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Original Article

Improvement of inspection system for reduction of small-scale construction site accident in Korea

Sejong LIM[1], Ah-ra OH[2], Jeong-hun WON[2]* and Jae-joon CHON[3]

[1]Occupational Safety Division, Ministry of Employment and Labor, Republic of Korea
[2]Department of Safety Engineering, Chungbuk National University, Republic of Korea
[3]Ministry of the Interior and Safety, Republic of Korea

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Abstract: This study analyzed the trend of construction accidents focused on the small-scale construction sites and the correlation between the ratios of official inspection by government and total fatality injuries per 10,000 people (TFR) by construction size in Korea. The method is to analyze statistical data for the construction accidents and official safety inspection system. In construction, accidents rate and TFR are recently increasing unlike other industries. In addition, the smaller the scale of construction sites, the higher the TFR, and vice versa. The smaller the scale of construction sites, the greater the degree of difference in the TFR for each year, and vice versa. In small-scale construction sites, which have amounted less than $273,000 (£231,000), approximately 45.7% of deaths occurred on sites between $36,400 (£30,800) and $182,000 (£154,000). The ratio of inspection, which represents the ratio of official inspection proportion to site share, is in inverse proportion to the TFR by construction size. As the ratio approached zero, TFR became higher, and the higher the ratio, the lower TFR since the official inspection was mainly carried out in medium and large-scale construction sites. To get an effect of official inspection, the focus of official inspection should move onto the small-scale construction site.

Key words: Construction accident, Small-scale construction site, Official inspection, Fatal injuries, Inspection ratio

Introduction

Construction industry has become one of the most hazardous industries in the history of industry all over the world[1–12]. According to the industrial accident report recently published by the Ministry of Employment and Labor (MOEL) of Korea, the industrial accident rate for the overall industry declined from 0.77% in 2006 to 0.5% in 2016, while that for the construction industry showed an increasing trend from 0.72% in 2006 to 0.84% in 2016. In this paper, the accident rate represents the number of workers with work-related illness or injury per 100 workers. The death rate owing to industrial accidents in the construction industry in Korea is the highest; the total number of deaths from industrial accidents in the construction industry in Korea from 2012 to 2016 was 2,596 (520 deaths a year on average) which accounts for 31.42% of all deaths from industrial accidents, according to statistics produced by the MOEL[13].

A total of 1,021,738 construction sites existed as of 2015 in Korea. Among them, the number of small-scale construction sites (with a budget of up to $273,000 (£231,000)) was 785,355, which constitutes a high proportion at 77%. It is these small-sized construction

*To whom correspondence should be addressed.
E-mail: jhwon@chungbuk.ac.kr

projects that are most prone to industrial accidents in the construction industry[14–19]. Despite diverse endeavors to prevent industrial accidents, small-scale construction sites have experienced a consistent increase in the number of industrial accidents. Therefore, it is clear that the number of industrial accidents in the overall construction industry will not be reduced without curtailing the number of industrial accidents in small-scale construction sites.

Research on small-scale construction sites has revealed that technical support for such construction sites is effective in preventing industrial accidents in Korea. Even though it is crucial for government to build channels for offering the necessary technical support to them[20], the government generally has focused on large-scale construction sites more than small-scale construction sites. If accidents occur simultaneously at large-scale construction sites and small-scale construction sites, the media tends to deal more with accidents at large-scale construction sites. Because of exposure to large-scale construction site repeated by the media, the public will likely neglect accidents happening at small scale construction sites[21, 22]. For this reason, attention has been focused on large-scale construction sites rather than solving small-scale construction sites' problems, and the government repeated mainly to respond the accidents of large-scale construction sites.

In Korea, as a way to prevent accidental deaths in the construction industry, mandatory regulations on occupational health and safety should be carried out according to the site size. Safety and health regulations on construction sites primarily focus on medium-scale (projects with a budget of $273,000 (£231,000)–$10.91 million (£9.23 million)) and large-scale (projects with a budget exceeding $10.91 million (£9.23 million)) construction projects. The regulations mandate large-scale construction projects to employ a dedicated and qualified safety manager, while medium-scale construction projects are obliged to receive technical guidance from specialized institutions. However, small-scale construction projects are not bound to have a safety manager during the construction or to receive technical guidance. Only a few of them avail technical guidance and support with government budget through technical support projects assigned by the government to be implemented by private organizations[23].

When it comes to the prevention of industrial accidents in the construction field, on-site supervision plays a crucial role[24–27]. Hopkins argued that the on-site safety supervisor at construction sites should be able to make decisions on the acceptable level of safety based on professional knowledge and expertise without being subject to any regulation, and that the occurrence of an industrial accident at construction sites is determined by the existence of a safety supervisor[28]. Niskanen claimed that construction safety supervision must be actively implemented, as the activities of occupational safety and health institutions and safety inspectors are effective in preventing industrial accidents in the construction field[29].

In Korea, official inspectors who belong to MOEL regularly (and sometimes irregularly) have conducted supervision of the safety and health management system in construction sites to prevent accident. Official inspection carried out according to inspection plans established by branches of MOEL for sites where serious accidents occur or accidents can occur frequently. And, official inspection can be performed for all construction sites regardless of construction size. However, in case of small-scale construction sites, there are some limitations to carry out official inspection because of various reasons such as construction inspection budget, organization, etc. As a result, small sites are being neglected as blind spots.

Thus, it is necessary to examine whether the Korean government's official safety inspection system is appropriately implemented or not for reducing industrial accident in small-scale construction sites. This study analyzed the correlation between the ratios of inspection and fatality injuries per 10,000 people by construction size in order to investigate the appropriateness of the current official inspection system. Using the data from MOEL, main accident statistics for construction sites were compared according to the site size. Then, occupancy ratio of inspection to occupancy ratio of number of workplace by construction size and fatality injuries per 10,000 workers were calculated.

Subjects and Methods

Small-scale construction sites

Construction site size was classified into three group by the construction budget in order to examine construction accident characteristics and official safety inspection system; large-scale construction site, medium-scale construction site, and small-scale construction site. First of all, large-scale construction site means the site that should employ a dedicated and qualified safety manager. Secondly, medium-scale construction site covers construction sites that should be obliged to receive technical guidance from specialized institutions. Finally, small-scale construction site, which does not have both a safety manager and technical guidance, is considered. In addition, the small-

scale construction site was subdivided into some groups according to construction budget.

- Small-scale construction sites (with a budget of up to $273,000 (£231,000))
- Medium-scale construction sites (projects with a budget of $273,000 (£231,000)–$10.91 million (£9.23 million))
- Large-scale construction sites (projects with a budget exceeding $10.91 million (£9.23 million))

Data analysis for construction accidents

The Korean government publishes the annual report of official statistics of industrial accidents[13]. This report shows statistical data for work-related injury and illness, which was approved for occupational injury and illnesses requiring medical care for more than 4 d and reported to Korea Workers' Compensation & Welfare Service. The statistical data consists of the number of workers, injured and diseased workers, death workers, industrial accident rate, fatality rate, frequency rate, and severity rate, etc. In addition, the data are classified into business scale by industrial type, accident type, the number of workers, sex, age, region, etc. In this study, the annual changes of main accident data and detailed construction data according to construction size were compared by extracting the official data from the report during recent 10 yr (2007–2016).

Firstly, the annual changes in the industrial accident rate, fatality rate, frequency rate, and severity rate of industrial accidents among overall industry, manufacturing industry, and construction industry were investigated to show seriousness of the construction industry accident. The accident fatality was divided into the accident fatality rate (AFR) and total fatality rate (TFR). TFR takes into account the deaths from both industrial diseases and work accidents, while the AFR considers only deaths directly related with industrial work accidents. Frequency rate means number of accidents per 1 million hours, which is an index of how often industrial accidents occur and indicates the frequency of industrial accidents taking place in each industry. Severity rate of industrial accidents means total working loss days per 1,000 h.

Detailed analysis for construction accidents by construction size of budget

The detailed analysis for small-scale construction sites was performed by size of construction budget. The industrial accident statistics of construction projects with different scales of project budget, particularly focusing on small-scale construction sites, were analyzed by examining the number of industrial injuries and deaths from source data of MOEL. The official data of industrial accidents[13] are based on the classification of construction projects determined by the number of workers in order to comply with the classification criteria for other industries. However, the obligation of employment of a dedicated safety manager and reception of technical guidance is mainly determined based on the classification of the amount of project budget. Thus, the source data of MOEL from 2012 to 2016, which do not open to the public, investigated instead of annual report for industrial accidents in order to calculate the accident statistics according to the size of construction budget.

Analysis of official inspection system

There is no duty for employing a health and safety manager or adopting technical help in small-scale construction sites, and business owners without an awareness of health and safety are not implementing proper safety management measures. Only, the MOEL regularly (and sometimes irregularly) dispatches official safety management inspectors to these small-scale construction sites where they carry out accident prevention activities. To suggest the improvement of official inspection, this study analyzed official safety inspection system which was done in 2015. The ratio of guidance and supervision relative to the number of sites by size was calculated, then the correlation between the ratio of official inspection by construction size and fatality ration was compared.

Results

Construction accident statistics in Korea

In order to identify the trend in the occurrence of industrial accidents in Korea, the trend of changes in the accident rate, fatality rate, frequency rate, and severity rate of industrial accidents in the overall industry, manufacturing industry, and construction industry were demonstrated in Figs. 1 and 2. The industrial accident rates in the overall industry and manufacturing industry in Korea have shown a consistently decreasing trend from 2007 (Fig. 1A). On the contrary, the rate for the construction industry showed an increasing trend until 2013, and recorded the highest rate at 0.92% in 2013. Thereafter, the rate sharply declined in 2014, although recently, it demonstrated an increasing trend again.

Total fatality rate (TFR) showed a decreasing trend in overall industry and manufacturing industry, while the construction industry represented fluctuating trend

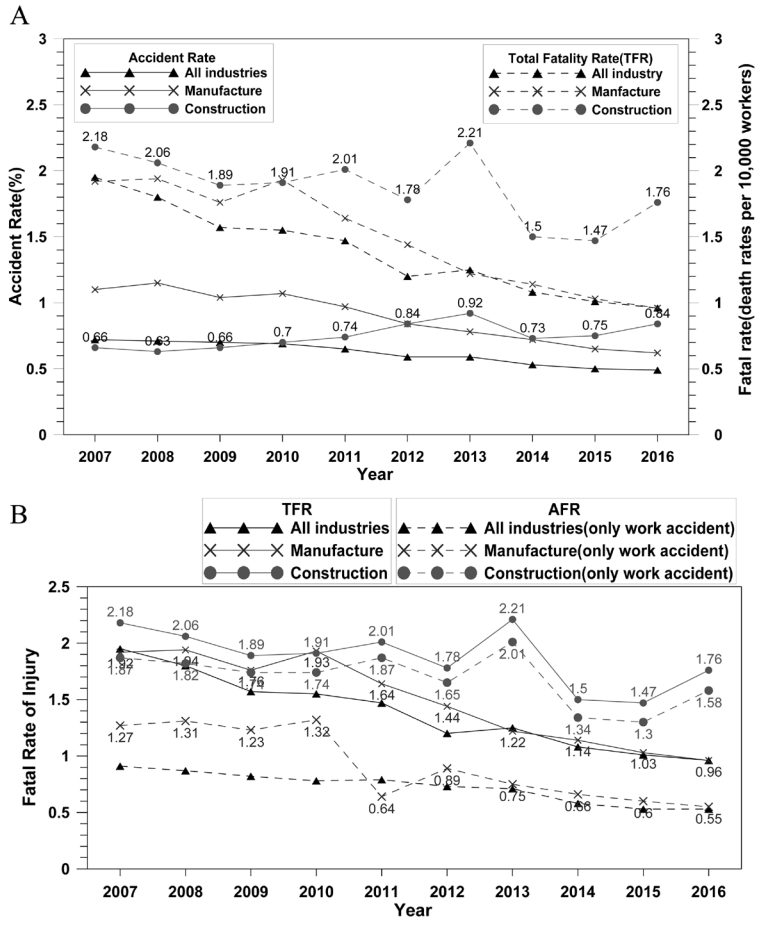

Fig. 1. Changes of industrial accident rate and fatality rate in Korea. (A) Accident rate and total fatality rate, (B) Comparison of total fatality rate (TFR) and accident fatality rate (AFR).

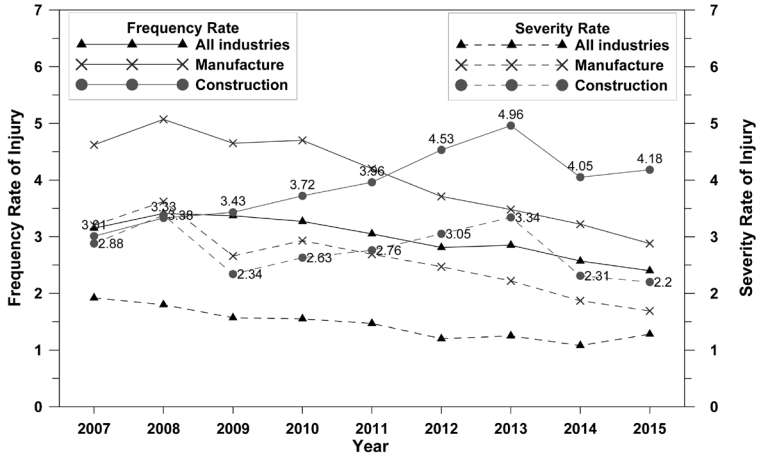

Fig. 2. Changes in the trend of frequency rate and severity rate.

(Fig. 1A). The rate for the construction industry was the highest at 2.21 in 2013, and thereafter, it drastically declined by 1.47 times from the rate in 2013, to 1.5 in 2014. However, recently, the fatality rate in the construction

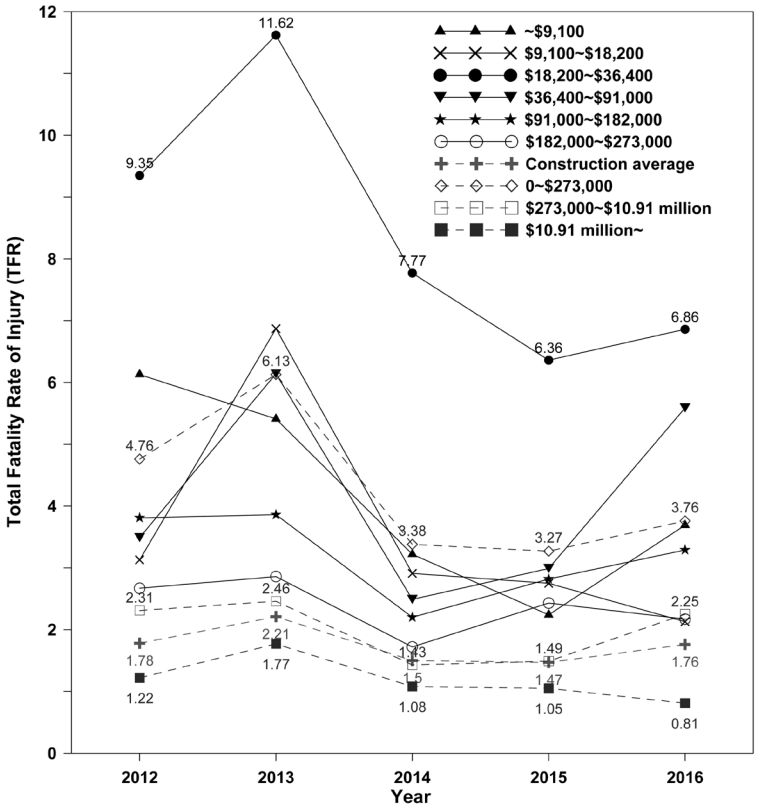

Fig. 3. TFR of construction projects with different construction scales.

industry has demonstrated an increasing trend as shown in previous research[30].

The accident fatality rate (AFR) including only industrial work accidents and TFR for the past 10 yr were compared in Fig. 1B. AFR of the construction field was generally higher than the rate of the overall industry. The TFR of the manufacturing industry maintained a similar level from 2007 to 2010, and thereafter, sharply declined from 2011 to record a figure lower by 1.8 times than that in 2016. The AFR in the construction industry was generally higher than that of the overall industry. In the construction field, the TFR is only 1.11 times higher than the AFR on average, while the TFR in the manufacturing field is 1.69 times higher than the AFR.

The frequency rate injury in the overall industry and manufacturing industry in Korea has shown a consistently decreasing trend (Fig. 2). However, the rate in the construction industry continuously increased until 2013 to reach the highest figure at 4.96 in 2013; subsequently, the rate decreased to 4.05 in 2014, although recently, it has been showing an increasing trend again. Analysis on the severity rate of industrial accidents in the manufacturing industry and construction industry for the past 10 yr showed a change in the level of severity rate in the industrial accidents in the manufacturing and construction industries in 2011 (Fig. 2). Until 2011, the severity rate of industrial accidents in the construction industry was lower than that of the manufacturing industry. However, since 2011, the rate in the construction field has been higher than that in the manufacturing field. Notably, the severity rate in the construction industry was higher by 1.5 times than that in the manufacturing industry in 2013.

Analysis of accident in small-scale construction site

TFR of construction projects with different scales from 2012 to 2016 were surveyed and analyzed in order to identify the occurrence of industrial accidents at small-scale construction sites. Figure 3 displays the TFR of construction projects with different scales. Among small-scale, medium-scale, and large-scale construction sites, the small-scale construction site represents the highest TFR, where followed by medium-scale site and then by large-scale site. The TFR for construction projects with $10.91 million (£9.23 million) or greater budget (large-scale construction site) were generally lower than the rates of the overall construction industry.

Table 1. Analysis of deaths in small-scale construction (2014–2016)

Number of deaths by construction size			Accident type		Places of falling accidents	
Classification	Number of deaths	Number of project sites	Classification	Number of deaths	Places	Number of deaths
≤$9,100	68	234,232	Fall	290	Temporary structures	75
$9,100–$18,200	35	136,949	Struck by falling object	26	Roofs	71
$18,200–$36,400	87	92,380	Pressed by moving object or vehicle	25	End part of structure	33
$36,400–$91,000	112	142,383	Hit by object or vehicle	23	Stairs and ladder	29
$91,000–$182,000	109	104,983	Collapse	18	Facility	22
$182,000–$273,000	73	64,242	Electricity	15	Opening	25
Total	484	775,169	Fire and explosions	6	Others	35
			Other	32	Total	290
			Total	435		

Figure 3 also shows detailed TFR in small-scale construction sites, classified as contracts of less than $273,000 (£231,000). The results revealed that the TFR on small-scale construction sites has fallen sharply since 2013, but has recently shifted to an increasing trend in 2016. Meanwhile, sites between $18,200 (£15,400) and $36,400 (£30,800) showed the highest TFR, whereas those between $182,000 (£154,000) and $273,000 (£231,000) showed the lowest in small-scale construction sites. The TFR on sites between $36,400 (£30,800) and $91,000 (£77,000) increased the most by 1.87 times from 2015 to 2016.

Detail analysis of accident characteristics in small-scale construction projects

Table 1 shows the number of accident deaths and the number of construction sites in small-scale construction with construction sizes of less than $273,000 (£231,000) between 2014 and 2016. The frequency of accidental deaths per site showed that the majority of deaths, 221, or 45.7% of the total, occurred on sites with contracts between $36,400 (£30,800) and $182,000 (£154,000). For the accident type, falls accounted for approximately 67%, which is a considerable proportion. When the falling accidents on small sites were analyzed by place, the largest number occurred in temporary structures (75 deaths), followed by roofs (71 deaths). Thus, temporary structures and roofs together cause approximately 50% of all deaths.

Analysis of the status of official inspection systems for small-scale construction sites

Figure 4A shows results for the ratio of sites receiving official inspection to the number of sites by size surveyed in 2015 to find out the status of construction site inspection. The results show that 552,974 small-scale construction sites less than $36,400 (£30,800) accounted for approximately 58% of all sites, which is a high proportion. However, only 0.03% of construction sites with a budget less than $36,400 (£30,800) received the official inspection. On the other hand, there are 9,282 construction sites bigger than $10.91 million (£9.23 million), which is approximately 60 times less than the number of small-scale sites, but the ratio of inspection is 29.6%. Table 2 and Fig. 4B show the correlation between ratio of inspection and TFR. The ratio of inspection denotes the ratio of official inspection proportion to site share by construction size. The site less than $36,400 (£30,800) has the highest TFR of 3.78 and the lowest ratio of official inspection share to site share. However, the large-scale construction with the lowest TFR of 1.05 represents the highest ratio of 2.889.

Discussion

The trend of accident statistics shows that the accidents in construction industry are recently increasing unlike other industries. Same to other countries, the accident rate and TFR in construction industry are higher than overall industry and manufacturing industry. By examining the frequency rate, industrial accidents occur more frequently in the construction industry, contrary to the decreasing trend of industrial accidents in the overall industry and manufacturing industry. In addition, industrial accidents occurring in the construction field can cause greater damage than those taking place in the manufacturing industry. Thus, more attention should be paid to construction safety management even though Korean government is focusing on reducing the construction accidents, recently. When examining the difference between the TFR and AFR, deaths of workers in construction industry are more closely

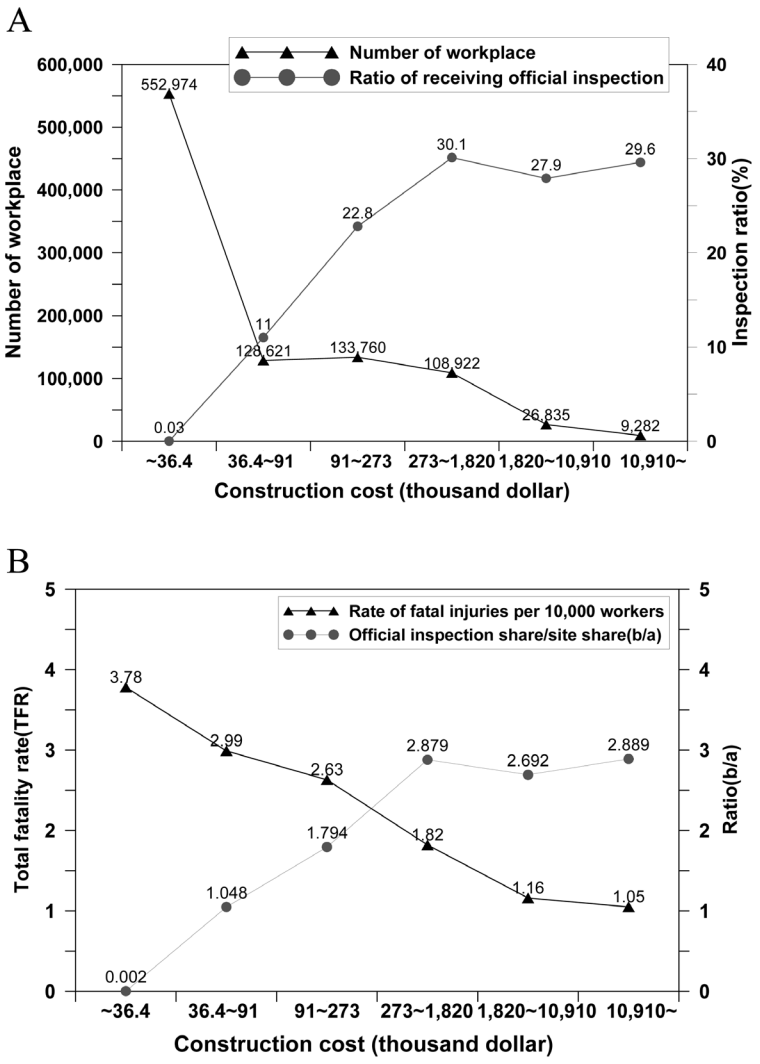

Fig. 4. Relation between inspection ratio and fatality rate by construction size. (A) Ratio of site receiving official inspection by construction size, (B) Ratios of official inspection proportion to site share and TFR by construction size.

Table 2. Relation between site share and official inspection share by construction size

Classification	Site share (a)	Official inspection share (b)	Ratio (b/a)
≤$36,400	51.2	0.1	0.002
$36,400–$91,000	12.6	13.2	1.048
$91,000–$273,000	13.1	23.5	1.794
$273,000–$1.82 million	10.7	30.8	2.879
$1.82 million–$10.91 million	2.6	7.0	2.692
>$10.91 million	0.9	2.6	2.889
Not classified	8.9	17.8	2.000

related with accidents taking place while working rather than with diseases.

The high accident and death rate in the construction industry indicate a misunderstanding of the main causes, together with inadequate and incorrectly targeted accident prevention measures. Therefore, it is important that identifying the nature of the accidents by classifying the construction sites by size and understanding their actual

status for having a great influence on reducing the accident rates. From the results of TRF by construction size, it is found that the smaller the scale of construction sites, the higher the TFR, and vice versa. Furthermore, the smaller the scale of construction sites, the greater the degree of difference in the TFR for each year, and vice versa. Such difference is believed to arise because small-scale construction projects are sensitive to even small changes from external or internal regulation on safety management, as they are usually not legally subject to safety management, and thus, safety management at such construction sites is not properly performed.

On the contrary, large-scale construction sites are legally mandated to perform safety management and subject to implementation of safety management system, including employment of a dedicated safety manager. For this reason, the degree of difference in their TFR is small, as they are not significantly affected by external safety management regulations and inspections. Concentrating on small-scale construction sites with a budget of up to $273,000 (£231,000) for accident prevention activities is expected to significantly contribute to reducing the overall accidents in the construction industry.

In small-scale construction sites with sizes of less than $273,000 (£231,000), approximately 30% of deaths occurred on sites smaller than $9,100 (£7,700), and 45.7% on sites between $36,400 (£30,800) and $182,000 (£154,000). Therefore, accidental death prevention activities for small construction sites should focus on these. In addition, accident prevention activities focused on falls on small construction sites would be highly effective in reducing the number of deaths[31, 32]. Regardless of site size, legal measures taken to ensure that workers are proficient in safety management while working at height would help prevent fatal falls.

Some countries strictly enforce safety regulations on all construction sites regardless of size. In France, a professional body for accident prevention in construction and public works has been established for prevention of accidents in the construction industry due to the high occurrence and severity of occupational accidents and diseases. In Germany, the technical inspectors guide and supervise all construction sites in their jurisdiction regardless of size. The inspectors autonomously determine their site visit schedule. When they visit a site, they also provide technical support through consultation simultaneously with supervision in most cases. Small construction sites post contact information for site managers and suppliers by work type so that inspectors can easily meet site workers as needed. On the contrary, in Korea, safety-related legal measures are applied depending on the construction contract size. Among accident prevention methods, official inspections by government can be carried out regardless of the site size.

Official inspections by government are mainly dispatched to large-scale construction sites. The analysis results for the official inspection done in 2015 revealed that only 0.03% sites among sites smaller than $36,400 (£30,800) was received official inspection even though they accounted approximately 58% of all sites. On the other hand, the number of sites $10.91 million (£9.23 million) or larger was approximately 60 times smaller; the official inspection was carried out 29.6% sites, which is higher by approximately 986 times than that of the small sites. As the construction size increased, the ratio of receiving official inspection, while the number of construction site decreased.

When calculating the ratio of inspection, which the ratio of official inspection proportion to site share, the ratio is in inverse proportion to the TFR by construction size. As the ratio approached zero, TFR became higher, and the higher the ratio, the lower TFR. It can be understood that either the official inspection was excessively focused on the medium and large-scale construction site with lower TFR or the official inspection reduced the TFR. However, in fact, the official inspection was emphasized in medium and large-scale construction sites. To get an effect of official inspection, the official inspection should be focused on small-scale construction sites; the curve of ratio will be similar to the TFR curve or flat curve at least.

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References

1) Bielby SC (1992) Site safety handbook. CIRIA, London.
2) Bureau of Labor Statistics (2001) Fatal workplace injuries in 2000: A collection of data and analysis. U.S. Government Printing Office, Washington, DC.
3) Cattledge GH, Hendricks S, Stanevich R (1996) Fatal occupational falls in the U.S. construction industry, 1980–1989. Accid Anal Prev **28**, 647–54. [Medline] [CrossRef]
4) Fabiano B, Parentini I, Ferraiolo A, Pastorino R (1995) A century of accidents in the Italian industry: relationship with the production cycle. Saf Sci **21**, 65–74. [CrossRef]
5) Jo BW, Lee YS, Kim JH, Rana Khan RMA (2017) Trend

analysis of construction industrial accidents in Korea from 2011 to 2015. Sustainability (Basel) **9**, 1297. [CrossRef]
6) Japan Construction Safety and Health Association Visual Statistics of Industrial Accidents in Construction Industry 2001. https://www.jniosh.go.jp/icpro/jicosh-old/english/statistics/jcsha/index.html. Accessed 2001.
7) Camino López MA, Ritzel DO, Fontaneda I, González Alcantara OJ (2008) Construction industry accidents in Spain. J Safety Res **39**, 497–507. [Medline] [CrossRef]
8) Carter G, Smith SD (2006) Safety hazard identification on construction projects. J Constr Eng M **132**, 197–205. [CrossRef]
9) Cheung SO, Tam CM, Tam V, Cheung K, Suen H (2004) A web-based performance assessment system for environmental protection: WePass. Construct Manag Econ **22**, 927–35. [CrossRef]
10) Gürcanli GE, Müngen U (2013) Analysis of construction accidents in Turkey and responsible parties. Ind Health **51**, 581–95. [Medline] [CrossRef]
11) Suárez Sánchez FA, Carvajal Peláez GI, Catalá Alís J (2017) Occupational safety and health in construction: a review of applications and trends. Ind Health **55**, 210–8. [Medline] [CrossRef]
12) Choi SD, Carlson K (2014) Occupational safety issues in residential construction surveyed in Wisconsin, United States. Ind Health **52**, 541–7. [Medline] [CrossRef]
13) Ministry of Employment and Labor, Industrial Accident Prevention Policy Division Occupational Injuries and Illnesses Statistics 2016. http://www.kosha.or.kr/www/boardView.do?contentId=373432&menuId=554&boardType=A2.html. Accessed December, 2017 (In Korean).
14) Schoonover T, Bonauto D, Silverstein B, Adams D, Clark R (2010) Prioritizing prevention opportunities in the Washington State construction industry, 2003–2007. J Safety Res **41**, 197–202. [Medline] [CrossRef]
15) Cheng CW, Leu SS, Lin CC, Fan C (2010) Characteristic analysis of occupational accidents at small construction enterprises. Saf Sci **48**, 698–707. [CrossRef]
16) Loosemore M, Andonakis N (2007) Barriers to implementing OHS reforms—the experiences of small subcontractors in the Australian construction industry. Int J Proj Manag **25**, 579–88. [CrossRef]
17) Shelton J, Martek I, Chen C (2016) Implementation of innovative technologies in small-scale construction firms: five Australian case studies. Eng Construct Architect Manag **23**, 177–91. [CrossRef]
18) Eivindson E, Innvær BE, Kolberg E, Merschbrock C, Rolfsen CN (2017) Inefficiencies in Norwegian small-scale construction, or the problem of too long trucks? Procedia Eng **196**, 543–9. [CrossRef]
19) Tsai HH, Peng SM, Yeh CY, Chen CJ, Chen RY (2011) An effective physical fitness program for small and medium-sized enterprises. Ind Health **49**, 311–20. [Medline] [CrossRef]
20) Bae KS, Yoon JD, Ahn HS, Shim GB (2013) Analysis on the current status of industrial accidents in construction industry and policy direction: focusing on small and medium-sized construction workplaces, 1st ed., 8–25, Industrial Relations Research Division, Korea Labor Institute (In Korean).
21) Lerner D (1953) A scale pattern of opinion correlates: communication networks, media exposure, and concomitant responses. Sociometry **16**, 266–71. [CrossRef]
22) Hopwood TL, Schutte NS (2017) Psychological outcomes in reaction to media exposure to disasters and large-scale violence: a meta-analysis. Psychol Violence **7**, 316–27. [CrossRef]
23) Kim TG, Kang YS, Lee HW (2011) A study on industrial accident rate forecasting and program development of estimated zero accident time in Korea. Ind Health **49**, 56–62. [Medline] [CrossRef]
24) Törner M, Pousette A (2009) Safety in construction—a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers. J Safety Res **40**, 399–409. [Medline] [CrossRef]
25) Tam CM, Zeng SX, Deng ZM (2004) Identifying elements of poor construction safety management in China. Saf Sci **42**, 569–86. [CrossRef]
26) Ale BJM, Bellamy LJ, Baksteen H, Damen M, Goossens LHJ, Hale AR, Mud M, Oh J, Papazoglou IA, Whiston JY (2008) Accidents in the construction industry in the Netherlands: an analysis of accident reports using Storybuilder. Reliab Eng Syst Saf **93**, 1523–33. [CrossRef]
27) McDonald MA, Lipscomb HJ, Bondy J, Glazner J (2009) "Safety is everyone's job:" the key to safety on a large university construction site. J Safety Res **40**, 53–61. [Medline] [CrossRef]
28) Hopkins A The National Research Centre for Occupational Health and Safety Regulation, The Australian National University New Strategies for Safety Regulators: Beyond Compliance Monitoring. http://digitalcollections.anu.edu.au/handle/1885/43220. Accessed March, 2005.
29) Niskanen T (2013) The effects of the enforcement legislation in the Finnish occupational safety and health inspectorate. Saf Sci **55**, 135–48. [CrossRef]
30) Lee HD, Song KJ, Won JH (2016) Accident characteristic evaluation of Korea construction workplace by analyzing industrial accident data from 2010 to 2014. J Inst Constr Technol **35**, 43–9 (In Korean).
31) Dong XS, Choi SD, Borchardt JG, Wang X, Largay JA (2013) Fatal falls from roofs among U.S. construction workers. J Safety Res **44**, 17–24. [Medline] [CrossRef]
32) Kaskutas V, Dale AM, Lipscomb H, Evanoff B (2013) Fall prevention and safety communication training for foremen: report of a pilot project designed to improve residential construction safety. J Safety Res **44**, 111–8. [Medline] [CrossRef]