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Relationship between Risk-causing Factors Perceived by Telecommunications Workers and Safety Motivation and Behavior

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Abstract

In this study, the structural relationship among risk factors, safety motivation, and safety behavior perceived by telecommunications workers was empirically verified. A survey was conducted on field workers at S telecommunications companies in Korea, and the following major results were obtained. First, among the risk factors perceived by telecommunications workers, personal, cultural, and institutional factors were found to have significant positive effects on workers' safety motivation. Second, workers' safety motivation had a significant positive effect on safety behavior. Third, among the risk factors of telecommunications companies, personal, cultural, and institutional factors did not significantly affect workers' safety behavior. Fourth, all risk-causing factors perceived by workers, such as personal, cultural, and institutional factors, indirectly affected safety behavior through safety motivation. This study presents the importance of perceiving risk factors in the workplace to prevent and alleviate industrial accidents by examining the effects of risk-causing factors perceived by carrier workers on safety motivation and behavior.

Index Terms: Telecommunication workers, Perceived risk-causing factors, Safety motivation, Safety behavior

I. INTRODUCTION

A. Background and Purpose of Research

Risk factors at telecommunications worksites are characterized by the fact that most accidents are of a serious nature compared to other industries, such as general services, transportation, distribution, and manufacturing, causing not only human loss but also significant material loss [1]. Risk factors directly or indirectly contribute to various risks experienced by telecommunications field workers while performing their duties [2]. In previous studies, factors that jeopardize worker safety were simply defined as accident causes, and their concepts were limited to those that could be seen as having a direct causal relationship with accidents. For example, Moon and Kong (2020) [3] showed that accident-causing factors were limited to facility-related factors that could have a direct causal relationship with accidents. However, Hyun (2010) [2] suggested a more comprehensive approach that included both direct and indirect factors that can cause accidents, including personal experience and cultural or institutional factors that can cause judgment errors. In summary, risk factors can be broadly defined as encompassing both human and external factors that pose a risk to telecommunications workers. These risk factors can cause telecommunications workers to ignore safety procedures and engage in careless behavior during work, ultimately increasing the risk of accidents. In contrast, safety motivation refers to the motivational factor that drives individuals or organizations to recognize goals and values related to safety and strive to achieve

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them [4]. It plays an important role in preventing accidents, maintaining a safe working environment, and promoting healthy and safe behavioral habits, thereby contributing to the creation of a safe working environment and safety culture. Safety motivation is influenced by various factors, such as individual responsibility, teamwork, leadership, organizational culture, and education [5]; therefore, satisfying the motivational factors of telecommunications field workers can increase their safety behavior [6]. Previous studies have reported that safety motivation is a strong antecedent variable influencing safety behavior [7-9]; thus, it is important to satisfy safety motivation factors to raise the level of safety behavior of telecommunications field workers. However, the causes of serious telecommunications worksite accidents, such as industrial accidents and serious injuries, or deaths of workers at telecommunications worksites that continue to occur are lacking [1]. The vicious cycle of focusing only on post-accident cleanup and having the same accident occur again afterwards is repeated. Risk factors perceived by workers ultimately act as a cause of hindering job involvement and impairing job effectiveness; thus, solutions for these risk factors through empirical verification of their impact. Thus far, research on accidents at telecommunications work sites has been limited to surveys of accident status and conditions or proposals for accident prevention measures. There has been no empirical research on identifying risk factors for accident prevention and whether certain risk factors can positively influence psychological factors, such as safety motivation and actual safety-related behavior. Although Byun and Jung (2021) [1] examined the relationship between telecommunications safety management systems and safety behavior, they were limited to deriving risk factors at telecommunications worksites and examining the relationship between safety motivation and behavior. Therefore, it is meaningful to empirically analyze the impact of risk factors at telecommunications worksites on workers' safety motivation and safety behavior. The purpose of this study was to identify the level of risk factors, safety motivation, and safety behavior among telecommunications field workers and to empirically verify the relationship between telecommunications risk factors and workers' safety motivation and safety behavior. Through this, we aim to derive risk factors that should precede the prevention of accidents at telecommunications worksites and provide suggestions for improving workers' compliance with safety. The specific research objectives are as follows: First, we verify the impact of risk factors perceived by telecommunications field workers on safety motivation. Second, we verify the impact of the safety motivation of telecommunications field workers on safety behavior. Third, we verify the impact of the risk factors perceived by telecommunications field workers on their safety behavior. Fourth, we verify the mediating effect of safety motivation on the relationship between the risk factors perceived by telecommunications field workers and their safety behavior.

II. THEORETICAL BACKGROUND

A. Risk-causing Factors

Risk at work sites can be defined in various ways, such as perspective, attitude, and experience, and can be measured as the likelihood, intensity, and exposure of all disasters in a particular activity, or as a combination of the likelihood and risk size of a particular event, or as a whole process of predicting risk size and determining risk tolerance for risk assessment [10-12]. Risk can affect all activities in the telecommunications business. The definition of risk factors at telecommunications worksites is easy to understand, but its detailed definition is vague, and it is very difficult to evaluate or measure. Therefore, the risk factors distinguished by previous research also vary depending on the researcher's perspective. Eun (2017) [13] presented six factors such as work management, machine management, site conditions, work environment, safety management, and human management as safety accident risk factors. Hyun (2010) [2] presented risk factors within the framework of institutional, cultural, and personal experiences. Institutional factors include education and work environment; cultural factors include culture related to performance and culture related to consideration; and personal accident experience includes accidents related to oneself and colleagues as well as accidents related to other organizational members and other general victims. These negatively perceived risk factors hinder workers' involvement and impair job effectiveness [14]. Therefore, solutions for these risk factors must be devised through empirical verification of their impact.

B. Safety Motivation

Campbell, McCloy, Oppler and Sager (1993) [15] explained through performance theory that motivation acts as a determinant of behavior, determining the direction and magnitude of behavior and its duration, and that behavior depends on motivational characteristics. In the field of safety, safety motivation directly influences compliance and participation behaviors as determinants of safe behavior [16], and antecedents such as perceived risk can influence safe behavior through the mediation of safety motivation [17,18]. Workers' safety motivation refers to the motivational factors that make individuals aware of and strive to achieve safety-related goals and values. It plays an important role in preventing accidents, maintaining a safe working environment, and promoting healthy and safe behaviors [7]. Previous studies have shown that safety motivation regulates the relationship

between organizational climate and job behavior [19] and is a predictor of safe behavior [7,20,21]. Workers' safety motivation is influenced by various factors, such as safety education, teamwork, leadership, and organizational culture and contributes to creating a safe working environment and safety culture [18]. In addition, the higher the safety motivation, the lower the accident rate, and thus, the overall performance of the organization can be improved. Therefore, safety motivation is a very important factor in the field of safety.

C. Safety Behavior

In industrial sites, safety refers to a state without the risk of accidents or disasters, that is, a state in which defects are absent so that a safer state can be reached. Safety is particularly related to work processes performed at work sites and is defined as the behavior performed by workers to secure and maintain safety throughout work [22]. Neal & Griffin (2006) [7] argued that safety culture is closely related to safety behavior and can prevent or reduce accidents. They also stated that safety values affect safety behaviors and the safe atmosphere at worksites. In other words, safety values and the atmosphere are efforts for safety behavior and can ultimately bring about safety behavior. In addition, Xia et al. (2017) [14] confirmed in their study on workers' risk perception and safety behavior that emotional risk perception has a greater impact than rational risk calculation and suggested new ways to improve safety behavior. These results suggest that safety culture, safety values, worksite atmosphere, and workers' risk perceptions are closely related to safety behavior. Therefore, if the values and atmosphere of safety are strengthened, workers will make more efforts toward safety behavior, which can ultimately create a safe working environment and prevent or reduce accidents. Additionally, because emotional risk perception has been shown to have a greater impact than rational risk calculation, it is necessary to explore new ways to consider this.

III. RESEARCH DESIGN

A. Survey Subjects and Survey

In this study, telecommunications field workers were selected as the sample group, and 300 questionnaires were distributed for approximately four weeks, from the first week to the fourth week of January 2021. Of these, 196 valid survey responses, after excluding questionnaires with missing responses for some items, were used in the final statistical analysis. During the survey, sufficient explanation and consent were obtained from the survey subjects, who were asked to fill out the self-administered questionnaire. The survey contents are presented in Table 1.

Table 1. Outlines of the investigation

Investigation period	From the first week of January 2021 to the fourth week of January 2021 (4 weeks)
Population	Workers at national telecommunications construction sites
Sample group	205 workers (A communication company) - 71 supervisors, 104 field workers, and 30 safety managers
Analysis	Out of 300 copies, 196 were valid questionnaires
Investigation method	Self-written method (Field distribution)

B. Research Model

In this study, we designed the risk factors of telecommunications as independent variables and the safety behavior variables of workers as dependent variables. There are several risk factors perceived by workers at telecommunications work sites; as these risk factors are perceived, motivation is provided to perform safe work, and this motivation for safety ultimately leads to behavior that seeks to comply with safety. In this study, we sub-factored risk factors at telecommunications worksites into three sub-factors, personal, cultural, and institutional, by referring to Eun (2017) and Hyun (2010). We designed a research model by single-factorizing worker safety motivations and behaviors.

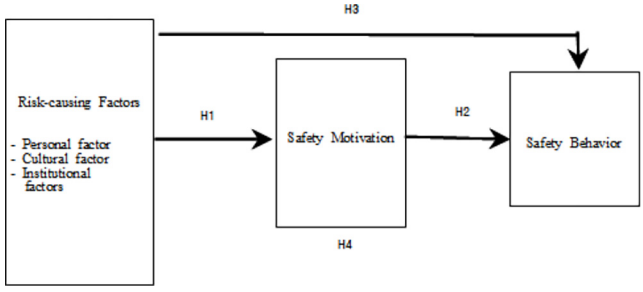

Fig. 1. Research Model.

C. Research Hypotheses

The relationship between an organization's safety and safety performance is that workers' accident freedom is a positive factor in the company's safety performance, and the higher the safety awareness of workers at the construction site, the lower the disaster rate. Previous studies have shown that as workers perceive risk factors for safety at work sites, their motivation for safety is formed and has a positive impact on safety behavior.

Based on the abovementioned studies and the model of this study, the following hypotheses were derived:

H1. The perceived risk factors of telecommunications workers positively impact safety motivation.

H1-1. The perceived personal factors of telecommunications workers positively affect safety motivation.

H1-2. The perceived cultural factors of telecommunications workers positively affect safety motivation.

H1-3. The perceived institutional factors of telecommunications workers positively affect safety motivation.

H2. The safety motivation of telecommunications workers positively impacts affects safety behavior.

H3. The perceived risk factors of telecommunications workers positively affects safety behavior.

H3-1. The perceived personal factors of telecommunications workers positively affects safety behavior.

H3-2. The perceived cultural factors of telecommunications workers positively affect safety behavior.

H3-3. The perceived institutional factors of telecommunications workers positively affect their safety behavior.

H4. Safety motivation has a mediating effect on the relationship between perceived risk factors and the safety behavior of telecommunications workers.

H4-1. Safety motivation has a mediating effect on the relationship between perceived personal factors and the safety behavior of telecommunications workers.

H4-2. Safety motivation has a mediating effect on the relationship between perceived cultural factors and the safety behaviors of telecommunications workers.

H4-3. Safety motivation has a mediating effect on the relationship between perceived institutional factors and the safety behavior of telecommunications workers.

D. Research Measurement Tool

1) Telecommunications Risk Factors

The risk factors perceived by telecommunications field workers were measured using three sub-factors: personal, cultural, and institutional. In this study, we composed survey questions by referring to Eun (2017) and Hyun (2010), measured each sub-factor using a 5-point Likert scale and assigned scores from 1 point for 'not at all' to 5 points for 'very much,' with higher total scores indicating higher levels of personal, cultural, and institutional risk factors perceived by telecommunications field workers.

2) Worker Safety Motivation

The safety motivation of telecommunications field workers was measured with one factor, and in this study, we composed survey questions by referring to Jeong et al. (2015), measured each sub-factor using a 5-point Likert scale, and assigned scores from 1 point for 'not at all' to 5 points for 'very much. Higher total scores indicate higher safety motivation of telecommunications field workers.

3) Worker Safety Behavior

The safety behavior of telecommunications field workers was measured with one factor, and in this study, we composed survey questions by referring to Kim (2019), measured each sub-factor using a 5-point Likert scale, and assigned scores from 1 point for 'not at all' to 5 points for 'very much. Higher total scores indicate higher safety behavior of telecommunications field workers.

4) Analysis Method

Data collected for this study were analyzed using SPSS 27.0 program and AMOS 27.0 program. First, the demographic characteristics of the survey subjects (telecommunications field workers) were presented as frequency and percentage, and descriptive statistical analysis (mean and standard deviation) was performed to understand the level of risk factors, safety motivation, and safety behavior perceived by telecommunications field workers. Second, confirmatory factor analysis (CFA) was conducted to verify the validity of the measurement tools for measuring the risk factors, safety motivation, and safety behavior of telecommunications companies, and Cronbach's α coefficient was calculated to verify reliability. Third, structural equation modeling (SEM) was performed to verify the relationship between the risk factors, safety motivation, and safety behavior of telecommunications companies. Fourth, bootstrapping was performed to verify the mediating effect of safety motivation on the relationship between risk factors and safety behavior of telecommunications companies. All analyses were performed at a statistical significance level of $p<0.05$.

IV. Empirical Analysis Results

A. Demographic Characteristics of Survey Subjects

General characteristics of survey participants, telecommunications safety managers, supervisors, and general workers are presented in Table 2. They were distributed among 29 safety managers, 71 supervisors, and 96 workers. First, in terms of employment type, there were 171 regular employees (87.2%), 17 non-regular employees (8.7%), and eight daily employees (4.1%). The age distribution was as follows: 23 people in their 20s (11.7%), 56 in their 30s (28.6%), 85 in their 40s (43.4%), and 32 aged 50 years or older (16.3%). Accidents during work at telecommunications companies were experienced by 51 people (26.0%) and not experienced by 145 people (74.0%), indicating that approximately three-quarters of the survey participants had no experience of accidents during work. In terms of education level, there were 3 high school dropouts (1.5%), 76 high school graduates (38.8%), 65 junior college graduates (33.2%), 51 four-year college graduates (26.0%), and 1 graduate or higher (0.5%). In contrast, the length of service was less than 6 months for 4 people (2.0%), more than 6 months to less than 1 year for 15

people (7.7%), more than 1 year to less than 3 years for 36 people (18.4%), more than 3 years to less than 5 years for 31 people (15.8%), and more than 5 years for 110 people (56.1%). Finally, the daily working hours were within eight hours for 84 people (42.9%), within 10 hours for 98 people (50.0%), within 12 hours for nine people (4.6%), and others for five people (2.6%), indicating that more than half (57.1%) of the total population worked more than eight hours a day.

In this study, the subjects were classified into various job groups and were further classified according to employment type, age, experience of safety accidents during work at a telecommunications company, education level, years of service, and daily working hours. As a result, there were some cases in which there were no participants for specific items.

B. Verification of Validity and Reliability of Measurement Tools

A confirmatory factor analysis was performed on the measurement model to verify the convergent and discriminant validity of the research model variables, such as the risk factors perceived by telecommunications workers (personal, cultural, and institutional factors), safety motivation, and safety behavior. In this study, model fit was analyzed using fit indices such as the χ^2 statistic, standardized root mean square residual (SRMR), Tucker Lewis index (TLI), comparative fit index (CFI), and root mean square error or approximation (RMSEA) with confidence intervals. Generally, a χ^2 statistic satisfying $p > 0.05$ is considered a good fit, but it is sensitive to sample size; thus, other fit indices should be considered first. Generally, TLI and CFI were considered good fits if they were above 0.90, SRMR was considered a good fit if it was below 0.08, and RMSEA was considered an excellent fit if it was below 0.05, a good fit if it was below 0.08, and an average fit if it was below 0.10 [23].

Considering the fit of the measurement model presented in Table 2, we obtained the following values: $\chi^2 = 4{,}334.177$ ($df = 2{,}045$, $p < 0.001$), SRMR = 0.044, TLI = 0.918, CFI = 0.924, RMSEA (90%CI) = 0.070 (0.068-0.072). Therefore, an overall good fit was obtained, and the measurement model was found to be appropriate. In addition, all measurement variables for latent variables, such as risk factors for telecommunications companies (personal factors, cultural factors, and institutional factors), safety motivation, and safety behavior, were statistically significant ($p < 0.001$) in

Table 2. Demographic characteristics of survey subjects

Categories		Safety manager		Supervisor		Workers		Totality	
		N	(%)	N	(%)	N	(%)	N	(%)
Employment type	Full-time	26	(89.7)	71	(100.0)	74	(77.1)	171	(87.2)
	Non-regular workers	3	(10.3)	0	(0.0)	14	(14.6)	17	(8.7)
	Daily work	0	(0.0)	0	(0.0)	8	(8.3)	8	(4.1)
Age	Twenty	6	(20.7)	6	(8.5)	11	(11.5)	23	(11.7)
	Thirty	6	(20.7)	25	(35.2)	25	(26.0)	56	(28.6)
	Forty	13	(44.8)	35	(49.3)	37	(38.5)	85	(43.4)
	Over 50s	4	(13.8)	5	(7.0)	23	(24.0)	32	(16.3)
Safety accident Experience or not	Experience	11	(37.9)	20	(28.2)	20	(20.8)	51	(26.0)
	No experience	18	(62.1)	51	(71.8)	76	(79.2)	145	(74.0)
Academic background	High school dropout	0	(0.0)	0	(0.0)	3	(3.1)	3	(1.5)
	High school graduate	11	(37.9)	18	(25.4)	47	(49.0)	76	(38.8)
	Junior college graduate	8	(27.6)	27	(38.0)	30	(31.3)	65	(33.2)
	University graduate	9	(31.0)	26	(36.6)	16	(16.7)	51	(26.0)
	Above Graduate school	1	(3.4)	0	(0.0)	0	(0.0)	1	(0.5)
Working years	Less than six months	1	(3.4)	1	(1.4)	2	(2.1)	4	(2.0)
	More than 6 months ~less than 1 year	0	(0.0)	7	(9.9)	8	(8.3)	15	(7.7)
	More than 1~less than 3 years	7	(24.1)	8	(11.3)	21	(21.9)	36	(18.4)
	More than 3~less than 5 years	5	(17.2)	10	(14.1)	16	(16.7)	31	(15.8)
	More than five years	16	(55.2)	45	(63.4)	49	(51.0)	110	(56.1)
One day working hours	Within 8 hours	9	(31.0)	25	(35.2)	50	(52.1)	84	(42.9)
	Within 10 hours	19	(65.5)	39	(54.9)	40	(41.7)	98	(50.0)
	Within 12 hours	1	(3.4)	4	(5.6)	4	(4.2)	9	(4.6)
	Etc.	0	(0.0)	3	(4.2)	2	(2.1)	5	(2.6)
	Sum	29	(100.0)	71	(100.0)	96	(100.0)	196	(100.0)

Table 3. Fit of measurement model

χ^2	df	*p*	χ^2/df	SRMR	TLI	CFI	RMSEA (90%CI)
4,334.177	2,045	.000	2.119	.044	.918	.924	.070(068-.072)

terms of factor loading and showed high values above 0.50 in standardized factor loading.

Construct reliability (CR) and average variance extracted (AVE) were evaluated to examine the convergent validity of the latent variables. Convergent validity refers to the degree of correlation between two or more measurement items for a single latent variable. Generally, if the construct reliability is above 0.70, and the average variance extracted is above 0.50, the convergent validity of latent variables is considered sufficient. As shown in Table 4, in the case of construct reliability (CR), all latent variables such as personal factors (0.912), cultural factors (0.876), institutional factors (0.859), safety motivation (0.887), and safety behavior (0.810) for telecommunications risk factors were above 0.70, and the average variance extracted (AVE) also showed that all latent variables such as personal factors (0.798), cultural factors (0.711), institutional factors (0.699), safety motivation (0.714), and safety behavior (0.722) for telecommunications risk factors were above 0.50, confirming convergent validity.

Discriminant validity refers to how different one latent

Table 4. Results of confirmatory factor analysis of risk-causing factors

Variables			Non-standardized Estimate	Standardized Estimate	Standard Error	t	CR	AVE
Personal Factor	→	PF1	1.000	0.931			0.912	0.798
	→	PF2	1.027	0.915	.051	23.504***		
	→	PF3	1.039	0.878	.049	21.130***		
	→	PF4	1.049	.0867	.7025	12.155***		
	→	PF5	1.090	.0865	.7224	13.371***		
	→	PF6	1.067	.0888	.6753	11.781***		
Cultural Factor	→	CF1	1.000	0.832			0.876	0.711
	→	CF2	.955	0.837	.065	14.508***		
	→	CF3	1.012	0.845	.069	14.516***		
	→	CF4	1.034	0.689	.095	12.919***		
	→	CF5	.8927	.0733	.6623	12.209***		
	→	CF6	.9702	.0791	.6626	12.209***		
	→	CF7	.9402	.0742	.6938	12.694***		
Institutional Factor	→	IF1	1.000	0.828			0.859	0.699
	→	IF2	.9485	0.837	0.065	14.478***		
	→	IF3	.8786	.0766	.6513	12.329***		
	→	IF4	.9446	.0788	.6336	12.446**		
	→	IF5	.9226	.0757	.6808	12.547***		
	→	IF6	1.234	0.880	0.070	15.166***		
	→	IF7	1.115	0.870	0.077	15.556***		
Safety Motivation	→	SM1	1.000	0.832			0.887	0.714
	→	SM2	1.150	.0798	.7541	14.482***		
	→	SM3	1.270	.0855	.7782	14.893***		
	→	SM4	1.175	.0813	.7514	14.427***		
	→	SM5	1.011	.0845	.6165	12.056***		
	→	SM6	.9366	.0525	.7816	18.051***		
	→	SM7	.7733	.0657	.5497	11.836***		
	→	SM8	.8862	.0562	.7003	15.726***		
	→	SM9	.8327	.0598	.6432	14.155***		
Safety Behavior	→	SB1	1.000	0.877			0.810	0.722
	→	SB2	0.933	0.912	0.060	17.881***		
	→	SB3	0.921	0.888	0.063	16.443***		
	→	SB4	0.973	0.829	0.066	16.338***		
	→	SB5	1.294	.1033	.7771	12.601***		
	→	SB6	1.492	.1147	.8353	13.131***		
	→	SB7	1.275	.1080	.7087	11.858 ***		

**p< .01, ***p< .001

Table 5. Correlation between study variables

Variables	Risk-causing Factor			Safety Motivation	Safety Behavior
	Personal Factor	Cultural Factor	Institutional Factor		
Personal Factor	.798				
Cultural Factor	.643***	.711			
Institutional Factor	.612***	.582***	.699		
Safety Motivation	.491***	.409***	.294**	.714	
Safety Behavior	.632***	.570***	.459***	.571***	.722

**p< .01, ***p< .001 (The diagonal values are the AVE values)

variable is from another. It is generally considered that if the average variance extracted for each of the two latent variables is greater than the square of the correlation coefficient between the two latent variables, discriminant validity is present [24]. The results of the discriminant validity verification are shown in Table 5, where the square of the highest correlation coefficient (0.643) between personal and cultural factors among the research variables (0.413) was lower than the average variance extracted for all research variables, indicating that discriminant validity was secured. Considering the correlations between the research variables, the risk factors perceived by telecommunications workers showed significant positive correlations with the safety motivation and safety behavior of telecommunications workers, and safety motivation and safety behavior also showed significant positive correlations.

C. Verification of Research Hypotheses

Structural equation modeling analysis was performed using AMOS 27.0, to verify the research hypotheses for examining the structural causal relationship between risk factors for telecommunications companies (personal, cultural, and institutional factors) and safety motivation and behavior of workers. The maximum likelihood method (ML) was used for the parameter estimation. First, the fit of the research model presented in Table 6 provided the following results: χ^2 = 4,325,889 (df = 2,297, p<0.001), SRMR = 0.049, TLI = 0.927, CFI = 0.926, RMSEA (90%CI) = 0.073 (0.071-0.075), indicating overall good fit and confirming that there was no problem in accepting the research results.

The results of verifying the hypotheses of this study set to examine the causal relationship between risk factors for telecommunications companies (personal, cultural, and institutional factors) and the safety motivation and safety behavior of workers are shown in Table 7.

Looking at the results of verifying research hypothesis 1, which was set to have a positive impact on safety motivation by the risk factors perceived by telecommunications workers, personal factors (standardized path coefficient = 0.263, t = 2.457, p < 0.05), cultural factors (standardized path coefficient = 0.282, t = 2.660, p < 0.01), and institutional factors (standardized path coefficient = 0.237, t = 2.356, p < 0.05) all had a significant positive impact on worker safety motivation. These results indicate that the higher the risk factors perceived by telecommunications workers, such as personal, cultural, and institutional factors, the higher their safety motivation. Therefore, workers must be made aware of the risk factors that can occur at work to motivate them to maintain safety during accident prevention. In particular, considering the relative influence of these factors in this study, as can be seen from the standardized coefficients, among the risk factors, cultural factors have the greatest influence in

Table 6. Fit of Research Model

χ^2	df	p	χ^2/df	SRMR	TLI	CFI	RMSEA(90%CI)
4,385.889	2,297	.000	1.909	.049	.927	.926	.073(.071~.075)

Table 7. Research hypotheses verification results (H1, H2, H3)

Path			Non-standardized path coefficient	Standard Error	Standardized path coefficient	t(C.R)
Personal Factor	→	**Safety Motivation**	.322	.132	.263	2.457*
Cultural Factor	→	**Safety Motivation**	.344	.131	.282	2.660**
Institutional Factor	→	**Safety Motivation**	.271	.117	.237	2.356*
Safety Motivation	→	**Safety Behavior**	.310	.093	.423	3.355***
Personal Factor	→	**Safety Behavior**	.034	.110	.038	.313
Cultural Factor	→	**Safety Behavior**	.090	.093	.107	.950
Institutional Factor	→	**Safety Behavior**	.086	.067	.111	1.325

increasing worker safety motivation. Therefore, research hypotheses 1-1, 1-2, and 1-3 were accepted.

Next, considering the results of verifying research hypothesis 2 that worker safety motivation affects safety behavior, worker safety motivation had a significant positive impact on safety behavior (standardized path coefficient = …423, $t = 3.355$, $p < 0.001$). These results indicate that the higher the safety motivation of telecommunications workers, the higher their safety behavior. Therefore, Hypothesis 2 was accepted.

Considering the results of verifying research hypothesis 3, the risk factors perceived by telecommunications workers will have a positive impact on worker safety behavior; personal factors (standardized path coefficient = 0.038, $t = 0.313$, $p > 0.05$), cultural factors (standardized path coefficient = 0.107, $t = 0.950$, $p > 0.05$), and institutional factors (standardized path coefficient = 0.111, $t = 1.325$, $p > 0.05$) had no significant impact on worker safety behavior.

Next, to verify research hypothesis 4, that safety motivation has a mediating effect on the relationship between risk factors perceived by telecommunications workers and worker safety behavior, bootstrapping was performed. Bootstrapping is a method used to estimate the distribution of parameters based on sample data when the population distribution is unknown. It is considered significant at a significance level of 0.05 when zero is not included in the 95% confidence interval (CI). The results of the analysis are presented in Table 8.

As a result of verifying the mediating effect of safety motivation in the relationship between risk factors perceived by telecommunications workers and worker safety behavior, the indirect effect of the personal facto → safety motivation → safety behavior path (standardized path coefficient = 0.107, 95%CI: 0.015-0.295, $p < 0.05$), the indirect effect of the cultural factor → safety consciousness → safety behavior path (standardized path coefficient = 0.084, 95%CI: 0.002-0.284, $p < 0.05$), and the indirect effect of the institutional factor → safety consciousness → safety behavior path (standardized path coefficient = 0.057, 95%CI: 0.003-0.169, $p < 0.05$) all included 0 in the 95% confidence interval; thus, the mediating effect was significant. Although risk factors perceived by workers did not directly affect their safety behavior, telecommunications risk factors indirectly influenced worker safety behavior through worker safety motivation, and it can be seen that safety motivation has a complete mediating effect on the relationship between risk factors perceived by telecommunications workers and worker safety behavior. Therefore, research hypotheses 4-1, 4-2, and 4-3

Table 8. Research hypotheses verification results (H4)

Path	Indirect Effect		
	Standardized path coefficient	95%CI	p
Personal factor → Safety motivation → Safety behavior	.107	(.015~.295)	.026
Cultural factor → Safety motivation → Safety behavior	.084	(.002~.284)	.048
Institutional factor → Safety motivation → Safety behavior	.057	(.003~.169)	.042

*Bootstrap sampling 1,000 times.

Table 9. Summary of research hypotheses verification results

	Hypotheses	Result
H1	The perceived risk-causing factors of telecommunications workers will have a positive effect on safety motivation.	
H1-1	The perceived personal factors of telecommunication service workers will have a positive effect on safety motivation.	Accepted
H1-2	The perceived cultural factors of telecommunication service workers will have a positive effect on safety motivation.	Accepted
H1-3	The perceived institutional factors of telecommunication service workers will have a positive effect on safety motivation.	Accepted
H2	The safety motivation of telecommunications workers will have a positive effect on safety behavior.	Accepted
H3	The perceived risk-causing factors of telecommunications workers will have a positive effect on safety behavior.	
H3-1	The perceived personal factors of telecommunications workers will have a positive effect on safety behavior.	Rejected
H3-2	The perceived cultural factors of telecommunications workers will have a positive effect on safety behavior.	Rejected
H3-3	The perceived institutional factors of telecommunication service workers will have a positive effect on safety behavior.	Rejected
H4	There will be a mediating effect of safety motivation in the relationship between perceived risk-causing factors and safety behavior of telecommunication workers.	
H4-1	There will be a mediating effect of safety motivation in the relationship between perceived personal factors and safety behavior of telecommunications workers.	Accepted
H4-2	There will be a mediating effect of safety motivation in the relationship between perceived cultural factors and safety behavior of telecommunications workers.	Accepted
H4-3	There will be a mediating effect of safety motivation in the relationship between perceived institutional factors and safety behavior of telecommunications workers.	Accepted

were accepted. The results of the verification of the research hypotheses are summarized in Table 9.

V. DISCUSSION AND CONCLUSIONS

In this study, we empirically verified the structural relationship among the risk factors perceived by telecommunications workers, safety motivation, and safety behavior. The main empirical analysis results are as follows:

First, we analyzed the impact of the risk factors perceived by telecommunications workers on safety motivation. Personal, cultural, and institutional factors, among the risk factors perceived by telecommunications workers, have a significant positive impact on worker safety motivation. These results indicate that the higher the level of perception of risk factors by workers, the higher their motivation for safety, suggesting that to motivate workers to maintain safety for accident prevention during work, it is necessary for workers to perceive risk factors first.

Second, we analyzed the impact of worker safety motivation on safety behavior. Thus, worker safety motivation had a significant positive impact on safety behavior. These results indicate that the higher the safety motivation of telecommunications workers, the higher their safety behavior, and it is suggested that to increase worker safety behavior for accident prevention, worker safety motivation must be prioritized. In other words, for workers to voluntarily engage in safety activities, such as complying with safety procedures and helping their colleagues' safety behavior, safety motivation must precede.

Third, we analyzed the impact of the risk factors perceived by telecommunications workers on their safety behaviors. Among the risk factors perceived by telecommunications workers, personal, cultural, and institutional factors had no significant impact on worker safety behavior. These results indicate that the higher the level of perception of risk factors by workers, the higher their safety behavior. Therefore, it is necessary for workers to perceive risk factors first to act to secure safety. These results suggest that the better workers perceive risk factors, the more likely they are to exhibit safety behaviors such as complying with safety regulations or wearing safety equipment, which can be linked to the recognition that it is an important behavior for their own safety and health.

Fourth, the mediating effect of safety motivation on the relationship between the risk factors perceived by telecommunications workers and safe behavior was analyzed.

In contrast to the third conclusion, which concerns the relationship between the risk factors perceived by telecommunications workers and safe behavior, that is, the relationship between the two variables, the fourth conclusion is different from the previous content in that it looks at the relationship between the risk factors perceived by telecommunications workers and safe behavior when workers' safety motivation intervenes. Thus, all personal, cultural, and institutional risk factors perceived by workers indirectly influenced safe behavior through safety motivation. This result showed a cascading effect, in which the higher the level of risk factors perceived by workers, the higher their safety motivation, and ultimately their safety motivation had a positive impact on workers' safe behavior. The results of this study showed that the risk factors perceived by telecommunications workers did not have a direct impact on workers' safe behavior but had a positive indirect effect on safe behavior through safety motivation, confirming that motivating workers for safety is a very important factor.

However, in a recent study by Byun and Jung (2021), which is similar to a previous study related to the safe behavior of telecommunications workers, it was reported that the safety management system of telecommunications companies could improve workers' safety awareness and compliance behavior by empirically analyzing the relationship between them. It has been shown that as workers' safety awareness increases, their behavior to comply with safety also increases [25]. When comparing these previous studies with the results of this study, it can be confirmed that workers' own safety awareness and safety motivation are very important factors in increasing the safety behavior of telecommunications workers.

This study provides basic practical data for presenting the importance of perceiving risk factors in the workplace by examining the risk factors perceived by telecommunications workers that affect their safety motivation and behavior to prevent and mitigate industrial accidents in the workplace. In addition, while previous studies have mainly focused on analyzing the status of worker safety consciousness and safety behavior and analyzing safety behavior according to worker perception of safety, this study has academic significance in that it derived factors that can motivate workers for their own safety and affect their safety behavior by subdividing the various factors that can cause accidents among workers into personal, cultural, and institutional factors.

However, this study had some limitations. The results were obtained by setting 196 telecommunications workers from a domestic telecommunications company as the survey sample. Therefore, if research is conducted on telecommunications workers not included in the survey, there may be differences in the results. Therefore, there may be limitations in generalizing the results of this study as research results that can be applied to all telecommunications companies in Korea. Therefore, in follow-up studies, it will be necessary to derive more generalized results by conducting a comprehensive study that expands the sample of this study limited to one domestic telecommunications company to all three telecommunications companies in Korea.

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