers’ awareness. Moreover, they stated that it would be effective to provide information about accidents rather than geographical information. However, professors raised the question of information distortion because the statistical information collected by KOSHA is limited. In addition, industry experts judged that it would be useful if it contained additional information, such as the cause of the disaster, disaster countermeasures, and effects, and provided sufficient publicity. Therefore, if a fatality map with related fall accident information is introduced, it will not only raise workers’ safety awareness about fall accidents but can also be used for other safety activities, such as education and training.

(4) Safety experts supporting foreign workers

OSHA’s diverse workforce/limited English proficiency coordinator is necessary. Experts insisted that a safety expert who can deal with foreigners is needed to meet the current situation in South Korea, where the number of foreign workers is increasing. By introducing this, it would be possible to clearly communicate precautions, warnings, and preventive measures to foreigners. However, the professors expressed concern about the decline in South Korean jobs and argued that a survey on the proportion of foreign workers and the language required was necessary. In the industry, there was a need for the amendment of laws and regulations requiring only the mother tongue be used in safety education, training of professional manpower, and support for financial resources.

In the United States, safety experts are assigned to foreign workers with limited English skills at sites, including local unions and small construction sites, to provide information on education and training, legal standards, and work hazards. Provision of information in this manner is effective in preventing accidents by improving the understanding of foreign workers [36]. Experts judged that it would be effective to use safety experts to provide education on fall risks and prevent fall accidents. As the number of foreign workers in South Korea increases, the occurrence of accidents also increases. If trained safety experts are secured for foreign workers, clear communication is possible. Therefore, it is necessary to improve related laws and regulations and to investigate the proportion of foreign workers and the required language range. In addition, if the standards for the scope of management of foreign workers by safety experts are established, it will be an effective program to prevent fall accidents among foreign workers.

Furthermore, some studies stated that cultural barriers are identified as one of the causes that lead to higher injury rates of foreign workers. However, OSHA required employers to provide several remedies to overcome the language barrier, but no requirements exist for addressing challenges associated with cultural differences. Abudayyeh and Albert stated Hispanic workers prefer to avoid uncertainty and suggested that construction supervisors should provide enough details to their Hispanic workers [37]. Al-Bayati suggested a productive conversation between Hispanic workers and supervisors and stated that supervisors should understand and value the family and close relationships among their Hispanic workers [38]. Therefore, the Korean construction industry also needs training to understand cultural diversity for all employees, including foreign workers.

5. Discussion

In private institutions, the United States has implemented various programs, such as VPP and SPP, to prevent fall accidents. In addition, Germany has a dual occupational safety and health system that manages and supervises the safety and health of industrial sites at both government and private institutions. However, there is considerable opposition from practitioners in South Korea, as safety management is currently being conducted mainly by the government, and it focuses on filing criminal charges on the person in charge after a safety accident occurs. To practically reduce the safety accident rate, it is necessary to take responsibility for accidents and solidify accident prevention devices and systems reflecting the opinions of practitioners before preparing a legal system based on strict regulations at the government level. Therefore, an approach from a different perspective to manage and supervise the safety and health of industrial sites at the private level should be considered.

In the United Kingdom and Japan, construction accidents have decreased by implementing customized safety policies to prevent industrial accidents. In particular, according to the Reporting of Injuries Diseases and Dangerous Occurrence Regulations (RIDDOR), the death rate has steadily declined since the United Kingdom's Health and Safety Commission (HSC) enacted the Health and Safety at Work Act in 1974. The 100,000-death toll rate decreased by 5 times in 2019 (0.45) from 1981 (2.0), which is the lowest in the European Union, such as Germany, France, Italy, and Spain. In the United Kingdom, private and public organizations cooperate with each other to provide and promote safety information reflecting the conditions of the construction site and implement educational programs. In Japan, to develop a standard safety management system suitable for specialized contractors, it is distributed through education and promotion [6].

In this study, only the cases in the United States were investigated and analyzed, and directions for improvement of laws and related policies suitable for South Korea were suggested. However, to find more diverse ways to improve, additional research on the laws, policies, and systems of more countries such as Japan, the United Kingdom, Germany, and Singapore is necessary. In particular, research and analysis should focus on what laws and preventive techniques these countries have used to reduce the accident rate.

6. Conclusions

Construction workers often have to work in high-rise buildings with a high risk of falling accidents [39]. A fall accident is a type of accident that is fatal to a worker's life. The United States has tried to eliminate the risk of fall accidents by utilizing fall prevention techniques, such as laws, systems, and programs. This study first analyzed the revision of the United States laws and standards related to fall accidents, reinforcement of management supervision, support for on-site safety management, education, and training, and then it collected expert opinions and proposed improvement measures considering the situation in South Korea.

First, the United States has continuously revised laws related to fall height, and it clearly states that the fall height is 6 ft (1.83 m). However, there is no clear law or standard for fall height in South Korea. Therefore, this study proposes the criterion for fall height to be 2.0 m or more.

Second, the United States continues to produce and update fall accident fatality maps for education and training through national fall prevention campaigns. Reflecting this, in this study, we suggest that South Korea create a fatality map that provides information on the cause, location, and countermeasures of the disaster.

Third, in the United States, experts were trained and assigned on-site by management for workforces with limited English-speaking proficiency to deliver clear information to workers. Reflecting this, South Korea proposed the introduction of safety experts for foreign workers after establishing the current language range of foreign workers, standards for the scope of support, and management for professional manpower.

Fourth, South Korea is currently carrying out safety management centered on the government, and there is considerable opposition from managers as it focuses on filing criminal charges on the person in charge after a safety accident occurs. Therefore, from the perspective of construction managers, an approach from another perspective to manage and supervise the safety and health of industrial sites should be considered.

The suggestions in this study are applicable to practice in South Korea. However, South Korean corporations stated that it was difficult to apply the case of the active fall prevention system in construction sites due to the problem of the decrease in work efficiency. Thus, there is a need for a system that can work more freely than the active fall prevention system in the United States. In addition, managers and workers at construction sites in South Korea have negative perceptions of the application of the new safety system. Therefore, in South Korea, it is also needed to improve workers' awareness of the application of the new system.

The scope of this study was limited to fall accident prevention techniques in the United States. Therefore, it is necessary to conduct an in-depth study on the improvement measures for fall accident prevention techniques in more countries, such as Japan, the United Kingdom, Germany, and Singapore. The results of this study will be used as basic data for the future improvement of laws and regulations, promotion of fall accident prevention projects, and development of fall accident prevention techniques.

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