

# Analysis of the Building Demolition Process of the Republic of Korea Based on Case Study

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**Abstract:** Recently, the demand for building demolition in Korea has been increasing due to the rising number of old buildings and diversification of the types of buildings subject to construction demolition, and the related market size has been continuously growing. On the other hand, the laws, systems, and safety management related to building demolition are not implemented vigorously enough, so safety accidents frequently occur during the demolition process. In this study, we introduce the case of the collapse of a demolition building in Gwangju Metropolitan City in 2021, and we analyze the cause of the safety accident with the survey report published by the Korean government. Also, this study consists of institutional aspects of the demolition construction process in Korea and practical aspects such as sub-contracts, which are two main problems. Although Korean construction-related laws prohibit re-subcontracting in principle, illegal re-subcontracting is prevalent in building demolition and the supervision of building demolition is poor. Also, the dismantling plan does not function effectively as a practical checklist at the construction site due to complicated procedures and many requirements.

In conclusion, for building demolition to be carried out more safely and efficiently, it is needed to reasonably improve related practices and systems in Korea.

**Key words:** demolition process, building, construction, case analysis, Gwangju, Republic of Korea

## 1. INTRODUCTION

### 1.1. Research Background and Purpose

Recently, the demand for building demolition in the Republic of Korea has been increasing due to the rising number of old buildings, the growing volume of urban redevelopment, and the diversification of the types of buildings to be dismantled. As a result, the size of the industry is continuously growing. On the other hand, laws, systems, and safety management related to building demolition in Korea are still vulnerable so industrial accidents occur frequently during the process. So, in this study, we introduce a recent case of an industrial accident during the demolition of a building and analyze several causes of the accident. In addition to the case study, we analyze the two major problems with the general building demolition process in Korea and suggest some implications.

### 1.2. Scope and Methodology of Research

This study set the main research scope to analyze Korea's building demolition process through case analysis and paper research and to suggest some implications. In particular, main causes of the 2021 Gwangju collapse accident are summarized, which is one of the remarkable accident cases related to the building demolition.

The method of the study is as follows:

First, analysis of the cause of the collapse accident was based on The Gwangju Accident Investigation Report published by the Central Building Accident Investigation Committee of the Ministry of Land, Infrastructure and Transport, as well as the government announcements and media articles.

Next, the analysis of Korea's building demolition process was focused on a survey of related laws, previous research, and interviews with experts or industry workers.

## 2. DEFINITION, STATUS AND LITERATURE REVIEW

### 2.1. Definition of Building Demolition

According to Article 2, Paragraph 7 of Korea's Building Management Act enacted in 2020, "demolition" means "destroying, cutting or removing all or part of a building for construction, major repairs, remodeling, or destruction of the building." Building demolition business in Korea is classified as "Structure Demolition and Scaffolding Business" by Article 7, Annex 1 of the Enforcement Decree of the Framework Act on Construction Industry, and among them, it falls under "Structure Demolition Work." The previous law included "Scaffolding Work" and "Pile Work" in the "Scaffolding and Structure Demolition Business", but from 2022 "Pile Work" was excluded and classified as it is now.

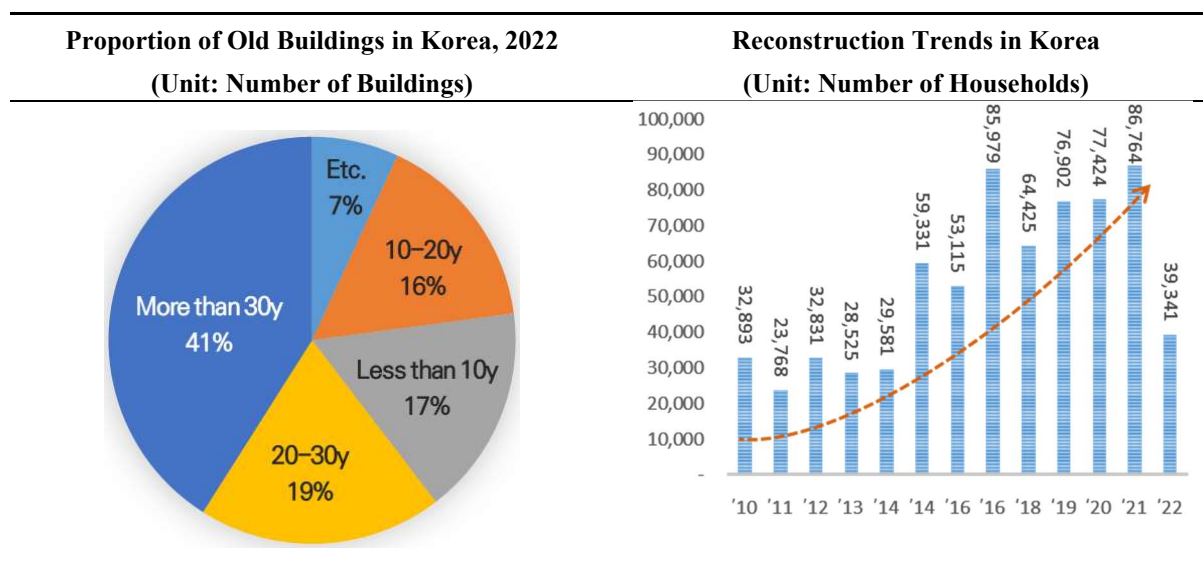
### 2.2. Current Status and Outlook of the Demolition Industry

The global building demolition market is expected to grow rapidly from \$32.6 billion in 2021 to \$55.5 billion in 2030(CAGR<sup>i</sup> of 6.1%) due to various factors such as urban redevelopment in emerging countries.<sup>ii</sup>

Accordingly, Korea's building demolition market is also expected to grow. The proportion of old buildings<sup>iii</sup> in Korea is continuously increasing from 29% in 2005 to 41% in 2022,<sup>iv</sup> and the scale of reconstruction has also grown approximately 2.6 times from 32,893 units in 2010 to 86,764 units in 2021.<sup>v</sup> The remodeling market also grew 2.2 times from KRW 7.813 trillion in 2002 to KRW 17.293 trillion in 2020 and is expected to expand to KRW 29.35 trillion in 2030(CAGR of 5.4% from 2020 to 2030).<sup>vi</sup>

The increase in the proportion of old buildings and the demand for reconstruction and remodeling in Korea will lead to the growth of the building demolition industry and an increase in the importance of demolition work.

**Figure 1.** Current status of the demolition industry in Korea



<sup>i</sup> Compound Annual Growth Rate

<sup>ii</sup> Brainy Insights, 2021.

<sup>iii</sup> Buildings more than 30 years after completion

<sup>iv</sup> Ministry of Land, Infrastructure and Transport Statistics System (data as of 2022)

<sup>v</sup> Ibid.

<sup>vi</sup> Park, 2020: 40,41.

### 2.3. Literature Review

In Korea, a large number of accidents have occurred during the demolition of buildings, and various prior studies regarding them were published. First, Choi et al. (2007) analyzed the status of the Korean and foreign building demolition industry and proposed improved standards based on the results of a survey on the construction safety education system. In this regard, Choi et al. (2010) proposed integrated safety management guidelines applied to all demolition work. Ha et al. (2010) also analyzed the status and problems of Korea's demolition-related laws based on a review of Japanese laws and proposed ways to improve the demolition laws. Ha (2012) conducted a survey targeting companies belonging to the Korea Demolition Professional Association, and derived plans for developing the demolition industry and fostering professional personnel based on the survey. Bae (2017) analyzed the status of building demolition accidents and fatal accidents from 2012 to 2016, conducted a survey of 165 management supervisors of demolition companies, and based on this, proposed a plan to improve the system to prevent accidents during the demolition work. Yoo et al. (2017) presented a plan to systematize the building maintenance and demolition process based on the analysis of overseas and Korean building maintenance and demolition management systems, from a more comprehensive perspective of building performance maintenance and demolition. Lastly, Heo (2020) attempted to establish the items and table of contents of the demolition plan about the building demolition permit system under the Building Management Act and summarized alternatives to strengthen the effectiveness of the demolition plan.

However, the previous studies mentioned above have limitations in that they were conducted before the major revision of the Building Management Act and the subsequent major changes in the building demolition process in recent years. In particular, there is still not sufficient research on the collapse accident in Hak-dong, Gwangju Metropolitan City in 2021, which acted as a catalyst for the revision of the Building Management Act. Therefore, what differentiates this study from other studies is that it conducts a causal analysis of the recent major accident in the building demolition process, and based on this, analyzes the problems of the overall demolition process in Korea centered on the Building Management Act and derives improvement plans.

## 3. ANALYSIS OF ACCIDENT CASE IN HAK-DONG, GWANGJU (2021)

### 3.1. Overview

This accident is a building demolition accident that occurred on June 9, 2021, in Gwangju Metropolitan City, one of Korea's six major cities. While demolition work using a crusher was being carried out at the back of the building to dismantle the structure, the structure tipped over to the front (roadside), killing 9 out of 17 passengers and injuring 8 on the bus while it was stopping at the bus stop.<sup>vii</sup>

Afterward, the Ministry of Land, Infrastructure and Transport, a Korean government department, formed the Central Building Accident Investigation Committee by Article 46 of the Building Management Act and Articles 32 and 33 of the Enforcement Decree of the same Act, and subsequently investigated and wrote a report based on site visits, collection of related information, and structure simulation.

### 3.2. Causal Analysis

The direct cause of the accident was the collapse of the building structure due to mud. In other words, the collapse of the beam on the first floor occurred due to the vertical load of the soil that had been filled more than 10 meters to carry out the demolition work. As a result, the soil flowed into the basement and the upper soil moved toward the front and bottom of the building. This moving soil acted as an impact load on the second and first floors of the building, causing the building to tip over. In addition, it is presumed that the impact load on the soil increased due to a decrease in the internal friction angle of the soil and an increase in the specific gravity of the soil during the watering process to prevent flying dust generated during the demolition process.<sup>viii</sup>

However, the fundamental causes of accidents can be said to be the following factors:

<sup>vii</sup> Ministry of Land, Infrastructure and Transport Central Building Accident Investigation Committee, 2021: 3

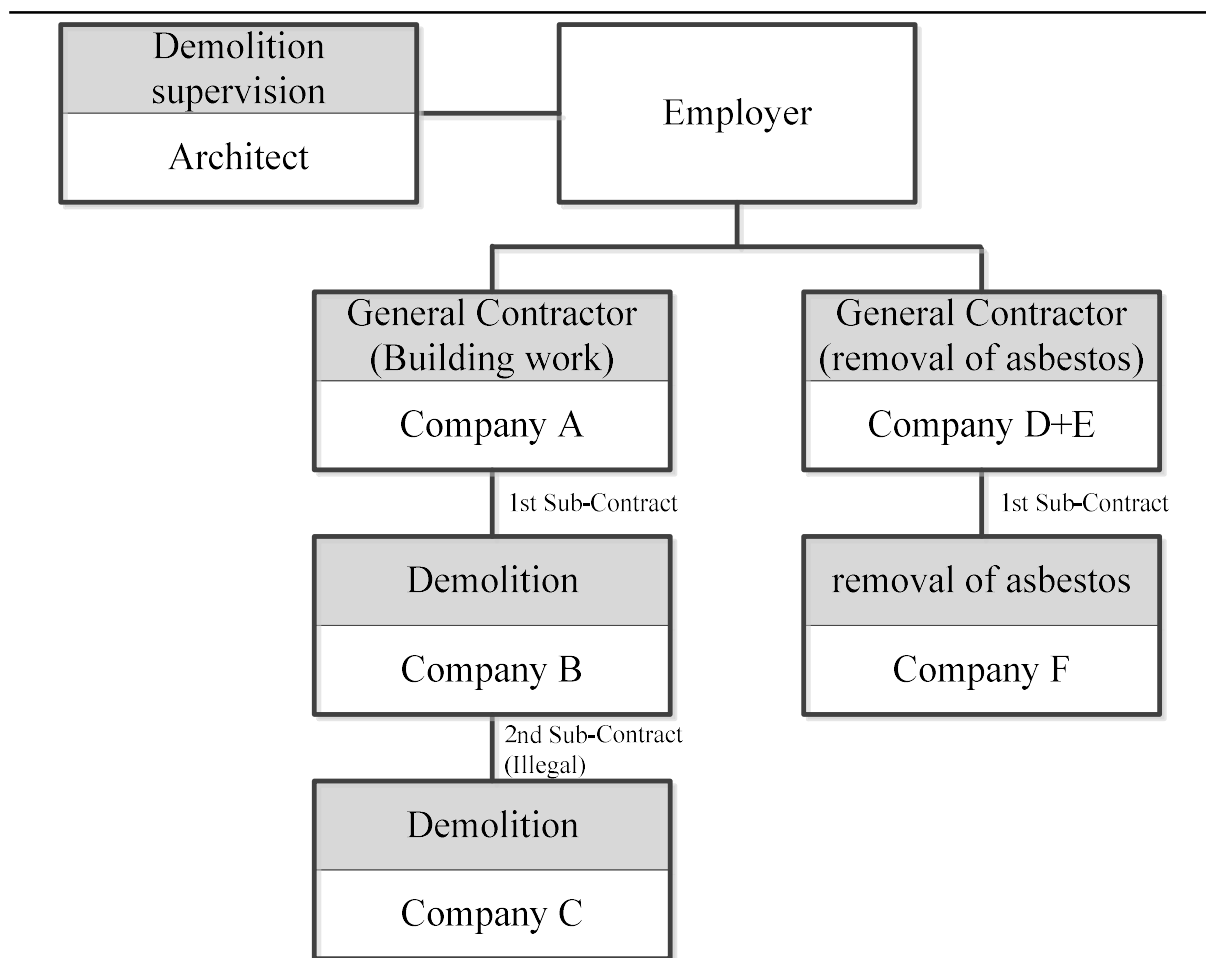
<sup>viii</sup> Ibid., 87.

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First, the demolition plan was written poorly without considering the situation of the site, and the reviewer's review was also insufficient. The construction company that prepared the demolition plan in this case according to the demolition plan preparation service ordered by Company B (the first subcontractor), prepared an insufficient demolition plan poorly based on photos, etc., without conducting an on-site investigation. There was no review of structural safety, applied load, and fall and collapse prevention measures, and the safety checklist indicating essential checkpoints for each major process was completely omitted.<sup>ix</sup> As a result, according to the results of the suitability review of the demolition plan conducted after the accident, the nonconformity rate was analyzed to be 80.5%. Especially No.4 “Work Sequence, Demolition Work and Structural Safety Plan” was inappropriate in 24 out of 26 items, and No.5 “Safety Management Plan” was in 10 out of 12 items. Most of the 66 inadequate items (92.4%) were omitted by the author, which was judged to be due to a lack of expertise of the author and reviewers.<sup>x</sup> The reviewer (the architects) also only requested supplementation of the demolition plan and did not check properly whether the request had been properly reflected.<sup>xi</sup>

Second, the construction method specified in the demolition plan was not followed, and even though the demolition method was changed and applied at the site, did not follow the related procedures. As shown in Figure 2, A (the general contractor) and B (the subcontractor specialized in demolition) discussed a new demolition method different from the method in the original demolition plan during the demolition work and then applied it to the site. However, there was no compliance with proper change procedures, additional structural review, or establishment of safety management measures.<sup>xii</sup>

**Figure 2.** Hak-dong, Gwangju Accident (2021) Demolition Work Organization Chart



<sup>ix</sup> Ibid., 14.

<sup>x</sup> Ibid., 88.

<sup>xi</sup> Ibid., 14,15.

<sup>xii</sup> Ibid., 89.

Third, there were problems in terms of construction management, such as the general contractor's responsibility being excluded and only the subcontractor being designated as the subject of the demolition work. According to the demolition work permit application in this case, A was excluded and only B was listed.<sup>xiii</sup> In addition, when contracting for supervision services, the employer excluded A and specified in the contract only B, who would perform the demolition work. This caused confusion in terms of construction management and supervision, and as responsibility became ambiguous, it became difficult for the general contractor to take responsibility for the demolition work and properly manage construction.<sup>xiv</sup>

Fourth, the supervision of the demolition work was not carried out properly. The architect designated as the supervisor of demolition work was supposed to perform tasks such as reviewing the demolition plan, checking essential checkpoints for each major process, and performing supervision work. However, contact was only made over the phone, so on-site supervision was not done properly.<sup>xv</sup>

Lastly, illegal multi-level subcontracting created a construction structure vulnerable to safety management. In principle, subcontracting of construction is prohibited in the South Korea.<sup>xvi</sup> According to article 29, paragraph 3 of Framework Act on the Construction Industry, a subcontractor may not subcontract the subcontracted construction work to another person. Nevertheless, in this case, B illegally subcontracted the actual demolition work to C. As a result, the demolition cost, which was originally KRW 280,000 per 3.3m<sup>2</sup> in A, was lowered to KRW 40,000 in C, which is only 14.3% of the A amount. Due to this structure, C had no choice but to have a motivation to unreasonably shorten the construction period to secure the minimum profit by saving direct construction costs and labor costs. As a result, in this case, the demolition work was bound to have a vulnerable structure in terms of safety management.<sup>xvii</sup>

### 3.3. Review

The result of the analysis of the Gwangju accident case confirms that the accident was not simply a coincidental one-time accident, but was directly induced by fundamental flaws in Korea's demolition construction processes and practices. Therefore, from now on, we will analyze the process and problems of building demolition work in Korea and briefly propose improvement measures.

## 4. ANALYSIS AND PROBLEMS OF KOREA'S BUILDING DEMOLITION PROCESS

### 4.1. Building Demolition Process in Korea

After the accident in Hak-dong, Gwangju in November 2021, the relevant provisions of the Building Management Act (hereinafter referred to as the "Act"), which is the law on the demolition of buildings, were significantly revised and came into effect on December 1, 2022. The following addresses major revisions of the law, and the overview of the construction sequence is shown in Figure 3.

Firstly, the principle is that when demolishing a building, the manager must obtain permission from the permitting authority. However, as an exception, the demolition of small buildings is regulated to be replaced by notification.

Secondly, regardless of the permit or report, the project manager must submit a demolition plan to the authorizer. However, there is a difference between the two; for the permit, the architect or structural engineer must personally prepare the demolition plan and sign and seal it, while in the case of a report, the architect or structural engineer must review and sign it. This is a strengthened regulation compared to the previous law, which only requires review by an architect or structural engineer.

Lastly, when revising the demolition plan, the law stipulates that changed permission or report must be submitted depending on whether it is subject to permission or reporting. The procedure is the same as the regulations for preparing a demolition plan. This is one of the newly legislated regulations that did not exist before the accident.

Meanwhile, in the supervision procedure, the demolition supervisor is given the right to supervise the overall construction to correct or stop the demolition work, request, and report to the permit holder if

<sup>xiii</sup> Ibid., 18.

<sup>xiv</sup> Ibid., 89.

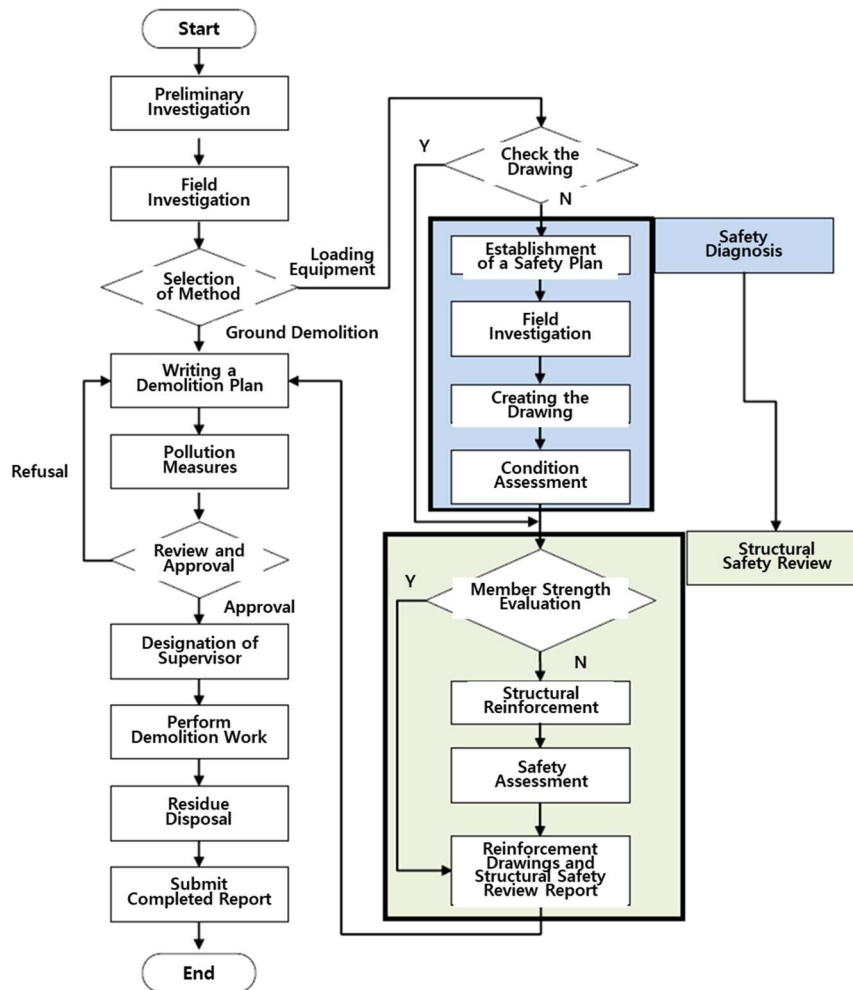
<sup>xv</sup> Ibid., 89.

<sup>xvi</sup> Ibid., 46,47.

<sup>xvii</sup> Ibid., 18.

the demolition is difficult to perform properly. This is another improvement made, by which the supervisor's authority and duties have been strengthened compared to before the accident.

**Figure 3.** Hak-dong, Gwangju Accident (2021) Demolition Work Organization Chart



#### 4.2. Problems with Korea's Building Demolition Processes and Practices

However, despite the legislation for the lessons learned from the accident, the dismantling of Korean buildings has lingering problems in the following aspects.

First, the dismantling construction approval and permitting process is taking an excessive amount of time. The dismantling period in Korea usually lasts 1 month, but for example, the median 50%, excluding the top and bottom 25%, of all the projects takes 8 to 37 days. In particular, buildings with a total floor area of less than 500m<sup>2</sup> take an average of 9 days, and the median 50% take 3 days to 25 days. In comparison, it takes 3-6 months to obtain approval and permission for dismantling a building; the data shows that excessive time and costs are spent on approval and permission.

Second, the contents of the decommissioning plan are excessive in volume and complex add thus practitioners and workers find it difficult to use them as a practical checklist in the field. The government's building dismantling construction manual for writing a dismantling plan is over 300 pages, and the standard format for a dismantling plan requires at least 100 pages to be written, making it difficult for small-scale demolition construction companies to write a large number of dismantling plans. In addition, due to the excessive volume and complicated writing method of the decommissioning plan, the decommissioning plan does not function as a practical checklist that can be checked in real-time while carrying out actual construction on site. As a result, potential discrepancies can occur between the construction methods and safety management measures specified in the decommissioning plan and the actual performance of decommissioning work on site.

Third, the participation of experts or practitioners who understand the expertise and specialties of decommissioning work is limited in the process of writing decommissioning plans and carrying out

construction. In principle, the decommissioning plan must be prepared or reviewed by an architect or structural engineer however, since there is no mandatory regulation requiring the architect or structural engineer to receive practical training or refresher training on dismantling work, most plans lack expertise. and do not take account of individual projects. Next, decommissioning construction supervisors and supervisors must receive training in decommissioning construction supervision, but managers, workers, etc. are not required to have professional education or experience related to decommissioning work, so it is necessary to secure expertise and accumulate experience during the decommissioning work process. It is a difficult environment to lose.

Lastly, illegal subcontracting is still widespread, making it difficult to secure expertise in dismantling work as well as appropriate safety management costs. Due to the nature of dismantling construction, on-site safety management and the use of appropriate construction methods are important, however the excessive cost reduction due to re-subcontracting makes it difficult for specialized dismantling construction companies to grow and allocate efficient amount of budget on safety management.

## 5. CONCLUSION

The purpose of this study is to analyze recent cases of accidents that occurred during Korea's demolition process and based on this, to present problems with Korea's demolition process and practices. To achieve the research purpose, this study analyzed the 2021 Hak-dong collapse accident in Gwangju Metropolitan City, one of the large-scale safety accidents that occurred in Korea in recent years. Despite the revision of laws after the accident, the problems that Korea's demolition process and practices still have are presented.

Ultimately, to reduce safety accidents that occur during the demolition process and establish more efficient and professional demolition process, such as shortening the demolition approval and permitting process, simplifying and clarifying the demolition plan, and establishing a training course for demolition workers. Furthermore, the industry's voluntary efforts to improve construction practices such as illegal subcontracting and formal on-site supervision are required; as to this, the Korean government is conducting research focusing on automating the preparation of demolition plans, establishing an integrated monitoring system for demolition work, and designing educational programs to foster demolition workers and experts.

However, since this study focused on presenting problems with Korea's demolition process and practices based on analysis of accident cases, additional research will be needed to suggest more specific solutions.

## ACKNOWLEDGMENTS

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