Industrial Health 2023, **61**, 102 – 111

Original Article

The impact of corporate culture on industrial accidents in high-risk industries: a cross-sectional survey

Jooman NOH[1], Seongjin LEE[1] and Hong Chong CHO[1]*

[1]Department of Economics, Dankook University, Republic of Korea

Received November 3, 2021 and accepted March 31, 2022
Published online in J-STAGE April 7, 2022
DOI https://doi.org/10.2486/indhealth.2021-0252

Abstract: The rate of industrial accidents in Korea is two to three times higher than those in advanced countries such as Germany. These accidents are mainly concentrated in high-risk industrial areas. Using the ninth wave of the Occupational Safety and Health Company Survey by the Occupational Safety and Health Research Institute (OSHRI), we analyzed the influence of corporate culture on the occurrence of occupational accidents in high-risk industries using negative binomial regression. We found that older workers and foreign workers had a positive effect on the accident rate, while female workers had a negative effect on the accident rate. In addition, it was found that the health and safety management organization also reduced occupational accidents. Corporate culture and workplace environment significantly reduced industrial accidents among workers. This suggests that internal elements of an organization such as corporate culture and working environment can have an impact in reducing the occurrence of industrial accidents.

Key words: Corporate culture, Working environment, High-risk industries, Industrial accidents, Negative binomial regression

Introduction

Since the 1960s, manufacturing and construction have played pivotal roles in Korea's economic growth, contributing to the advancement of the industrial structure and economic growth. Development in steel, electricity, shipbuilding, petrochemicals, etc. advanced under the policy of fostering the heavy chemical industry, which contributed significantly to Korea's economic growth.

However, with this rapid growth in Korea, high industrial accident rates have coexisted. Although Korea's industrial accident rate has continuously decreased, the rate is still high compared to those of other advanced countries. According to a report released by Office for Government Policy Coordination (OPC) in 2018, the number of deaths is declining but still very high, at 4.58% in the 1970s, 0.68% in 1988, and 0.53% in 2014[1]. The number of industrial accident deaths per 10,000 Korean workers is two to three times higher than those of in other advanced countries such as Germany. For example, Korea's accident mortality rate is 0.58, which is considerably higher than Germany's 0.16, Japan's 0.19, and USA's 0.36.

Expectations and interest in safety are increasing, but large-scale casualties still occur repeatedly in industrial sites. As of 2016, the economic loss from industrial accidents (accidents and diseases) was approximately 21.4 trillion won, and according to a cooperative report from relat-

*To whom correspondence should be addressed.
E-mail address: hongcho@dankook.ac.kr

ed ministries, industrial accident deaths are especially concentrated in high-risk areas such as manufacturing and construction. More than three-quarters of the fatalities occurred in the construction (499 persons, 51.5%) and manufacturing (232 persons, 23.9%) industries. Many of these accidents occurred in chemical, metal, machinery, and shipbuilding industries during manufacturing. Therefore, it is necessary to set a target for reducing industrial accident deaths, including specific and systematic policy measures to achieve it.

Recently, the government expressed an active commitment to reducing the occurrence of industrial accidents in high-risk industries. On January 10, 2018, President Moon announced that he would halve the death toll in the three major areas (construction, construction machinery and equipment, and shipbuilding and chemical), including ensuring industrial safety by 2022[2]. Accordingly, a Cabinet meeting on January 23, 2018, voted to reduce industrial accidents through intensive management of high-risk areas including metal machinery manufacturing (construction, construction machinery and equipment, shipbuilding and chemical, metal machinery manufacturing).

There are several previous studies related to the occurrence of industrial accidents. Kang *et al.* (2004) reviewed the occupational health research of the Korean industry from the 1960s to the 1990s and concluded that research on health promotion, job stress, and psychological problems of work organizations is worth paying attention to nationally[3]. Rhee *et al.* (2013) analyzed the impact of regulatory conformity on industrial accidents[4]. They categorized various regulations into four types according to their nature and studied how they affect the occurrence of industrial accidents. Their result indicated that all four regulation categories had a positive effect on reducing the number of industrial accidents. Another related study that focused on the interaction between a labor union and the Occupational Safety and Health Committee reported that the committee reduced the occurrence of industrial accidents and particularly had a greater effect on companies without labor unions[5].

Kim and Park (2020) reported a significant association between economic indicators and the frequency of industrial accidents monthly[6]. The authors stated that the number of monthly industrial accidents was closely related to the manufacturing operation rate, the difference in productivity in the service industry, and the number of construction projects initiated. Oah *et al.* (2018) study on industrial accident risk perception revealed that a safe atmosphere and leadership were the most important factors in better perception of risk[7]. Another study demonstrated that the number of industrial workers and sales and in-house partners increased the occurrence of industrial accidents[8].

Studies using a quantitative model focusing on the role of the corporate culture and welfare in the reduction of workplace human accidents are scarce, and reports have emerged that the culture of companies has a significant impact on the occurrence of industrial accidents[9–11] and that companies that are interested in promoting employee-friendly corporate culture and worker welfare can reduce human factor accidents[12–14].

Hence, this study analyzed the effect of internal factors (corporate culture and welfare) on the occurrence of industrial accidents in the high-risk industries using the negative binomial regression. We examined internal and external characteristics of the entities, to identify implications for high-risk industrial safety policies emphasized by the government.

Subjects and Methods

Data

This study used the ninth wave of the Occupational Safety and Health Company Survey (2018) carried out by OSHRI. The survey was first conducted in 2002, and surveys of manufacturing, construction and seven other industries are conducted every three years. In this study, we focused on high-risk industries. High-risk industries refer to construction machinery and equipment, shipbuilding and chemical, metal machinery manufacturing, and construction industries based on the “measures to reduce industrial accident deaths” announced in a 2018 joint report by OPC.

This research is answered by the person in charge of safety and health management of each company in a table-assisted personal interview (TAPI). It aims to receive responses from 2,000 companies in the manufacturing industry, 2,000 in seven other industries, and 1,000 in the construction industry. When the initially selected companies refuse to respond, the alternative sample companies respond and set the target number. In the survey used in this study, the response rate of the original sample was 38.6%, and the rest were answered through alternative samples.

The number of sick people and companies with zero employees were not considered to be a dependent variable in this study. This is because it is difficult to establish an accurate causal relationship, through data, whether the disease occurred at the workplace or due to the personal characteristics of the worker. In other words, when the number of sick people is summed with the number of accidents, it be-

Table 1. Description of variables

Variable	Description
NOA	Dependent variable; Number of accidents
NOW	Control variable; Total number of workers
RatioW	Ratio of woman workers
RatioF	Ratio of foreigner workers
Ratio55y	Ratio of aged above 55 years workers
Union	Dummy variable; Labor union status
HSM	Dummy variable; 1 for the existence of health and safety management organization in a company and 0 otherwise
RMeeting	Dummy variable; 1 for the existence of regular meetings between workers and supervisors in a company and 0 otherwise
RPStress	Dummy variable; 1 for the existence of response procedures in the event of work-related stress in a company and 0 otherwise
TChange	Dummy variable; 1 for the existence of business time change in a company and 0 otherwise
ASchedule	Dummy variable; 1 for the existence of action when performing long hours of work or irregular schedules in a company and 0 otherwise

comes difficult to determine the exact causal relationship. Therefore, our dependent variable was only the number of accident victims. The description of variables is presented in Table 1.

We had four variables relating to the culture and circumstance of an employee-friendly company. All four variables consist of yes or no, and the variable is set to 1 for yes and 0 for no. Here, the employee-friendly corporate culture and environment meant internal characteristics, not external characteristics, such as demographic characteristics. RMeeting can be regarded as a culture of a company that communicates through regular meetings, not through one-sided instructions from the supervisor. Jun *et al.* (1997) conducted a study to investigate the relationship between job stress and mental health and found that subjective job stress is significantly related to mental health, and poor relationships with superiors affect mental health. RMeeting was closely related to the results[15].

RPStress can be considered to be an indication of the company culture in which the company is actively interested in the working environment of the worker. TChange represents the characteristics of employee-friendly company culture that allows it to change its working hours to suit the convenience of its workers. Similarly, to TChange, ASchedules represent an employee-friendly company culture that reflects the convenience of workers.

Tables 2 and 3 respectively present the basic statistics of all industries and high-risk industries. The samples of the number of accident victims are mainly concentrated near zero. Accidental disaster is an extremely rare event, hence the skewness of the average. Also, Table 4 and 5 respectively present the pairwise correlations of all industries and high-risk industries.

Model

Since the number of accidents in the industry is discrete, a count model is used if it is used as a dependent variable. The Poisson regression model is a typical count model and is used when the variance and mean are the same, which must be greater than zero. However, overdispersion problems occur when the variance is greater than the mean. The Poisson regression model cannot obtain a consistent estimator. If there is an overdispersion problem, a negative binomial regression model can be used[16]. The Poisson regression model is expressed as presented below:

$$P(Y_i = y_i \mid \mathbf{x}_i) = \frac{e_i^{-\mu_i}\mu_i^{y_i}}{y_i!},\ y_i = 0,1,2,\cdots, i = 1,2,\cdots,n \qquad (1)$$

where $\mu_i = E(Y_i) = Var(Y_i) = \exp(\mathbf{x}_i'\beta) > 0$, $\mathbf{x}_i = [1, x_{1i}, x_{2i}, \cdots, x_{Ki}]'$, $x_{1i}, x_{2i}, \cdots, x_{Ki} (\in \mathbb{R})$ are independent variables of i-th company and $\beta = [\beta_0, \beta_1, \cdots, \beta_K]'$ is the parameter vector. The mean and variance of the Poisson model must have the same each other and must be greater than zero.

In addition, since the number of accidental casualties tends to be higher in companies with many workers, it is appropriate to consider the proportion of accidental casualties to the number of people in the company rather than the number of accidents. The method of considering the proportion of dependent variables with only integers above zero is to use an offset, which is to add a natural logarithmic total number as an independent variable and then hold the coefficient at 1. Therefore, a model that can control the total number of workers in a company is established by rewriting the μ_i in equation (2) as follows:

Table 2. Summary statistics of all industries

Variable	Obs	Mean	SD	Min	Max	Unit
NOA	4,859	0.251	0.991	0	31	Person
NOW	4,859	138.2	169.757	1	2,045	Person
RatioW	4,859	0.381	0.318	0	1	%
RatioF	4,859	0.036	0.100	0	1	%
Ratio55y	4,859	0.167	0.218	0	1	%
Union	4,859	0.213	0.410	0	1	Dummy
HSM	4,859	0.755	0.430	0	1	Dummy
RMeeting	4,859	0.735	0.442	0	1	Dummy
RPStress	4,859	0.511	0.500	0	1	Dummy
TChange	4,859	0.493	0.500	0	1	Dummy
ASchedule	4,859	0.713	0.452	0	1	Dummy

SD, Standard deviation; Min, Minimum; Max, Maximum; Obs, Observations

Table 3. Summary statistics of high-risk industries

Variable	Obs	Mean	SD	Min	Max	Unit
NOA	2,084	0.286	1.019	0	25	Person
NOW	2,084	133.2	153.8128	1	1,403	Person
RatioW	2,084	0.161	0.188	0	1	%
RatioF	2,084	0.061	0.129	0	1	%
Ratio55y	2,084	0.149	0.186	0	1	%
Union	2,084	0.203	0.402	0	1	Dummy
HSM	2,084	0.867	0.340	0	1	Dummy
RMeeting	2,084	0.736	0.441	0	1	Dummy
RPStress	2,084	0.439	0.496	0	1	Dummy
TChange	2,084	0.422	0.494	0	1	Dummy
ASchedule	2,084	0.668	0.471	0	1	Dummy

SD, Standard deviation; Min, Minimum; Max, Maximum; Obs, Observations

Table 4. Pairwise correlations of all industries

	RatioW	RatioF	Ratio55y	Union	HSM	RMeeting	RPStress	TChange	ASchedule
RatioW	1								
RatioF	−0.182***	1							
Ratio55y	0.140***	0.101***	1						
Union	−0.124***	−0.070***	−0.082***	1					
HSM	−0.200***	0.064***	−0.058***	0.086***	1				
RMeeting	−0.017	−0.003	−0.038**	0.015	0.064***	1			
RPStress	0.160***	−0.072***	−0.022	0.077***	0.108***	−0.001	1		
TChange	0.114***	−0.063***	0.025	0.05***	0.070***	0.009	0.350***	1	
ASchedule	0.082***	−0.074***	−0.052***	0.052***	0.053***	0.029*	0.394***	0.371***	1

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5. Pairwise correlations of high-risk industries

	RatioW	RatioF	Ratio55y	Union	HSM	RMeeting	RPStress	TChange	ASchedule
RatioW	1								
RatioF	−0.047*	1							
Ratio55y	−0.169***	0.255***	1						
Union	−0.083***	−0.076***	−0.034	1					
HSM	−0.108***	0.020	0.067**	0.050*	1				
RMeeting	−0.042	−0.029	−0.039	0.052*	0.096***	1			
RPStress	0.043	−0.046*	−0.071**	0.062**	0.135***	0.088***	1		
TChange	−0.028	−0.044*	−0.017	0.053*	0.069**	0.056*	0.358***	1	
ASchedule	0.017	−0.089***	−0.09***	0.051*	0.058**	0.092***	0.395***	0.398***	1

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

$$\begin{aligned} \mu_i &= \exp(\mathbf{x}_i'\beta)\, S_i \\ &= \exp(\mathbf{x}_i{}'\beta + 1\cdot \ln S_i) \\ \Leftrightarrow \ln \mu_i &= \mathbf{x}_i{}'\beta + 1\cdot \ln S_i \\ \Leftrightarrow \ln\frac{\mu_i}{S_i} &= \mathbf{x}_i{}'\beta \end{aligned} \quad (2)$$

where $S_i(\in N)$ represents the total number of people in the i-th company and estimates the parameter β using a method that holds the estimation coefficient of ln S_i to 1 concerning ln μ_i.

If the problem of overdispersion occurs, then the standard error of the regression coefficient is biased. So, the negative binomial regression should be performed. The negative binomial distribution assumes that the parameters of the Poisson distribution follow a gamma distribution (Poisson-gamma mixture distribution), and the model assumes that the dependent variables follow a negative binomial distribution[17, 18].

In the overdispersion model, the variance is defined as in equation (3) and when assuming a negative binomial distribution, $g(\mu_i)=\mu_i^2$. α is a parameter indicating the degree of overdispersion.

$$Var(y_i) = \mu_i + \alpha\cdot g(\mu_i), \alpha \geq 0 \quad (3)$$

The null hypothesis of the test for the presence of overdispersion in negative binomial regression is $H_0{:}\alpha=0, H_1{:}\alpha>0$[19]. The null hypothesis is that overdispersion does not exist. The test statistics are calculated as follows[20]:

$$D = \frac{(n-1)Var(y_i)}{E(y_i)} \quad (4)$$

n is the size of the sample. The rejection of the null hypothesis is determined by a two-sided test in a chi-squared distribution with a degree of freedom of n–1. If the P-value is less than or equal to 0.05, the null hypothesis is rejected. Another way is to verify that $Var(y_i)/E(y_i)$ has a value greater than 1.25, which can then be determined to be overdispersed. The test found that there was overdispersion in Table 6. Therefore, we performed a negative binomial regression rather than a Poisson regression.

We also derive from the mean-variance relationship that negative binomial regression is more appropriate than Poisson regression. Fig. 1 below are scatter plots showing the relationship between the mean and variance of the dependent variable using bootstrap, and the black line represents a 45-degree line. Poisson regression is suitable if the dots are on the 45-degree line, but negative binomial regression is more suitable if they are above 45-degree.

The negative binomial regression model satisfies $\sigma_i^2=\mu_i+\alpha\,\mu_i^2$, which can be expressed as follows:

$$\begin{aligned} &P(Y_i = y_i|\mathbf{x}_i) \\ &= \frac{\Gamma(y_i+\alpha^{-1})}{\Gamma(\alpha^{-1})\Gamma(y_i+1)}(1+\alpha\mu_i)^{-\alpha^{-1}}(1+\alpha^{-1}\mu_i^{-1})^{-y_i} \\ &= \frac{\Gamma(y_i+\alpha^{-1})}{\Gamma(\alpha^{-1})\Gamma(y_i+1)}\left(\frac{1}{1+\alpha\mu_i}\right)^{\alpha^{-1}}\left(\frac{\alpha\mu_i}{1+\alpha\mu_i}\right)^{y_i} \\ &= \left\{\prod_{j=0}^{y_i-1}(j+\alpha^{-1})\right\}\frac{1}{y_i!}\left(\frac{1}{1+\alpha\mu_i}\right)^{\alpha^{-1}}\left(\frac{\alpha\mu_i}{1+\alpha\mu_i}\right)^{y_i}, \\ &y_i = 0,1,2,\cdots, \quad i = 1,\cdots,n \end{aligned} \quad (5)$$

where $\Gamma(\cdot)$ is a gamma function expressed as follows:

$$\Gamma(z) = \int_0^\infty x^{z-1}e^{-x}dx, \quad z>0 \quad (6)$$

We use the maximum likelihood method to obtain parameter β, and the log-likelihood function to obtain the maximum likelihood estimator (MLE) is as follows:

Table 6. Results of the overdispersion test

The industry	$Var(y_i)/E(y_i)$	D	P-value
All industries	3.9104	18,996.6300	0.0000
High-risk industries	3.6373	7,576.3820	0.0000

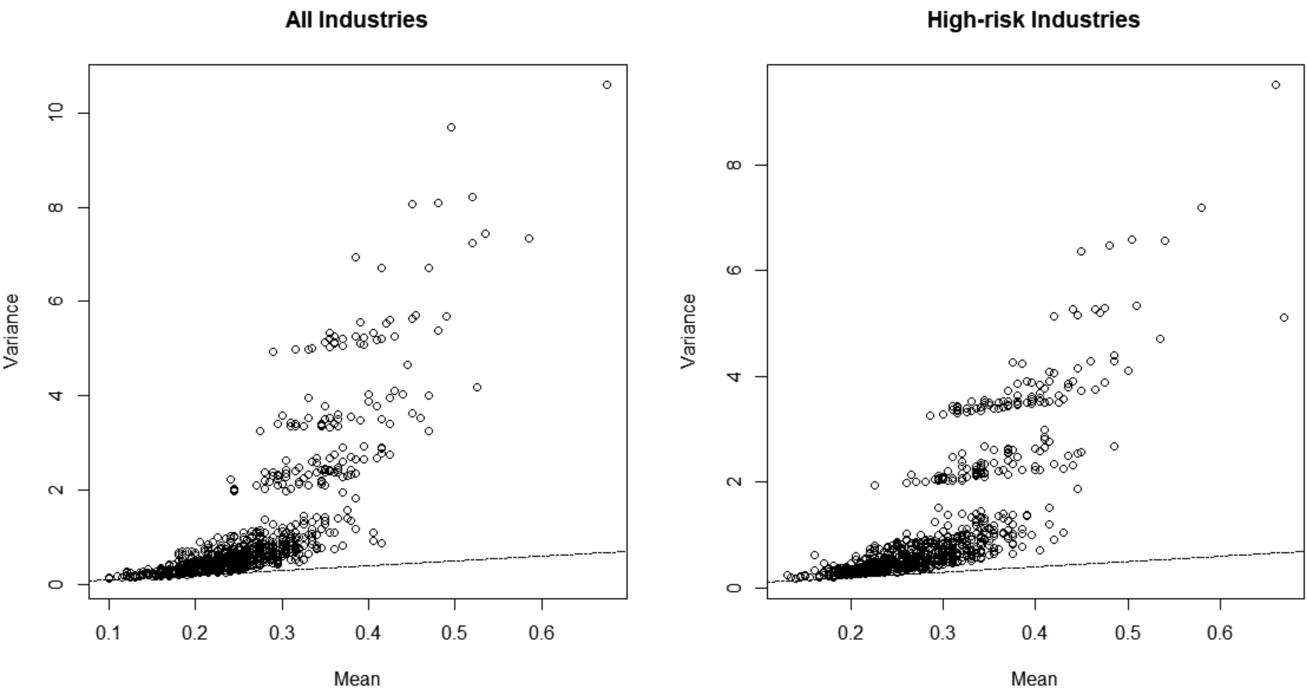

Fig. 1. Mean-Variance Trends.

$$\max_{\beta} \sum_{i=1}^{n} l(\alpha, \beta),$$

$$l(\alpha,\beta) = \left(\sum_{j=0}^{y_i - 1} \ln(j + \alpha^{-1}) \right) - \ln(y_i!) - (y_i + \alpha^{-1}) \ln(1 + \alpha \cdot \exp(\mathbf{x}_i'\beta)\, S_i) + y_i \ln \alpha + y_i(x_i'\beta + \ln S_i) \quad (7)$$

Results

The details of the results of this study are presented in Tables 7 and 9. All the analyses were based on the data of the ninth wave of the Occupational Safety and Health Company Survey.

Table 7 presents the corporate culture factors that influenced industrial accidents in all industries. There are models that include and exclude four variables related to the corporate culture that influenced industrial accidents, which are the core variables of this study. The coefficients of both models had the same sign, and only union coefficients were insignificant in the model except for the corporate culture.

RPStress, TChange and Aschedule were significantly associated with industrial accidents. That is, industrial accidents decreased in organizations that had an existing business time change in a company, had a response procedure in the case of work-related stress, and measures taken during long work hours or irregular schedules. This implies that the factors that provide convenience and a free atmosphere for workers in most workplaces reduce the accident rate.

Analysis of all workplaces indicated that older workers and foreign workers had a positive effect on the accident rate, while female workers had a negative effect on the accident rate. The reason for this finding might be that the proportion of female workers is relatively low in production jobs, which are high-risk jobs for mainly older workers and foreign workers. As presented in Table 8, the percentage of female workers working in production jobs was 33.01%. The coefficient value (Table 7) showed a positive result in the composition of the health and safety management (HSM), because HSM exists mainly in workplaces

Table 7. Determinants of industrial accidents in all industries

Variable	Coefficient	Standard error	Coefficient	Standard error
RatioW	**−0.9848*****	0.1474	**−0.7961*****	0.1493
RatioF	**1.1329*****	0.3744	**0.9995*****	0.3732
Ratio55y	**1.1618*****	0.1878	**1.1291*****	0.1874
Union	−0.1622	0.1013	−0.1031	0.1011
HSM	**0.2831*****	0.1086	**0.3703*****	0.1096
RMeeting			0.0939	0.0968
RPStress			**−0.2286****	0.0967
TChange			**−0.1656***	0.0949
ASchedule			**−0.3300*****	0.1015
Intercept	**−6.2866*****	0.1244	**−6.0863*****	0.1501

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Models that exclude and include four variables related to the corporate culture.

Table 8. Ratio of foreign, aged, and female workers by occupation

	Occupation	Foreign worker	Aged worker	Female worker	All workers
All industries	Management/Profession/Office	6.56%	20.00%	38.70%	35.96%
	Service/Sales	2.23%	18.36%	28.29%	16.20%
	Production/Simple labor/Skilled agricultural and fisheries workers	91.21%	61.64%	33.01%	47.84%
	Employment type (Foreign, Aged, Female)	6.54%	26.95%	66.51%	100%
High-risk industries	Management/Profession/Office	4.24%	11.17%	25.21%	25.92%
	Service/Sales	0.30%	0.73%	1.95%	1.51%
	Production/Simple labor/Skilled agricultural and fisheries workers	95.46%	88.10%	72.84%	72.57%
	Employment type (Foreign, Aged, Female)	19.06%	38.64%	42.30%	100%

that are classified as high-risk industries. According to the ninth wave of the Occupational Safety and Health Company Survey data, 86.7% of HSM committee exists in high-risk industries.

Table 8 summarizes the ratios by occupation and employment type, and the characteristics of each employment type show that the overall proportion of female workers is high. Also, Table 8 presents the proportion of foreign and elderly workers engaged in production/simple labor/agriculture and fisheries skilled jobs. Foreign workers (95.46%) and aged workers (88.10%) in high-risk industries are relatively more engaged in production jobs than the average of all workers in production jobs (72.57%). Considering that an average of 72.57% of all workers in high-risk industries is engaged in production jobs and the proportion of female workers to all workers, a relatively low percentage of female workers (72.84%) is engaged in production jobs.

The Fig. 2 and 3 below shows the fitted number of assets according to the worker's ratio based on the estimation result. For example, the graph of foreign workers ratio is shown in the following equation. Only ratioF is a variable, and the rest of the variables are fixed as average values.

$$y = \exp(\beta_1 ratioF + E(constant + \beta_2 ratioW + \beta_3 ratio55y + \cdots + \beta_9 ASchedule)) \cdot E(S) \quad (8)$$

Table 9 also presents models that include and exclude four variables related to the corporate culture that influenced industrial accidents, which are the core variables of this study. The coefficients of both models had the same sign, and only union coefficients were insignificant in the model except for the corporate culture.

In addition, in the last column of the Table 9, survey respondents may hesitate to respond to accident questions, so only samples of accidents occurred among high-risk industries were selected and analyzed. In the first and second columns of Table 9, the significance of the coefficients of all variables was the same, and the signs were also in the same direction.

First, in the first and second columns of Table 7, the relationship between female workers, foreign workers, elderly (55-year-old) workers and the accident rate were statistically significant, with foreign and older workers having positive relationships with accident rates. This is mainly because foreign workers tend to work in 3D (Difficult, Dirty, and Dangerous). This is because the characteristics of foreign workers and older workers indicate that they tend to take up the low-skilled production and simple labor jobs.

The positive significant relationship between the ratio of foreign workers, the ratio of older workers, and the ratio of industrial accidents shows that a new policy direction is needed in the future, given the aging population and the gradually increasing number of foreign workers. There was an inverse relationship between being a female worker and the occurrence of occupational accidents. The finding on the indirect relationship between female workers and the occupational accident rate is due to female workers' tendency to work in the service or support industry, rather than in production areas, which are high-risk sites.

All four variables related to the employee-friendly corporate culture and environment gave negative results, whereas three independent variables related to the corporate culture were statistically significant: (1) regular meetings between workers and their immediate bosses (RMeeting), (2) preparation of work-related stress procedures (RPStress), and (3) actions taken on long-term or irregular schedules (ASchedule). The negative significant relationship between the occurrence of industrial accidents and corporate culture variables is consistent with prior studies' argument that internal factors of an entity, such as an atmosphere that emphasizes safety and a leadership emphasizing safety, has an impact on improvement of risk awareness[7].

Finally, it should be noted in the last column of Table 9 that the sign of foreign workers came out in a negative direction, and corporate culture variables except for RPStress came out with no statistical significance.

The reason for the change in the sign of foreign workers is that extreme values exist in the sample. Among the high-risk industries, 357 workplaces have had accidents at least once. Of these samples, which account for about 35% of the total number of accidents, foreign workers accounted for only about 0.05% of the accidents. Therefore, it can be said that the bias occurred due to the existence of a workplace with a very large number of accidents.

The reason the other corporate culture variables except for RPStress were not statistically significant is that the sample was set for only the companies where the accident

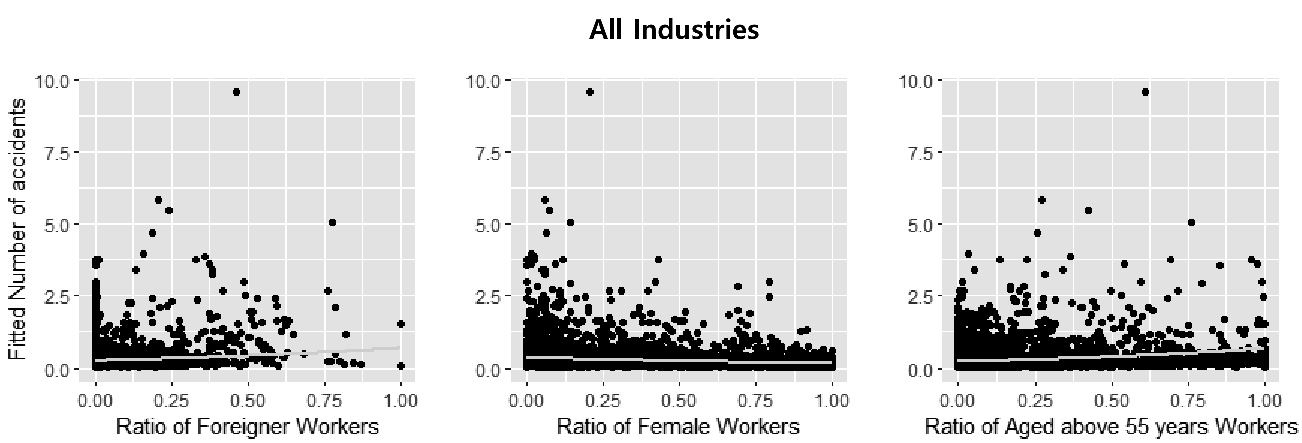

Fig. 2. Fitted value and regression curve according to worker's ratio of all industries.

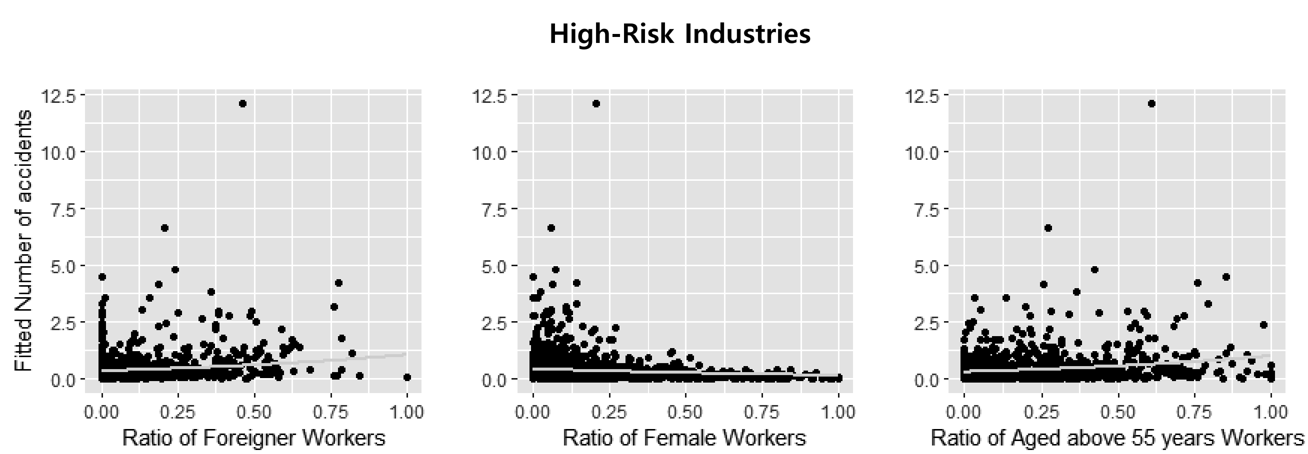

Fig. 3. Fitted value and regression curve according to worker's ratio of high-risk industries.

Table 9. Determinants of industrial accidents in high-risk industries

Variable	(1)	(2)	(3)
RatioW	**−1.0039*** ** (0.0071)	**−0.9625*** ** (0.3712)	−0.1440 (0.3628)
RatioF	**1.1823*** ** (0.4280)	**1.0897*** ** (0.4210)	**−0.9225*** ** (0.3151)
Ratio55y	**1.3270*** ** (0.3210)	**1.1465*** ** (0.3197)	**0.5367** ** (0.2733)
Union	−0.1138 (0.1489)	−0.0809 (0.1486)	**−0.3752*** ** (0.1259)
HSM	**−0.5530*** ** (0.1725)	**−0.3202* ** (0.1749)	**−0.4172*** ** (0.1558)
RMeeting		**−0.2615* ** (0.1349)	−0.1702 (0.1158)
RPStress		**−0.4661*** ** (0.1432)	**−0.3661*** ** (0.1252)
TChange		−0.1559 (0.1432)	−0.0096 (0.1287)
ASchedule		**−0.4245*** ** (0.1408)	−0.1844 (0.1164)
Intercept	**−5.6820*** ** (0.1845)	**−5.5186*** ** (0.2119)	**−3.6492*** ** (0.1944)

Standard errors are in the parentheses.
***p<0.01, ** p<0.05, * p<0.1

occurred, so the company where the accident occurred would not care about the corporate culture.

The Fig. 3 below shows the fitted number of assets according to the worker’s ratio based on the estimation result.

Discussion

The main purpose of this study was to analyze influencing factors for the occurrence of industrial accidents in high-risk industries. We used data on all industries and high-risk industries from the ninth wave of the Occupational Safety and Health Company Survey (2018) conducted by OSHRI. Qualitative variables were converted into dummy tables. In particular, we focused on the culture of the company, to examine whether the employee-friendly culture of a company and a caring working environment for workers affected the occurrence of industrial accidents. In addition, we used negative binomial regression, rather than for general linear regression methods, to analyze the data because of the properties of this study.

It is noteworthy that foreigners and elderly workers have a positive effect on the accident rate. Foreign workers are exposed to higher risk because they mainly engage in production jobs and work in high-risk fields. By contrast, the occurrence of accidents was lower among female workers because a relatively high proportion of them work in non-production fields such as support work rather than production fields.

In high-risk industries, foreign workers are thought to be vulnerable groups, and HSM organizations played a role in reducing the occurrence of industrial accidents in these industries. This suggests that the safety measures for foreign workers should be considered more carefully given the current situation of decreasing productive population and increasing proportion of foreign workers due to the aging and low birth rates in Korea.

All four independent variables on the corporate culture in this study showed inverse relationship with occurrence of industrial accidents. In high-risk industries, regular meetings between workers and their immediate supervisors (RMeeting), response procedure in case of work-related stress (RPStress), and measures taken for long hours of work or irregular schedules (ASchedule) were found to be statistically significant. All three variables can be regarded as variables that indicate the convenience of workers from the perception of workers. Therefore, convenience and liberal organizational culture provided to workers have an effect on reducing the occurrence of industrial accidents.

This study had some limitations. Owing to the nature of the Occupational Safety and Health Company Survey, errors may occur because of the characteristics of the respondents and in the qualitative variables as reflected in the model. Therefore, bias in estimating coefficients may occur. However, despite these limitations, this study quantified qualitative variables and reflected them in the model as much as possible.

Conclusion

Although limitations need to be considered carefully, the implication of our finding is that future measures by government to reduce the occurrence of industrial accidents should provide support for not only the external factors, such as supervising the safety of companies, but also changes to the internal culture of companies, including incentives. Attention should be paid particularly to worker characteristics and corporate internal components, from a micro perspective, beyond the macro perspective, in the process of developing policies, particularly in the high-risk industries.

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