

# A Study on the Application of Smart Safety Technology at Construction Sites in South Korea

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**Abstract:** Among all industries, the construction industry still remains a traditional one with low productivity due to its labor-intensive and field-dependent production system, its supplier-oriented industrial structure, and the disruption of the information flow between participants.

In addition, the construction industry in South Korea has recently been required to transform itself according to social trends such as aging, the reduction of skilled workers, and the shortening of working hours, and the disaster and death rates in the industry, which are more than twice as high as those in other industries, are making it more necessary to solve chronic safety problems.

Therefore, the purpose of this study is to grasp the actual condition of safety management on construction sites in South Korea and analyze cases of K-smart technology utilization for preventing safety accidents on construction sites. The study investigated and analyzed the following. First, construction sites in South Korea were analyzed by type of safety accident, by type of construction, and by construction contract amount. Second, the current status of accidents on small-sized construction sites with a high fatal accident rate and cases of safety accidents on construction sites were investigated. The results of the study are expected to contribute to the dissemination and spread of smart safety technology for not only identifying major factors in safety accidents that occur on construction sites but also preventing workers from suffering accidents.

**Key words:** Smart Safety Technology, Accident, Worker Falling, Smart Safety Technology, In South Korea Construction Site

## 1. INTRODUCTION

Many changes occur in the working environment of a construction site depending on stages of construction work, and there are various components on the site, such as manpower, heavy equipment, and facilities, thus making it difficult to stabilize safety management there. Most safety accidents that occur on construction sites are often caused by workers' failure to comply with safety regulations, bad practices, and unsafe on-site environments, and in particular, these problems occur more frequently in small-sized construction sites with relatively weak safety management[1-3]. Workers lose their lives every year in accidental falls, collisions, etc. on construction sites, as shown in the cases of a worker who died after colliding with a forklift on the new construction site

A in June 2021 and a concrete form worker who died after falling while working at height on the construction site B in May of the same year in South Korea[2, 4-6].

However, construction site safety still relies on the manpower-centered way of thinking, which is based on the expertise of managers, and the limitations of management due to insufficient safety manpower, safety insensitivity, etc., are continuously pointed out[7-10]. Therefore, this study intends to analyze not only major factors in safety accidents that occur on construction sites but also accident cases that actually occurred on construction sites in South Korea.

## 2. SURVEY

### 2.1. Current Status of Safety Accidents on Construction Sites in South Korea

Over the past 5 years, 2,355 workers have lost their lives due to industrial disasters on construction sites, and this means that about 1.3 workers die every day on construction sites[11, 12]. On average, about 470 fatal accidents occur on construction sites every year, thus accounting for half of the deaths in all industries, and accordingly the construction industry has a very high risk compared to other industries[13, 15].

The death rate, which represents the rate of fatal accidents per 10,000 workers, is more than three times higher in the construction industry as compared with other industries every year, thus indicating the urgent necessity of effective management of safety accidents. When comparing the death rate of the domestic construction industry with that of the construction industries in some other advanced countries, such as the US, UK, and Singapore, it was confirmed that it was up to 13 times higher[14, 16-17].



**Figure 1.** Distribution of construction site fatalities by year and percentage of deaths in construction industry by country

Accidents in the construction industry continued to occur in 2020[12, 15]. The number of accident victims on construction sites nationwide was 26,799 and 567 of them died, which accounts for 27.5% of the total combined number of deaths that occurred in all industries, thus showing the highest death rate. In particular, 458 people died in accidents among the industrial disasters in the construction industry, thus indicating that it is the type of industry with the highest risk of on-site accidents[17-19].

### 2.2. Safety Accident Management and Policy Trends Concerning Construction Sites in South Korea

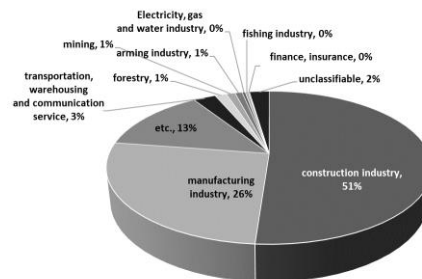
The South Korean government has implemented measures to prevent accidents, such as tower crane failures, falls from height, etc. with the goal of reducing safety accidents on construction sites[11,13,15]. In 2020, the government established the ‘Construction Safety Innovation Scheme

(April 2020)', and it has since been making continuous efforts to prevent accidents by deriving key tasks[11,13,15]. Looking at the Innovation Scheme carefully, one can see that it is divided into the following measures: reinforcing intensive management of vulnerable areas, clarifying responsibilities and authorities by project entity, and laying the foundation for site-centered safety management. There are also parts that need to be supported by technological improvement in order to strengthen the effectiveness of these measures. Examining its details shows that the Innovation Scheme is intended to push ahead with not only the formation and operation of the 'National Monitoring Group', a separate safety management organization, as a method to secure a safety net by strengthening on-site monitoring and inspection, but also mandatory installation of CCTVs for monitoring whether workers are wearing protective equipment, etc. on the construction sites of apartment houses of a certain size (16 floors, etc.) or over[14-15]. Moreover, the Innovation Scheme is aimed at pushing ahead with the expansion of public works after the pilot application of smart safety equipment to prevent collisions, caught-in/between equipment accidents, etc., and this technological system is being continuously developed and centered around each construction company beyond the government.

### 3. ANALYSIS

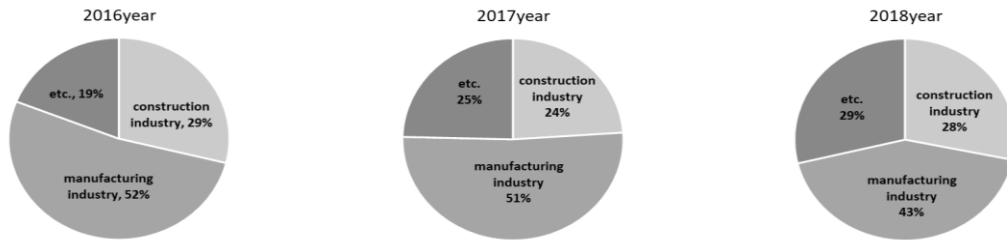
#### 3.1. Analysis of Types and Current Status of Fatal Accidents on Construction Sites in South Korea

To find out the distribution of general characteristics of deaths in occupational accidents on construction sites, a total of 2,575 cases were analyzed: 890 cases (34.6%) in 2016, 885 cases (34.4%) in 2017, and 800 cases (31.1%) in 2018. As for the distribution of 2,575 death cases in occupational accidents by type of industry, the construction industry accounted for 1,312 cases (51.2%), the largest proportion, followed by the manufacturing industry accounting for 673 cases (26.2%), and the service industry accounting for 346 cases (13.5%).



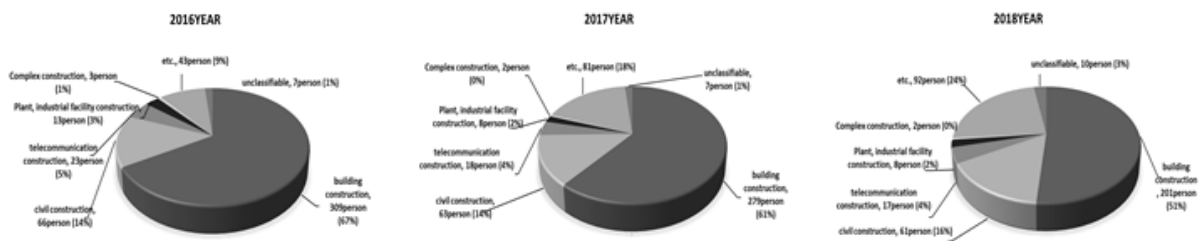
**Figure 2.** Distribution of accident fatalities in business by industry types

Based on the distribution of death cases in occupational accidents by type of industry, this study classified the types of industry subject to distribution analysis into the construction industry, the manufacturing industry, and other industries. The figure below shows the distribution of death cases in occupational accidents by year and by type of industry based on the classification of the types of industry into three categories. The construction industry and the manufacturing industry showed a decreasing trend, whereas other types of industry showed an increase from 19.0% in 2016 to 23.3% in 2018.



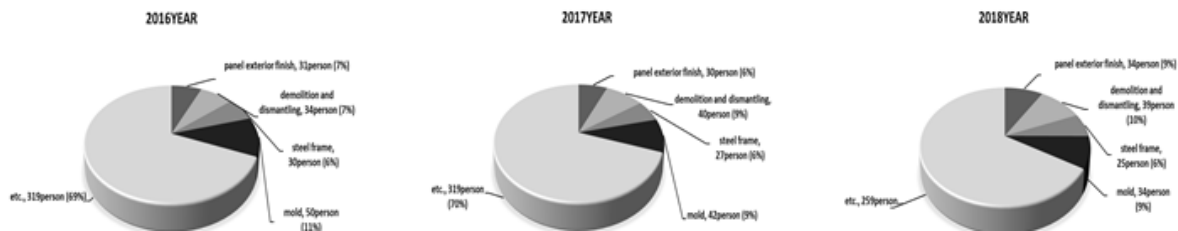
**Figure 3.** Distribution of accident fatalities in business by year and industry

When looking at the distribution of construction types by year regarding death cases in occupational accidents in the construction industry, one can see that construction work accounts for about 60% and civil work for 15% each year.



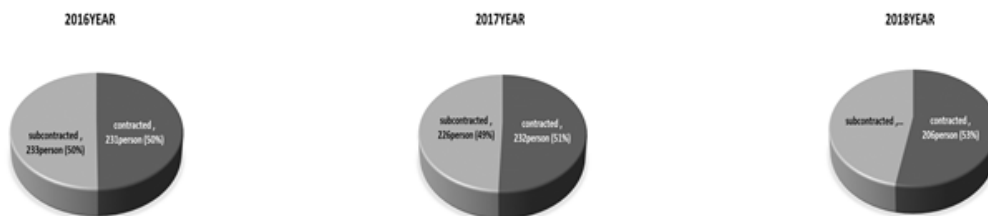
**Figure 4.** Distribution by construction type (large category)

As a result of checking the major unit processes with the highest number of death cases in occupational accidents, the top 4 unit processes were found to be the formwork process, the demolition and dismantling process, the exterior panel finishing process, and the steel frame process.



**Figure 5.** Unit process distribution (construction industry)

As a result of classifying the workplaces involved in death cases in occupational accidents into the workplaces of contractors and those of subcontractors, both groups of workplaces were found to show similar death rates, with the difference in death rates between the two groups being not significant: less than 5%.



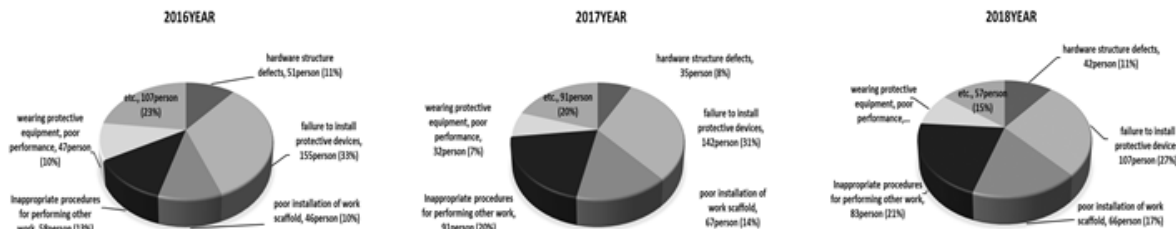
**Figure 6.** Distribution of contracted and subcontracted workplaces (construction industry)

When looking at the distribution of contract amounts for the construction projects involved in death cases in occupational accidents in the construction industry, one can see that about 70% of the total number of deaths occurred on construction sites each representing a project of less than KRW 2 billion.



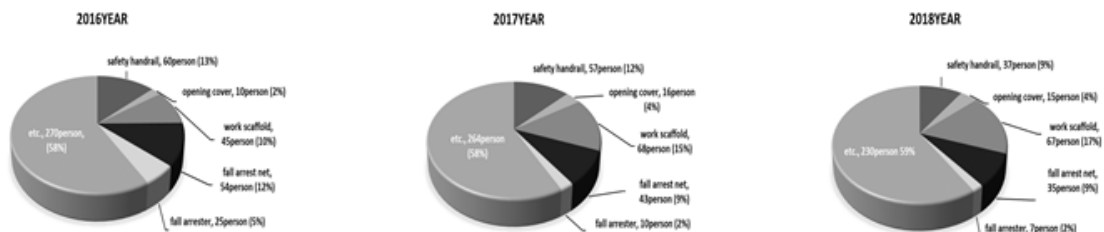
**Figure 7.** Distribution by construction amount (construction industry)

In the distribution of unsafe conditions in the construction industry, poor conditions due to failure to install protective devices were found to account for the largest proportion, followed by inappropriate work performance procedures.



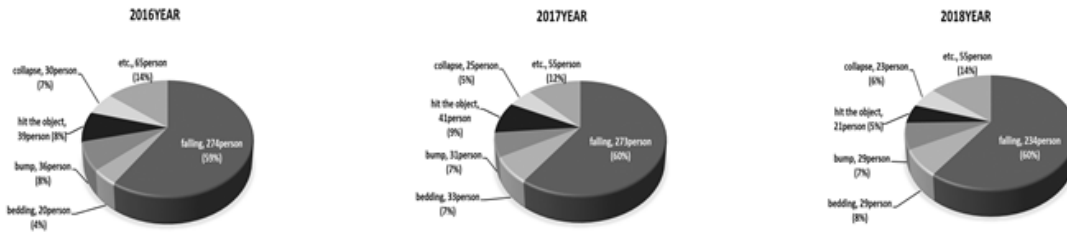
**Figure 8.** Distribution of insecure conditions (construction industry)

Work platforms and safety railings account for a large proportion of the uninstalled safety protection facilities regarding death cases in occupational accidents in the construction industry.



**Figure 9.** Distribution of uninstalled safety protection facilities (construction industry)

Fall accidents were the most common form of death cases in the construction industry, accounting for about 60% of the total, regardless of the year. The second most common form of accidental death cases was being hit by an object in 2016 and 2017 and being pressed under an object and bumping into an object in 2018.



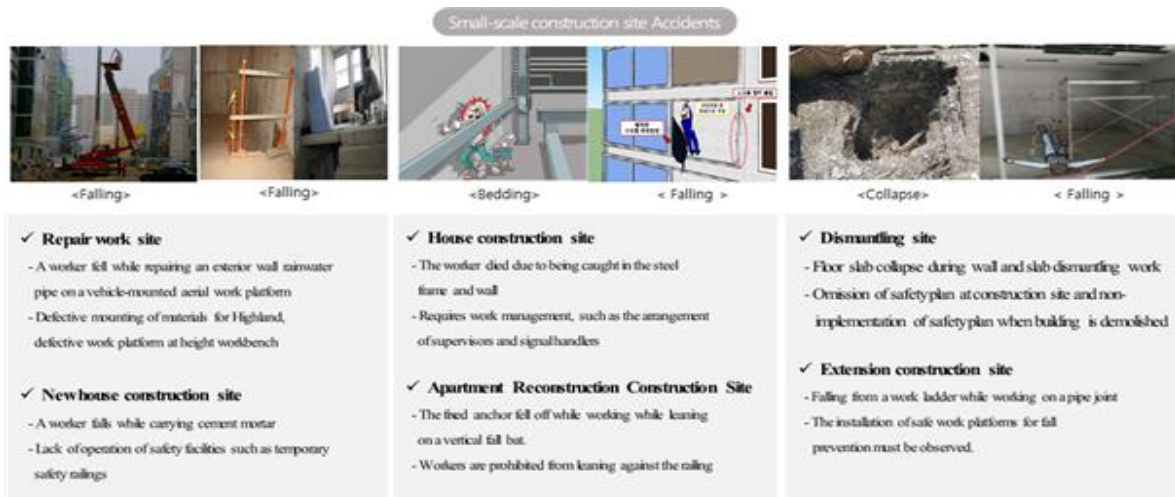
**Figure 10.** Distribution of major forms of occurrence (construction industry)

### 3.2. Safety Accident Cases on Construction Sites

#### 3.2.1. Current Status of Accidents on Small-Sized Construction Sites

50.1% (428 deaths) of a total of 855 industrial accident deaths in South Korea in 2019 occurred on construction sites, and 283 deaths (66.1%) among them, or two out of every three construction site deaths, occurred on small-sized construction sites, each representing a project of less than KRW 5 billion, whereas 235 deaths occurred on private construction sites and 48 deaths on public construction sites.

Therefore, it is judged that it is necessary to carefully inspect small-sized construction sites each representing a project of less than KRW 5 billion, which have insufficient safety management capabilities and high death rates in construction site accidents, and that it is also necessary to strengthen the monitoring of small-sized construction sites because a large number of deaths occur on them with their poor safety management



**Figure 11.** Cases of small-scale construction site safety accidents



**Figure 12.** A case of safety accident in civil and building construction

### 3.3. Safety Accident Cases on Highway Construction Sites

It is understood that safety accidents on highways mainly occur during construction or maintenance work. Types of safety accidents include falls, drops, caught-in/between equipment accidents, and diseases. The following types of accidents occurred as listed in descending order of their incidence: falls, caught-in/between equipment accidents, and drops.

**Table 1.** Types of Highway Accidents and Accident Details

classification	type	accidents case
<b>construction</b>	object fall	Injuries caused by falling rocks while pumice cleaning in the tunnel
	narrowness	Narrowness due to transformer conduction while the moving installation work of the transformer outside the tunnel
	falling	Falling while pier formwork dismantling work
	falling	Falling while going down the bridge inspection stairs
<b>maintenance</b>	falling	Falling while crack repair work in Geumgang 4th Bridge floor plate
	falling	Falling from the side of the work safety rail while the repair work of the deteriorated section

## 4. CONCLUSIONS

This study grasped the actual condition of safety management on construction sites in South Korea and investigated cases of smart safety technology utilization for preventing safety accidents on construction sites. The results obtained through this study are summarized as follows.

(1) In South Korea, accidents continue to occur in the construction industry, and the number of deaths from accidents is the highest among industrial disasters. Thus, one can see that it is the type of industry with the highest risk of on-site accidents. In addition, when looking at the type of accident, one can confirm that the risk of fall accidents is significantly high, and the next most common cause of death was the result of workers being caught in or between or being struck by nearby equipment and objects.

(2) According to the results of classification by construction size, it was found that small and medium-sized construction sites, each representing a project of less than KRW 5 billion (and each

having less than 50 workers), were more vulnerable than large-sized construction sites. Therefore, it is judged that it is necessary to support a smart construction safety system to strengthen the monitoring of small-sized construction sites.

(3) In the case of public construction sites, the Ministry of Land, Infrastructure and Transport of South Korea is taking measures for immediate provision of safety information, such as real-time identification of workers and equipment locations and predictive prevention of accidents, such as warnings of access to dangerous areas and warnings of equipment collision.

(4) Finally, even if the government comes up with highly effective policies, unless there is any change in the safety awareness of construction site workers or in any system that can properly manage their safety awareness, safety accidents and management on construction sites will repeat the mistakes of the past. Therefore, it is considered necessary to establish a safety management system on each construction site, strengthen the safety awareness of construction site workers, and reduce the gap between government policies and construction site procedures.

## **ACKNOWLEDGEMENTS**

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