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Effects of Job Satisfaction, Organizational Support and Risk Perception on Safety Consciousness in Confined Space Workers

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Objective: This study aims to investigate the effects of organizational support, risk perception and job satisfaction on safety consciousness in confined space works.

Background: Confined space works are rated as hazardous works with high injury frequency and fatalities. But there were few researches for the occupational injury of the confined space workers.

Method: Questionnaire survey targeting 236 workers working in confined spaces were carried out to construct the structural equation model on safety consciousness. The participants were all male workers, and they install and maintain or clean facilities mainly in the confined spaces.

Results: A structural equation model for safety consciousness was proposed, and validated based on perceived organizational support, risk perception and job satisfaction factors. Perceived 'organizational support' contributed significantly to 'worker's safety consciousness' both directly and indirectly. Also, perceived 'worker's safety consciousness' was also affected by perceived 'job satisfaction' and 'risk perception'. In terms of magnitude of relationships, the direct effect of perceived 'job satisfaction' on 'worker's safety consciousness' was the greatest among the interrelationships among latent factors.

Conclusion: Workers' safety consciousness can function as a leading indicator for safety and hazard prevention of workers.

Application: The results can be used in developing safety prevention programs for confined space workers.

Keywords: Confined space; Safety consciousness; Structural equation model; Job satisfaction; Risk perception

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1. Introduction

Confined space means any place, including any chamber, tank, vat, silo, pit, trench, pipe, sewer, flue, well or other similar space in which, by virtue of its enclosed nature (HSE, 1997). Confined space works are rated as hazardous works with high injury frequency and fatalities because confined spaces may contain toxic, oxygen-deficient, and/or explosive atmospheres and may contain particular physical hazards, such as contents that can engulf or collapse on a worker, piping and fittings under high

pressure and temperature, unguarded machinery, and exposed electrical hazards (Kim et al., 2016; Pettit et al., 1996; Wilson et al., 2012). Workers are killed or seriously injured in confined spaces each year in the Republic of Korea. Those killed include people working in the confined space and those who try to rescue them without proper training and equipment (HSE, 2014). For accident prevention in confined space work, facility inspection, protective gear wearing, worker's training and management and supervision should be systematically conducted before entering the working space. That is, employers must carry out a suitable and sufficient assessment of the risks for all work activities to decide what measures are necessary for safety (HSE, 1997).

Measures to prevent occupational accidents can be divided into two approaches. One is based on lagging indicators revealing the characteristics of industrial accidents, and the other is based on leading indicators, such as safety audit or safety consciousness. Safety environment can be continuously managed by identifying the weaknesses of a system and taking an action using the leading indicators (Flin et al., 2000). Thus, worker's safety awareness for working conditions and organizational support as well as characteristics of industrial accidents can be used in developing safety prevention programs.

Previous studies showed that organizational support, worker's risk perception, job satisfaction, and safety consciousness factors are regarded as the factors that can affect industrial accidents. Jeong et al. (2015) investigate the correlation between office environment satisfaction levels and workers' subjective symptoms. Safety consciousness is defined as a positive attitude and awareness toward acting safely. Westaby and Lee (2003) reported that safety consciousness is one of the variables mediating exogenous variable effect, such as safety activity, self-esteem and organizational support, in relation with hazard occurrence. McLain (1995) emphasized the risk perception can directly affect worker's attitudes and behaviors, such as job satisfaction, stress and distraction from work tasks. Job satisfaction is defined as degree to which a worker experiences positive affection towards his or her job, and it can affect safety consciousness (Gyekye, 2005; Locke, 1969). Both safety training and procedures, on-site job hazards, and engineering and administrative controls are also associated with reduced workplace injuries (Kinn et al., 2000). Various services including education, training, consulting and technology support can be included in the organizational support. Safety training provides employees the knowledge and skills necessary to perform the job safely and high-quality jobs have direct and indirect effects on occupational injuries (Barling et al., 2002). Also, in a workplace where a safety program was successfully implemented with manager's solid commitment to safety, accidents sharply decreased if workers receive proper education and training.

Therefore, there is a need to check how organizational support including safety training can affect job satisfaction, risk perception and safety consciousness. Also, it is necessary to find the relationships among organizational, working condition, and worker's consciousness and satisfaction factors. Structural equation model is valuable for finding the causal relationships between the factors. Choe et al. (2001) identified casual relationships between user satisfaction of Internet website and performance measures using the structural equation model.

This study investigate the effects of organizational support, risk perception and job satisfaction on safety consciousness using a structural equation model, and identify any causal relationships or interrelationships among latent factors.

2. Methods

2.1 Research model and variables

Structural equation modelling is a statistical methodology that takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon. Figure 1 shows structural equation research model and variables. In Figure 1, factors (latent variables) are represented as ellipse in shape, such as job satisfaction, risk perception, organizational support, and safety consciousness. Observed variables are represented as squares, and these observation variables in the model are rated on a 1-5 (5=best) scale.

Job satisfaction factor is measured by satisfaction level on works and working environment. Risk perception factor is measured by perception level on accident frequency, severity, and risk. Organizational support factor is measured by perception level on safety training, safety facilities, safety service experience, and service effectiveness. Worker's safety consciousness factor is measured by worker's safety awareness and compliance with safety rules.

This study sets up the following hypotheses based on the conceptual model
- Hypothesis 1: Worker's risk perception has a positive impact on safety consciousness.
- Hypothesis 2: Worker's job satisfaction has a positive impact on safety consciousness.
- Hypothesis 3: Organizational support has a positive impact on safety consciousness.
- Hypothesis 4: Organizational support has a positive impact on worker's job satisfaction.
- Hypothesis 5: Organizational support has a positive impact on worker's risk perception.

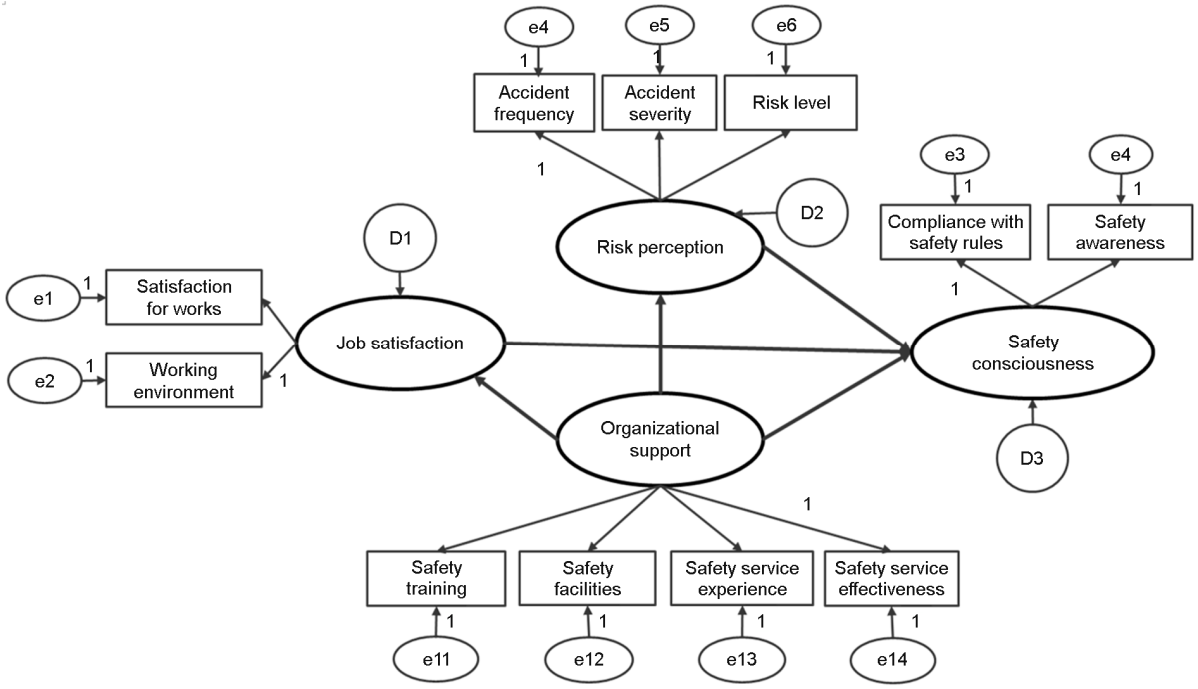

Figure 1. Proposed structural equation model

2.2 Subjects and data analyses

Questionnaire survey targeting 236 workers working in confined spaces were carried out. The participants were all male workers, and they install and maintain or clean facilities mainly in the confined spaces, such as a septic tank, water storage tank, manhole for communications, waterworks and sewage and storage tank.

Analysis of the structural equation model comprises validating the measurement model and fitting the structural model. The measurement model is evaluated by reliability analysis, convergent validity analysis and discriminant validity analysis. The effects of job satisfaction, organizational support and risk perception on safety consciousness using structural model analysis are analyzed based on the interrelationships between the constructs. AMOS 18 and SPSS 21 are used for the analysis.

3. Results

3.1 Construct validation by convergent validity and discriminant validity

The confirmatory factor analysis is useful for construct validation because it can measure standardized regression weight between measurement variables and latent variables, and evaluate model's fit. This study conducts verification through convergent validity and discriminant validity.

Standardized regression weight generally ranges between 0.5 and 0.95 for convergent validity (Bagozzi and Yi, 1988). Additionally, it is checked if critical ratio is greater than 1.965 and $p<0.05$. Fornell and Larcker (1981) proposed the equation for calculating AVE, and convergent validity is regarded as existing if AVE is over 0.5., convergent validity is acceptable if construct reliability value is greater than 0.7. Table 1 shows the results of confirmatory factor analysis. The standardized regression weight, critical ratio, AVE and construct reliability are judged to be adequate for the thresholds.

Table 1. Results of confirmatory factor analysis and convergent validity analysis

Confirmatory factor	Standardized regression weight (> 0.5)*	Standard error	Critical ratio (> 1.965)	*p*-value (< 0.05)	Average variance extracted (> 0.5)	Construct reliability (> 0.7)
Accident frequency <- Risk perception	0.904	0.106	8.445	***	0.798	0.888
Accident severity <- Risk perception	0.934					
Satisfaction for works <- Job Satisfaction	0.891	0.098	10.112	***	0.827	0.905
Working environment <- Job satisfaction	0.851					
Compliance with rules <- Safety consciousness	0.889				0.745	0.853
Safety awareness <- Safety consciousness	0.732	0.094	8.367	***		
Service effectiveness <- Organizational support	0.717	0.042	15.747	***	0.617	0.759
Service experience <- Organizational support	0.999					

Note: ( )*: validity criterion

Discriminant validity means the degree that each latent variable is discriminated. That is, if correlation coefficient among latent variables is low, discrimination validity exists. Table 2 shows the review results of discriminant validity. There are several methods to verify discriminant validity. First, for each latent variable, it is checked whether the AVE value exceeds the square value of correlation coefficient among constructs ($ø^2$) (Fornell and Larcker, 1981). The maximum correlation coefficient among latent variables is 0.570. There exists discriminant validity, because the AVE values of the job satisfaction and safety consciousness are 0.827 and

0.798, and are larger than the square of the coefficient $(0.570)^2 = 0.325$.

Table 2. Correlation coefficients, average variance extracted, and construct reliability

Factors	Correlation coefficient			Average variance fxtracted	Construct reliability
	Job satisfaction	Risk perception	Safety consciousness		
Job satisfaction	–			0.827	0.905
Risk perception	0.238	–		0.798	0.888
Safety consciousness	0.570	0.297	–	0.745	0.853
Organizational support	0.113	0.225	0.245	0.617	0.759

Second, it is tested if the correlation coefficient between the constructs is '1'. This means that there is no difference between the constructs. Namely, discriminant validity is regarded as existing, if 95% (Ø±2×Standard error) confidence interval does not include '1.0' (Anderson and Gerbing, 1988). Therefore, there exists discriminant validity.

Next, it is checked if χ^2-difference, which is calculated between the constrained model and the unconstrained model, is over 3.84 (Anderson and Gerbing, 1988; Fornell and Larcker, 1981; Steenkamp and Van Trijp, 1991). The unconstrained model indicates there is no constraint in the factor analysis, and the constrained model indicates the model in which correlation coefficient is fixed to 1 among the latent variables with high correlation coefficient. The unconstrained model gives $\chi^2 = 105.6$ and df = 16. The constrained model gives $\chi^2 = 39.074$ and df = 15. The χ^2 difference of the unconstrained and constrained models is 66.526, and is larger than 3.84. Therefore, there can be discriminant validity.

3.2 Results of structural equation model analysis

3.2.1 Verification of structural equation model

If model fit is not adequate, there is no meaning despite good path result in a model. So, the indices of model fit are as important as hypothesis test. Goodness of fit index values of .90 or greater indicate well-fitting models (Hooper et al., 2008). Comparative fit index and incremental fit index values close to .95 or greater are recognized as a good model-fit (Hu and Bentler, 1999). Root

Table 3. Model fit criteria and results

Model fit indices	Criteria	Statistics	Judgement results
Chi-square	$p > 0.05$	$p = 0.032$	insufficient
Root mean-squared residual	< 0.05	0.068	insufficient
Goodness of fit index	> 0.9	0.973	sufficient
Root mean squared error of approximation	< 0.08	0.056	sufficient
Incremental fit index	> 0.9	0.987	sufficient
Comparative fit index	> 0.95	0.986	sufficient

mean squared error of approximation values less than 0.08 suggest an adequate model-fit.

Table 3 shows model's fit indices. Research model gives model fit indices slightly insufficient for the criteria, especially for χ^2 and root mean-squared residual. The modification index gave no relationship that can reduce χ^2 value and the research model is concluded to be suitable for the data.

3.2.2 Hypothesis verification

Figure 2 is the final model including standardized path coefficient. Hypothesis is accepted when *p*-value is less than 0.05, and critical ratio value is bigger than 1.965. Table 4 shows the result of hypothesis testing, and all the hypotheses are accepted.

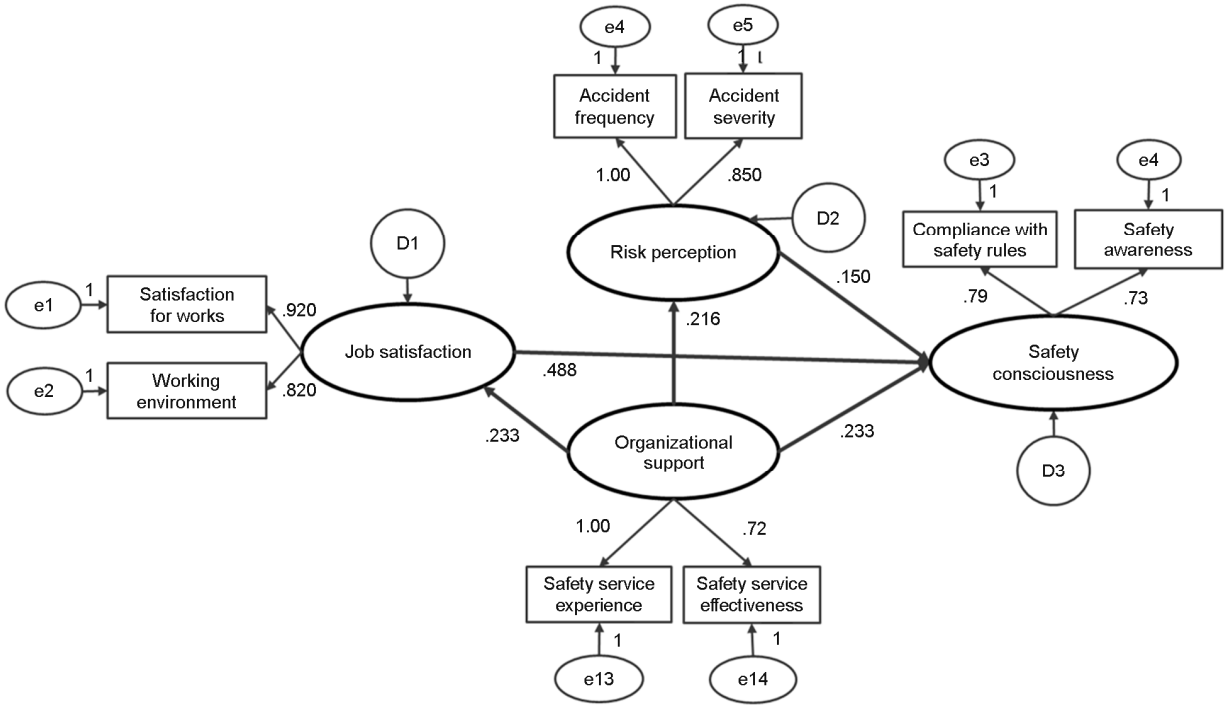

Figure 2. Final structural equation model

Table 4. Hypothesis verification results

Hypothesis	Path	Standardized path coefficients	Critical ratio	*p*	Result
1	Risk perception -> Safety consciousness	0.150	2.431	0.015	Accept
2	Job satisfaction -> Safety consciousness	0.488	6.866	***	Accept
3	Organizational support -> Safety consciousness	0.233	3.545	***	Accept

Table 4. Hypothesis verification results (Continued)

Hypothesis	Path	Standardized path coefficients	Critical ratio	*p*	Result
4	Organizational support -> Job satisfaction	0.233	3.263	0.001	Accept
5	Organizational support -> Risk perception	0.216	3.305	***	Accept

In Hypothesis 1 testing, perceived risk perception contributed significantly to worker's safety consciousness (standardized path coefficient = 0.150). That is, as a worker perceives the risk of accident frequency and severity more seriously, the higher level of safety consciousness is shown.

In Hypothesis 2 testing, job satisfaction has a positive impact on worker's safety consciousness (standardized path coefficient = 0.488). As a worker has higher job satisfaction level on works and working environment, worker's job satisfaction level is helpful to safety consciousness level on safety awareness and compliance with safety rules.

In Hypothesis 3 testing, organizational support has a positive impact on worker's safety consciousness (standardized path coefficient = 0.233). That is, perceived organizational support contributed significantly to worker's safety consciousness both directly and indirectly.

In Hypothesis 4 testing, organizational support has a positively impact on job satisfaction (standardized path coefficient = 0.233). The higher perceived organizational support, the higher level of job satisfaction.

In Hypothesis 5 testing, organizational support has a positively impact on risk perception (standardized path coefficient = 0.216). As a worker has more experience receiving the safety service, it can be helpful to worker's risk perception more sensitively.

3.2.3 Analysis of construct effect

Figure 2 show that 'risk perception', 'job satisfaction' and 'organizational support' have a direct effect on 'safety consciousness', respectively, and that a mediating effect by job satisfaction and risk perception exits between organizational support and safety consciousness level. The effects of the individual factors on safety consciousness can be analyzed along with the test of significance for the direct and indirect effects.

The standardized path coefficient as shown in Table 4 is the direct effect, and *p*-value shows the significance. To test the significance of indirect effect, a bootstrapping method is applied. The total effect of organizational support on the worker's safety consciousness is, 0.379, the sum of the direct effect (0.233) and mediating effects (0.146) through job satisfaction (0.233*0.488) and risk perception (0.216*0.15).

4. Discussion and Conclusion

This study identified the factors affecting worker's safety consciousness, examined the relationships of those factors, and also analyzed their direct and indirect effects on safety consciousness. In the study, the collected data were verified as having reliability and validity, and the structural equation model of worker's safety consciousness consisting of four factors was verified as suitable,

and all paths were significant. The proposed three factors (risk perception, job satisfaction and organizational support) had a direct impact on worker's safety consciousness. Regarding organizational support, it was proved that there was an indirect effect on the safety consciousness by the mediating effect of job satisfaction and risk perception. The direct effect of job satisfaction was 0.488, which was relatively higher than 0.379, the total effect of organizational support, and 0.15 of risk perception.

First, this study confirmed that worker's risk perception has a direct effect on worker's safety consciousness. This confirmed that subjective perception on risk affects worker's attitudes and behaviors (McLain, 1995), and that such attitudes and behaviors affect safety climate and worker's safety consciousness (Mearns and Flin, 1995).

Second, this study confirmed that worker's job satisfaction has a direct effect on worker's safety consciousness. Job satisfaction is close to an aggregate indicator on working condition (Neal et al., 2000), and is affected by the support level of organizational safety and welfare. This study confirmed the research that if workers perceive their organization regard safety and welfare important, and that they are satisfied with the current system, the workers positively perceive the current safety climate, which affects organizational behaviours (Gyekye, 2005).

Third, this study confirmed that organizational support has a direct effect on worker's safety consciousness. This confirmed the preceding researches that the management's commitment and safety training was pointed out as the difference between the companies with high hazard rate and those with low hazard rate and that management's commitment or safety training can affect organizational safety climate and worker's safety consciousness (Zohar, 1980).

Fourth, this study confirmed that organizational support has a direct effect on job satisfaction. This means that there is a mediating effect on worker's safety consciousness because job satisfaction affects worker's safety consciousness.

As examined above, worker's safety consciousness reflects risk perception that how seriously workers perceive accident frequency and severity, and also reflects worker's perception on working condition, namely overall perception on the safety and welfare offered by a company. Not only management's participation in safety activity, but organizational support including safety training, can encourage worker's safety consciousness.

Worker's safety consciousness can function as a leading indicator for safety and hazard prevention of workers like safety audit or safety climate. Especially, in the occupation such as confined space workers, of which working place and work details are changing, worker's safety consciousness is important in hazard prevention and safety activity. Because the work environment cannot be controlled, hazards can be prevented in advance by providing safe work environment through establishing and managing worker's safety consciousness, workplace' safety climate and organizational safety culture.

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