Factor Analysis by Industry Impact of Workers Participation and Occupational Safety Health Communication on Safety Behavior

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ABSTRACT

Recently, although the government is strengthening laws about safety and regulations such as the enforcement of the Severe Accident Punishment Act, industrial accidents and safety-related accidents occur frequently, and LH incidents such as the absence of reinforcing bars during building construction are emerging. It tells us that the problem is still serious. There are many causes of industrial accidents, but the most fundamental reason is the unsafe behavior of workers. Therefore, to reduce industrial accidents, the first priority is to improve safety behaviors of workers. In this study, we suggest ways to promote workers safety behavior with the industrial safety and health research institute's industrial safety and health survey data and analyze the effect of workers' participation and communication on safety behavior by industry. The results of this study are meaningful in that they have analyzed workers' participation, occupational safety and health communication(OSH communication), and safety behavior together and presented measures to promote workers' safety behavior considering the characteristics of each industry. In the future, each workplace needs to make efforts to promote worker safety behavior and create a safe working environment by establishing an occupational safety and health communication system suitable for workers' participation and industrial characteristics.

Keywords**: *industrial accident, safety behavior, workers participation, occupational safety and health communication, multiple regression analysis***

INTRODUCTION

Recently, serious industrial accidents as we have known from the mass media frequently occur in domestic industrial sites. As a result, the public is showing a lot of interest in the issues related to safety and health and is paying attention to them. The government is making efforts to promote safety and health in various ways including the implementation of the Serious Accident Punishment Act, but the industrial accident rate has not significantly decreased.

According to the 'Industrial Accident Analysis 2021' by the Ministry of Employment and Labor, the number of workers who suffered industrial accidents requiring medical care for more than 4 days was 122,713, a 13.23% increase from 108,379 in the previous year. The number of deaths due to disasters also increased by 0.87% from 2,062 in the previous year to 2,080. The accident rate calculated by considering the number of injured and the number of workers also increased by 0.06 [17].

The causes of industrial accidents are very complex and there are various reasons. Heinrich, a great scholar in the field of safety management, said that 88% of industrial accidents are caused by unsafe behavior [10]. Therefore, in order to prevent industrial accidents, it is very important to reduce unsafe behaviors of workers and rather increase safety behaviors. Here, safety behavior refers to a series of behaviors that individuals perform for safety [19]. In other words, it means actions such as safely proceeding with work orders and always wearing safety equipment to prevent danger [23].

Until now, many studies have been conducted on safety behavior, workers' participation, and occupational safety and health communication(OSH communication), but there are only a few studies that analyze safety behavior, workers' participation, and OSH communication together. Here, workers' participation refers to discussions and proposal activities conducted by workers at places of communication such as meetings, and OSH communication refers to the exchange of information related to occupational safety and health between organizations and individuals [1-3,11].

In this study, the impact of workers participation and communication on safety behavior by industry, company size, revenue(construction cost), non-regular worker employment rate, and safety and health organization composition and safety and health survey data using 'Occupational Safety and Health Survey Data' from the OSHRI(Occupational Safety and Health Research Institute) By analyzing each organizational structure, we intend to present guidelines for promoting safety behavior.

LITERATURE REVIEW

Research on Safety Behavior

First of all, domestic and international studies related to safety behavior are as follows. Lee & Cho have proposed that the greater the number of dangerous machines and instruments, the lower the safety behavior, and consequently, the higher the risk of industrial accidents [12]. Lim et al. examined the levels of psychological trauma, mental health, and safety-related freaks among manufacturing workers who had experienced a serious accident, and found that a serious accident had a psychological impact on workers, which adversely affects safety-related variables. said to go insane and cause another accident [16].

Moon at al. has suggested that safety leadership affects safety behavior and safety atmosphere and has a greater effect on participation behavior than compliance behavior [18]. Song at al. said that safety culture has a positive effect on safety awareness and safety behavior of manufacturing workers, and that safety awareness shows a partial mediating effect in the relationship between safety culture and safety behavior [19].

Gao et al. showed that conscientiousness had the strongest correlation with workers' safety behavior in the Big Five personality traits of construction workers, followed by extraversion, agreeableness, and neuroticism [6]. In addition, agreeableness and conscientiousness showed positive correlations with workers' safety behaviors, and extraversion and neuroticism showed negative correlations with workers' safety behaviors. Grocutt et al. analyzed the effects of three safety support elements (senior manager, direct supervisor, and colleague) on workers' injuries and safety behavior [8]. It was shown that it played a role in predicting the decrease in injury and the increase in the frequency of safety behavior.

He et al. analyzed the relationship between the four dimensions of PsyCap(self-efficacy, hope, resilience, optimism) and safety behavior(safety compliance, safety participation) and the mediating role of communication ability [9]. As a result, self-efficacy had a positive effect on safety compliance and safety participation, resilience had a positive effect on safety participation, but hope was not directly related to safety behavior, optimism had a negative effect on safety participation, and communication ability had a negative effect on PsyCap's hope. and found to mediate the relationship between optimism and safety participation.

Research on Workers Participation

Domestic and international studies on workers participation are as follows.

Yi et al. have investigated that workers participation and communication have a greater effect on reducing the incidence of industrial accidents than industrial accident prevention activities [24]. Park & Na said that the higher the workers participation, the lower the industrial accident rate [20]. Lee et al. stated that among safety and health enhancement factors in the construction industry, including securing employer commitment to safety and health, government policy support and regulatory improvements, and compliance with worker safety and health regulations, worker engagement in safety and health activities has the highest impact on safety and health improvement [13]. In the study by Cooney, various perspectives on the transition of youth with disabilities were explored, incorporating the voices of young adults, parents, and professionals [5]. The research highlighted the diverse experiences and challenges faced by these groups, providing valuable insights into the transition process and the support systems needed to facilitate successful outcomes.

Renner, have explored that workers participation is the key to accident prevention, and that maximum accident prevention can only be achieved through maximum workers participation [21]. He also argued that hierarchical structures and the internalization of workers' hierarchies in most workplaces prevent full participation by workers. Geldart et al. indicated that collaboration between workers and management through Joint Health and Safety Committees (JHSC) plays a significant role in creating and maintaining a safe and healthy workplace, and workplaces with active workers' participation in JHSC exhibited lower injury rates [7].

Research on Occupational Safety and Health Communication

Domestic and international studies on OSH communication are as follows.

Seo et al. highlighted that communication regarding workplace safety is the most critical factor in shaping

safety consciousness [22]. In this context, safety consciousness refers to safety knowledge and attitude towards compliance with procedures, underscoring the importance of communication. Lee & Kim stated that communication has a positive impact on the safety climate and a negative impact on the frequency of industrial accidents [14]. Lee et al. asserted that communication has a positive influence on safety participation and compliance, and a negative impact on the frequency of industrial accidents [15]. They further indicated that effective communication contributes to a reduction in industrial accidents.
Zhang et al. emphasized that the safety communication of supervisors plays a crucial role in shaping the safety climate within work teams and influences workers' safety compliance and participation behavior [25]. Cigularov et al. found that safety communication between construction site supervisors and workers, along with the Error Management Climate (EMC) of construction firms, impacts work-related pain but not work-related injuries [4]. Based on a review of the aforementioned prior research, it is evident that workers' participation and industrial safety and health communication are vital factors concerning industrial accidents and safety. Additionally, research on safety climate and culture related to safety behavior, as well as studies concerning workers' participation and industrial safety and health communication in relation to industrial accidents and safety, has been extensively conducted. However, studies that simultaneously consider safety behavior, workers' participation, and industrial safety and health communication are scarce [26-30].

RESEARCH METHODOLOGY

This study aims to investigate the impact of workers participation and industrial safety and health communication on safety behavior. The data will be categorized by industry, and further analyzed by company size, revenue (construction cost), proportion of non-regular employment, and safety and health organization composition.
The reason for dividing this study by industry is because different industries have varying working environments, and the degree of accident risk also differs. Therefore, by categorizing the data by industry, the study aims to identify variables that have a positive impact on safety behavior while accounting for these industry-specific differences in work environments and accident risks.

Variable Selection

As shown in Table 1, there are seven independent variables for workers participation: regular meetings between workers and superior(W1), regular meetings of all workers(W2), ad-hoc meetings(W3), information dissemination(W4), online discussion(W5), proposal system(W6), and worker survey(W7). OSH communication consists of three variables: communication between headquarters and branches(O1), communication between safety and health departments and employees(O2), communication between employees(O3) was established. The dependent variable, safety behavior, consisted of four items: safety performance, safety device, safety procedure, and safety state.

Table 1: Independent Variable Description

variable		contents
workers participation	W1	Regular meetings between workers and superior
	W2	Regular meetings of all workers
	W3	Ad hoc meetings
	W4	Information dissemination (newsletter, website, etc.)
	W5	Online discussion (social media discussions and online discussions)
	W6	Proposal system
	W7	Worker survey
occupational safety and health communication	O1	Communication between headquarters and branch offices
	O2	Communication between safety and health department and employees
	O3	Communication between employees

Hypothesis Setting

As shown in Figure 1, the research model was set up to identify the effects of workers' participation and OSH communication on safety behavior for each industry.

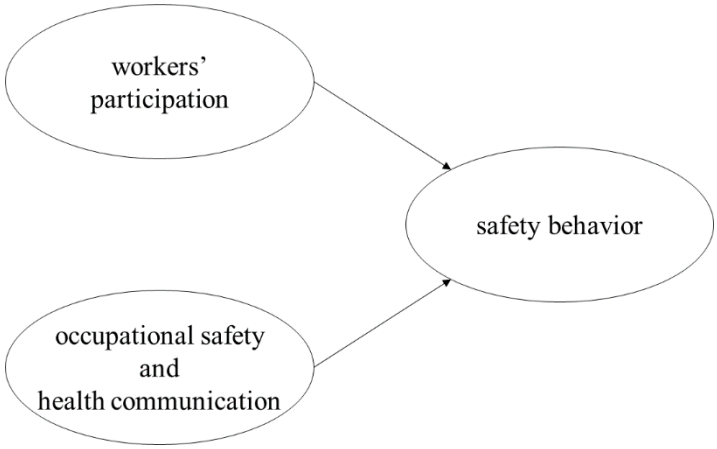

Fig. 1: Research Model

In addition, the hypotheses assumed in this study were set as follows by industry, company size, revenue(construction amount), non-regular employment rate, and safety and health organization composition.
H1-10: *Regular meeting between workers and supervisor will not affect safety behavior.*
H1-11: *Regular meeting between workers and supervisor will affect safety behavior.*
H1-20: *Regular meetings of all workers will not affect safety behavior.*
H1-21: *Regular meetings of all workers will affect safety behavior.*
H1-30: *Ad hoc meetings will not affect safety behavior.*
H1-31: *Ad hoc meetings will affect safety behavior.*
H1-40: *Information dissemination will not affect safety behavior.*
H1-41: *Information dissemination will affect safety behavior.*
H1-50: *Online discussion will not affect safety behavior.*
H1-51: *Online discussion will affect safety behavior.*
H1-60: *Proposal system will not affect safety behavior.*
H1-61: *Proposal system will affect safety behavior.*
H1-70: *Worker survey will not affect safety behavior.*
H1-71: *Worker survey will affect safety behavior.*
H2-10: *Communication between headquarters and branch offices will not affect safety behavior.*
H2-11: *Communication between headquarters and branch offices will affect safety behavior.*
H2-20: *Communication between safety and health department and employees will not affect safety behavior.*
H2-21: *Communication between safety and health department and employees will affect safety behavior.*
H2-30: *Communication between employees will not affect safety behavior.*
H2-31: *Communication between employees will affect safety behavior.*

Research Subject

Data from the 9th 'Occupational Safety and Health Survey(2018)' conducted by the OSHRI under the Korea Occupational Safety and Health Agency(KOSHA) targeting safety and health managers or operators in 5,000 workplaces in 17 cities and provinces nationwide. Used of the total 5,219 data, 4,071 data were used with 1,148 missing values removed. Among the dependent variables and independent variables, the survey was conducted using a Likert 5-point scale for communication, and among the independent variables, workers' participation was composed of binary variables and the survey was conducted.
Table 2 shows the structure and distribution of data. It is divided into five categories by industry, company size, revenue(construction cost), non-regular employment rate, and safety and health organization composition.

Research Methodology

The data will be segmented by industry(manufacturing, other industries, construction industry) and further disaggregated by company size, revenue(construction cost), non-regular employment rate, safety and health organizations composition. The statistical package SPSS 25 will be utilized to quantitatively analyze the impact of workers' participation and industrial safety and health communication on safety behavior.
For reference, the category 'Other Industries' within the industry classification includes comprehensive management of buildings, hygiene and similar services, various other businesses, health and social welfare activities, educational services, wholesale and retail trade, repair of consumer goods, and business support

services.

Table 2: data descriptive statistics

*m.v: missing value					
industry			**contents**	**data(%)**	**total(m.v)**
Manufacturing(total)			over 50 people (factory, production line)	1,501(37%)	4,071 (1,148)
Other industries(total)			over 50 people	1,542(38%)	
Construction industry(total)			over 12 billion KRW (construction site in progress)	1,028(25%)	
Company size (1~2)	Manufacturing	M1	over 50 people ~ Less than 100 people	860(57%)	1,501(0)
		M2	over 100 people	641(43%)	
	Other industries	I1	over 50 people ~ Less than 100 people	907(59%)	1,542(0)
		I2	over 100 people	635(41%)	
Revenue (Construction cost) (3~5)	Manufacturing	M3	less than 10 billion KRW	365(24%)	1,500(1)
		M4	over 10 billion KRW ~ less than 50 billion KRW	610(41%)	
		M5	over 50 billion KRW	525(35%)	
	Other industries	I3	less than 5 billion KRW	728(47%)	1,540(2)
		I4	over 5 billion KRW	812(53%)	
	Construction industry	C3	over 12 billion KRW ~ less than 50 billion KRW	492(48%)	1,028(0)
		C4	over 50 billion KRW	536(52%)	
Non-regular employment rate (6~7)	Manufacturing	M6	0%	1,129(75%)	1,501(0)
		M7	over 0%	372(25%)	
	Other industries	I6	0%	869(56%)	1,542(0)
		I7	over 0%	673(44%)	
	Construction industry	C6	less than 75%	440(45%)	984(44)
		C7	over 75%	544(55%)	
safety and health organization (8~9)	Manufacturing	M8	organization	1,227(82%)	1,501(0)
		M9	no organization	274(18%)	
	Other industries	I8	organization	1,041(68%)	1,542(0)
		I9	no organization	501(32%)	
	Construction industry	C8	organization	980(95%)	1,028(0)
		C9	no organization	48(5%)	

RESEARCH RESULT

Statistical Analysis Result

In order to verify the impact of workers participation and industrial safety and health communication on safety behavior, a multiple regression analysis was conducted using SPSS 25. Table 3 represents the results of the multiple regression analysis, displaying only the significant variables.

The explanatory power of the regression models was approximately 22%, 18.5%, and 20.4% respectively. Additionally, the Durbin-Watson statistics were approximately 1.727, 1.800, and 1.733 respectively, which are close to 2. This indicates that there is no violation of the assumption of independence of residuals. Moreover, the Variance Inflation Factor(VIF) values were all below 10, suggesting the absence of multicollinearity issues.

Table 3: Multiple linear regression analysis results: industry

industry	**variable**	**B**	**Std. E**	**Beta**	**t**	**p**	**VIF**	**model**
Manu-facturing	w2	0.155	0.030	0.120	5.142	0.000	1.047	F=42.105($p<0.001$) R^2= 0.220 Adj R^2= 0.215 D.W= 1.727
	w6	0.091	0.029	0.075	3.136	0.002	1.104	
	o1	0.093	0.025	0.122	3.659	0.000	2.142	
	o2	0.104	0.031	0.131	3.334	0.001	2.935	
	o3	0.170	0.032	0.195	5.257	0.000	2.640	

Other industries	w1	0.146	0.033	0.108	4.459	0.000	1.094	F=34.666(p<0.001) R^2= 0.185 Adj R^2= 0.179 D.W= 1.800
	w2	0.074	0.030	0.058	2.427	0.015	1.073	
	w6	0.068	0.034	0.050	2.004	0.045	1.171	
	o2	0.131	0.034	0.179	3.846	0.000	4.060	
	o3	0.106	0.032	0.130	3.346	0.001	2.855	
Construction industry	w1	0.151	0.044	0.097	3.431	0.001	1.028	F=25.994(p<0.001) R^2= 0.204 Adj R^2= 0.196 D.W= 1.733
	w2	0.110	0.042	0.075	2.628	0.009	1.051	
	o1	0.141	0.037	0.161	3.834	0.000	2.248	
	o3	0.237	0.039	0.246	6.057	0.000	2.103	

In the manufacturing, among workers participation factors, regular meetings of all workers(w2) and proposal system(w6) had the highest positive impact on safety behavior. Regarding OSH communication, communication between employees(o3), communication between safety and health department and employees(o2), and communication between headquarters and branch offices(o1) had a positive influence on safety behavior.

In other industries, the most influential workers participation factors were regular meetings between workers and superior(w1), regular meetings of all workers(w2), and proposal system(w6). Concerning OSH communication, communication between safety and health department and employees(o2) and communication between employees(o3) had a significant positive impact on safety behavior.

In the construction industry, regular meetings between workers and superior(w1) and regular meetings of all workers(w2) were the most influential workers' participation factors. As for OSH communication, communication between employees(o3) and communication between headquarters and branch offices(o1) had the highest positive impact on safety behavior.

In the manufacturing industry, the dominant workers participation factor was regular meetings of all workers(w2). In other industries and the construction industry, regular meetings between workers and superior(w1) had the highest impact. In terms of communication, communication between employees(o3) was the most influential in manufacturing and construction, while communication between safety and health department and employees(o2) had the greatest impact in other industries.

Table 4 presents the results of the multiple regression analysis by company size, and the statistical analysis results were found to be significant. The explanatory power of the regression models was approximately 18.6%, 28.6%, 17.5%, and 21% respectively. The Durbin-Watson statistics were approximately 1.700, 1.829, 1.832, and 1.899 respectively, indicating no issues with the assumption of independence of residuals. Additionally, all VIF values were below 10, suggesting the absence of multicollinearity problems.

Table 4: Multiple linear regression analysis results: company size

C	variable	B	Std. E	Beta	t	p	VIF	F	R^2	AdjR^2	D.W
M1	w2	0.138	0.039	0.113	3.567	0.000	1.048	19.396 (p<0.001)	0.186	0.176	1.700
	w6	0.157	0.038	0.131	4.099	0.000	1.058				
	o1	0.127	0.035	0.166	3.633	0.000	2.171				
	o3	0.128	0.043	0.149	2.966	0.003	2.620				
M2	w2	0.151	0.049	0.108	3.093	0.002	1.077	25.245 (p<0.001)	0.286	0.275	1.829
	w3	0.131	0.058	0.079	2.267	0.024	1.062				
	o2	0.161	0.046	0.202	3.492	0.001	2.958				
	o3	0.216	0.049	0.244	4.407	0.000	2.708				
I1	w1	0.123	0.041	0.095	3.017	0.003	1.082	19.039 (p<0.001)	0.175	0.166	1.832
	w2	0.096	0.038	0.079	2.492	0.013	1.089				
	o2	0.186	0.044	0.259	4.248	0.000	4.026				
I2	w1	0.188	0.055	0.129	3.425	0.001	1.121	16.613 (p<0.001)	0.210	0.198	1.899
	w5	0.206	0.075	0.104	2.745	0.006	1.127				
	w6	0.107	0.053	0.079	2.037	0.042	1.179				
	o3	0.165	0.050	0.198	3.296	0.001	2.846				

From the perspective of workers participation, for manufacturing industries with less than 100 employees(M1), the proposal system(w6) was found to be effective. On the other hand, for manufacturing industries with 100 or more employees(M2), communication between headquarter and branch offices(w2) was effective. In all other industries(I1, I2), regular meetings between workers and superior(w1) were effective.

Regarding OSH communication, for manufacturing industries with less than 100 employees(M1), communication between headquarters and branch offices(o1) was effective. Conversely, for manufacturing industries with 100 or more employees(M2), communication between employees(o3) was effective. In other industries with less than 100 employees(I1), communication between safety and health department and employees(o2) was effective. For other industries with 100 or more employees(I2), communication between employees(o3) was effective.

Table 5 presents the results of the multiple regression analysis by revenue (construction cost), and the statistical analysis results were found to be significant. The explanatory power of the regression models was approximately 18.6%, 17.2%, 34.2%, 18.3%, 19.8%, 24%, and 19.2% respectively. The Durbin-Watson statistics were approximately 1.782, 1.768, 1.841, 1.818, 1.990, 1.737, and 1.795 respectively, indicating no issues with the assumption of independence of residuals. Additionally, all VIF values were below 10, suggesting the absence of multicollinearity problems.

Table 5: Multiple linear regression analysis results: revenue(construction cost)

	variable	B	Std. E	Beta	t	p	VIF	F	R^2	AdjR^2	D.W
M3	w2	0.136	0.059	0.115	2.300	0.022	1.094	8.069 (p<0.001)	0.186	0.163	1.782
	w6	0.191	0.062	0.155	3.100	0.002	1.087				
	o1	0.101	0.051	0.132	1.991	0.047	1.920				
M4	w6	0.130	0.044	0.113	2.944	0.003	1.068	12.418 (p<0.001)	0.172	0.158	1.768
	o1	0.091	0.043	0.124	2.132	0.033	2.430				
	o2	0.126	0.053	0.161	2.384	0.017	3.316				
M5	w2	0.285	0.055	0.194	5.178	0.000	1.093	26.717 (p<0.001)	0.342	0.329	1.841
	o2	0.140	0.048	0.168	2.902	0.004	2.614				
	o3	0.271	0.054	0.290	4.999	0.000	2.629				
I3	w1	0.108	0.046	0.083	2.350	0.019	1.096	16.076 (p<0.001)	0.183	0.172	1.818
	w2	0.094	0.043	0.076	2.184	0.029	1.064				
	w3	0.162	0.071	0.080	2.283	0.023	1.091				
	o2	0.150	0.050	0.209	3.022	0.003	4.215				
I4	w1	0.174	0.047	0.122	3.689	0.000	1.100	19.822 (p<0.001)	0.198	0.188	1.990
	o2	0.106	0.048	0.140	2.207	0.028	4.031				
	o3	0.168	0.047	0.202	3.608	0.000	3.137				
C3	w1	0.150	0.062	0.098	2.410	0.016	1.041	15.228 (p<0.001)	0.240	0.225	1.737
	w2	0.179	0.059	0.125	3.047	0.002	1.067				
	w6	0.168	0.066	0.108	2.554	0.011	1.141				
	o1	0.132	0.049	0.161	2.714	0.007	2.242				
	o3	0.156	0.056	0.165	2.778	0.006	2.240				
C4	w1	0.129	0.063	0.083	2.063	0.040	1.044	12.479 (p<0.001)	0.192	0.177	1.795
	o1	0.162	0.056	0.170	2.887	0.004	2.258				
	o3	0.307	0.055	0.311	5.590	0.000	2.015				

From the perspective of workers participation, for manufacturing industries with less than 50 billion KRW(M3, M4), the proposal system(w6) was found to be effective. On the other hand, for manufacturing industries with 50 billion KRW or more(M5), regular meetings of all workers(w2) were effective. In all other industries(I3, I4), regular meetings between workers and superior(w1) were effective. Among construction industries with revenues between 12 billion KRW and 50 billion KRW(C3), general regular meetings of all workers(w2) were effective. For construction industries with revenues of 50 billion KRW or more(C4), meetings between workers and superior(w1) were effective.

Regarding OSH communication, for manufacturing industries with less than 10 billion KRW(M3), communication between headquarters and branch offices(o1) was effective. For manufacturing industries with 10 billion KRW to 50 billion KRW(M4), communication between safety and health department and employees(o2) was effective. However, for M5, communication between employees(o3) was effective. For industries with less than 5 billion KRW(I3), communication between safety and health department and employees(o2) was effective. For industries with 5 billion KRW or more(I4), communication between employees(o3) was effective. In the construction industry, communication between employees(o3) was

effective across all cases.

Table 6 presents the results of the multiple regression analysis by non-regular employment rate, and the statistical analysis results were found to be significant. The explanatory power of the regression models was approximately 22.4%, 28%, 20.1%, 18.6%, 18.1%, and 25.7% respectively. The Durbin-Watson statistics were approximately 1.708, 2.047, 1.798, 1.955, 1.771, and 1.786 respectively, indicating no issues with the assumption of independence of residuals. Additionally, all VIF values were below 10, suggesting the absence of multicollinearity problems.

Table 6: Multiple linear regression analysis results: mon-regular employment rate

E	variable	B	Std. E	Beta	t	p	VIF	F	R^2	AdjR^2	D.W
M6	w2	0.134	0.035	0.104	3.852	0.000	1.059	32.184 (p<0.001)	0.224	0.217	1.708
	w3	0.100	0.045	0.059	2.202	0.028	1.038				
	w4	0.093	0.035	0.073	2.618	0.009	1.106				
	w6	0.130	0.033	0.107	3.881	0.000	1.090				
	o1	0.135	0.031	0.176	4.436	0.000	2.262				
	o3	0.143	0.038	0.161	3.757	0.000	2.644				
M7	w2	0.211	0.060	0.161	3.503	0.001	1.058	14.026 (p<0.001)	0.280	0.260	2.047
	w4	-0.144	0.059	-0.118	-2.459	0.014	1.147				
	o2	0.187	0.057	0.248	3.299	0.001	2.833				
	o3	0.219	0.061	0.265	3.611	0.000	2.698				
I6	w1	0.103	0.044	0.076	2.367	0.018	1.107	21.532 (p<0.001)	0.201	0.191	1.798
	w2	0.096	0.040	0.075	2.379	0.018	1.075				
	w7	0.110	0.051	0.069	2.160	0.031	1.105				
	o1	0.109	0.038	0.148	2.883	0.004	2.824				
	o2	0.126	0.046	0.163	2.736	0.006	3.801				
I7	w1	0.195	0.050	0.144	3.918	0.000	1.098	15.168 (p<0.001)	0.186	0.174	1.955
	o2	0.129	0.051	0.187	2.533	0.012	4.410				
	o3	0.154	0.048	0.202	3.194	0.001	3.256				
C6	o1	0.187	0.053	0.239	3.521	0.000	2.414	9.484 (p<0.001)	0.181	0.162	1.771
	o3	0.158	0.061	0.169	2.601	0.010	2.201				
C7	w1	0.187	0.063	0.114	2.980	0.003	1.051	18.443 (p<0.001)	0.257	0.243	1.786
	o3	0.299	0.054	0.292	5.483	0.000	2.029				

From the perspective of workers participation, for manufacturing industries without non-regular employment(M6), proposal system(w6) was found to be effective. On the other hand, for manufacturing industries with non-regular employment(M7), general regular meetings of all workers(w2) were effective. In all other industries (I6, I7), regular meetings between workers and superior(w1) were effective. For construction industries with non-regular employment rate below 75%(C6), workers participation did not show significant effects. However, for construction industries with non-regular employment rate of 75% or higher(C7), regular meetings between workers and superior(w1) were effective.

Regarding OSH communication, for M6, communication between headquarters and branch offices(o1) was effective. For M7, communication between employees(o3) was effective. In industries without non-regular employment(I6), communication between safety and health department and employees(o2) was effective. For industries with non-regular employment(I7), communication between employees(o3) was effective. For C6, communication between headquarters and branch offices(o1) was effective, while for C7, communication between employees(o3) was effective.

Table 7 presents the results of the multiple regression analysis by safety and health organization structure, and the statistical analysis results were found to be significant in all cases except for C9. The explanatory power of the regression models was approximately 21%, 23.4%, 18.7%, 15.7%, and 21.5% respectively. The Durbin-Watson statistics were approximately 1.689, 1.997, 1.816, 1.915, and 1.715 respectively, indicating no issues with the assumption of independence of residuals. Additionally, all VIF values were below 10, suggesting the absence of multicollinearity problems.

Table 7: Multiple linear regression analysis results: safety and health organization composition

O	variable	B	Std. E	Beta	t	p	VIF	F	R^2	AdjR^2	D.W
M8	w2	0.153	0.033	0.122	4.663	0.000	1.050	32.235 (p<0.001)	0.210	0.203	1.689
	w6	0.104	0.032	0.087	3.230	0.001	1.125				
	o1	0.095	0.028	0.123	3.424	0.001	1.978				
	o2	0.120	0.034	0.148	3.549	0.000	2.661				
	o3	0.151	0.035	0.170	4.277	0.000	2.430				
M9	w2	0.158	0.077	0.114	2.039	0.042	1.076	8.050 (p<0.001)	0.234	0.205	1.997
	w7	0.259	0.089	0.160	2.916	0.004	1.040				
	o3	0.259	0.083	0.312	3.116	0.002	3.436				
I8	w1	0.131	0.041	0.094	3.226	0.001	1.072	23.726 (p<0.001)	0.187	0.179	1.816
	w6	0.084	0.037	0.068	2.250	0.025	1.153				
	o1	0.072	0.031	0.103	2.331	0.020	2.472				
	o2	0.121	0.039	0.162	3.104	0.002	3.436				
	o3	0.107	0.037	0.130	2.939	0.003	2.478				
I9	w1	0.161	0.058	0.122	2.789	0.005	1.110	9.136 (p<0.001)	0.157	0.140	1.915
	o2	0.163	0.069	0.216	2.373	0.018	4.807				
C8	w1	0.139	0.045	0.090	3.128	0.002	1.025	26.474 (p<0.001)	0.215	0.206	1.715
	w2	0.109	0.042	0.075	2.574	0.010	1.048				
	o1	0.128	0.037	0.146	3.421	0.001	2.244				
	o3	0.266	0.039	0.276	6.756	0.000	2.058				
C9	non-significant variables										

From the perspective of workers participation, for manufacturing industries with safety and health organizations (M8), regular meetings of all workers (w2) were effective. On the other hand, for manufacturing industries without safety and health organizations (M9), worker survey (w7) was effective. In all other industries (I8, I9), regular meetings between workers and superior (w1) were effective. For construction industries with safety and health organizations (C8), regular meetings between workers and superior (w1) were effective, while for construction industries without safety and health organizations (C9), the effect of workers participation was not observed.

Regarding OSH communication, for M8 and M9, communication between employees (o3) was effective. For I8 and I9, communication between safety and health department and employees (o2) was effective. For C8, communication between employees (o3) was effective, while for C9, the effect of OSH communication was not observed.

Table 8 presents a summary of the analysis results to determine the order of influence in the manufacturing industry. From the workers' participation perspective in manufacturing industries, the effects of regular meetings of all workers (w2) was observed. From the perspective of OSH communication, communication between employees (o3) was effective. Interestingly, for M7, there was a negative effect observed for the information dissemination(w4).

Table 8: Variable influence: Manufacturing

var.	industry	company size		revenue			employment		organization	
	M	M1	M2	M3	M4	M5	M6	M7	M8	M9
w1										
w2	**1**	**2**	**1**	**2**		**1**	**2**	**1**	**1**	**2**
w3			2				4			
w4							3	**-1**		
w5										
w6	2	1		1	1		1		2	
w7										1
o1	3	1		1	2		1		3	
o2	2		2		1	2		2	2	
o3	**1**	**2**	**1**			**1**	**2**	**1**	**1**	**1**

Table 9 presents the order of influence in the other industries. In the aspect of workers' participation in other industries, regular meetings between workers and superior(w1) showed an effect, and in the aspect of OSH communication, communication between the safety and health department and employees(o2) demonstrated an effect.

Table 9: Variable influence: Other industries

var.	industry	company size		revenue			employment		organization	
	I	I1	I2	I3	I4	-	I6	I7	I8	I9
w1	**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**
w2	2	2		3			2			
w3				2						
w4										
w5			2							
w6	3		3						2	
w7							3			
o1							2		3	
o2	**1**	**1**		**1**	**2**		**1**	**2**	**1**	**1**
o3	2		1		1			1	2	

Table 10 illustrates the order of influence in the construction industry. In terms of workers' participation in the construction industry, regular meetings between workers and superior(w1) showed an effect, and in the aspect of OSH communication, communication between the safety and health department and employees(o2) demonstrated an effect.

Table 10: Variable influence: Construction industry

var.	industry	company size		construction cost			employment		organization	
	C	-	-	C3	C4	-	C6	C7	C8	C9
w1	**1**			**3**	**1**			**1**	**1**	
w2	2			1					2	
w3										
w4										
w5										
w6				2						
w7										
o1	2			2	2		1		2	
o2										
o3	**1**			**1**	**1**		**2**	**1**	**1**	

CONCLUSION

With recently increasing the number of fatalities and injuries due to industrial accidents, there has been a growing interest in safety and health. Regulations related to safety have also been strengthened. Consequently, numerous studies on safety have been conducted. Previous research has highlighted the significance of workers participation and OSH communication as crucial factors in industrial accidents and safety. Furthermore, safety behaviors have been identified as effective preventive measures against industrial accidents. However, there has been a lack of direct research examining the relationship between workers participation, OSH communication, and safety behavior.

In this study, we have investigated the relationship between safety behavior, workers participation, and OSH communication, and to statistically analyze their effects. The entire dataset was categorized into five groups based on industry, company size, revenue(construction cost), non-regular employees rate, and safety and health organization composition. This allowed for a multifaceted analysis of the influence of these factors on safety behavior in different industries.

Key findings from this study show that the methods of workers participation and communication that positively impact safety behaviors differ among industries. These findings can be summarized as follows:

First, in the manufacturing industry, to enhance safety behaviors among workers, it is important to actively promote worker regular meetings of all employees and encourage the implementation of proposal system. Additionally, continuous communication related to industrial safety and health between employees, between the safety and health department and employees, and between headquarters and branch offices is essential.

Secondly, in other industries, activating regular meetings between workers and superior, involving all workers, and promoting proposal systems are crucial steps. Facilitating effective communication between the safety and

health department and employees, as well as between employees, is also important.
Thirdly, in the construction industry, consistent organization of regular meetings between workers and superior and meetings involving all workers is necessary. Furthermore, the emphasis should be placed on fostering smooth communication between employees and between headquarters and branch offices.
These findings suggest significant insights by analyzing workers participation, occupational safety and health communication, and safety behaviors concurrently, tailored to the characteristics of different industries. Future research should delve deeper with more comprehensive analysis, considering group differences and utilizing more recent data.

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