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Research Article

The effect of alternative measurement and evaluation techniques on safety performance in employee training

Orkun DALYAN[1,*], Hatice DALYAN[1], Mehmet PİŞKİN[2,*], Ömer Faruk ÖZTÜRK[3], Erdal CANPOLAT[4]

[1]*Department of Occupational Health and Safety, Intitute of Graduate Studies, Çanakkale Onsekiz Mart University, Çanakkale, 17100, Türkiye*
[2]*Department of Food Processing, Çanakkale Technical Sciences Vocational School, Çanakkale Onsekiz Mart University, Çanakkale, 17020, Türkiye*
[3]*Department of Chemistry, Faculty of Science, Çanakkale Onsekiz Mart University, Çanakkale, 17020, Türkiye*
[4]*Department of Science Education, Faculty of Education, Fırat University, Elazığ, 23119, Türkiye*

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ABSTRACT

Occupational health and safety training constitutes an important implementation step of the proactive employee welfare, health, and safety approach. In occupational health and safety training, measurement and evaluation methods should be applied accurately, efficiently, and effectively to evaluate whether learning and behavioral goals are achieved. In this research, a survey consisting of thirty questions was applied to a sample of 140 employees to determine the effect of alternative assessment tools on safety performance in occupational health and safety training. The obtained data were analyzed using the Statistical Package for Social Sciences 22 software program for reliability and exploratory factor analysis, and the Analysis of Moment Structures and Structural Equation Model 21 software program for confirmatory factor analysis, respectively. It was determined that the average score of the experimental group subjected to hazard detection poster exams using alternative assessment tools exceeded the average score of the control group taking traditional multiple-choice exams and that the level of participation in occupational health and safety regulations had a moderate positive effect on safety performance.
The importance of both compulsory occupational health and safety training for primary school graduates and customized training programs for this group was emphasized. There was a positive and significant correlation between occupational health and safety compliance and safety performance. It was strongly suggested that interventions be tailored to optimum effectiveness according to training levels and that businesses also take proactive approaches to increase compliance with occupational health and safety regulations, such as organizing incentive activities and providing ongoing occupational health and safety training. A safer workplace environment should be promoted by effectively transforming the knowledge and skills acquired in occupational health and safety training into observable behaviors.

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*__Corresponding author.__
*E-mail address: orkundalyan@outlook.com; mehmetpiskin@comu.edu.tr

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INTRODUCTION

Measurement and evaluation are significant parts of the learning process and are used to understand individuals' levels of learning [1]. Good measurement and evaluation not only help accurately determine individuals' learning levels but also help educators and individuals understand their needs. To create an effective measurement and evaluation system, the steps to follow include selecting appropriate measurement tools, evaluating the suitability of these tools, evaluating individuals' performance, providing feedback, and analyzing data [2].

Occupational health and safety (OHS) is an important issue for the health and safety of everyone in the workplace. Various measures need to be taken to ensure the safety of employees in the workplace. However, for these measures to be effective, employees need to be aware of and trained on this subject [3]. OHS training helps employees identify workplace risks and take measures to protect themselves and other employees [4]. By recognizing workplace hazards and learning safe working methods, employees can prevent accidents and injuries in the workplace.

Assessment tools used in OHS training help evaluate the effectiveness of the training and the individuals' learning levels [5]. These assessment tools include exams and tests, simulations and scenarios, evaluation forms, and feedback [6]. Exams and tests enable individuals to understand what they have learned and remember the information accurately. Simulations and scenarios help employees learn about the hazards and risks they may encounter in real life and how to deal with such situations [7]. Evaluation forms are used to measure employees' awareness and knowledge of OHS issues in the workplace. Feedback can be used to measure individuals' learning levels. These assessment tools help evaluate the effectiveness of OHS training and assist in taking necessary precautions for employee safety [8].

Safety performance is defined as the results that aim for safety, in direct proportion to the safety culture that businesses have [9]. It is also used to refer to OHS performance, defined as the measurable results of a workplace's management of OHS risks [10]. It can motivate employees and use the information to reward them. Various data such as accident statistics, near-miss and hazardous incident reports, management's perspective on safety, and evaluation of training are used as indicators of safety performance. Measuring safety performance allows the evaluation of the compliance of the business or its sub-units with OHS and makes possible the improvement of problematic areas [11]. There are various studies in the literature aiming to identify the components that constitute safety performance. Neal et al. [12] emphasized the significant impact of safety participation and compliance components on safety performance in their study. Similarly, in a study in the healthcare sector that determines the role of safety climate in the correlation between job stress and safety performance, safety performance was examined under two factors employee compliance and participation [13]. Sawacha et al. [14] reported that seven factors affect safety performance in construction sites. Wu et al. [15] emphasized that safety performance was mostly affected by the leadership component of management. The uncertainties in the literature about safety performance have led researchers to identify the factors that affect safety performance.

This study aimed to determine the effects of alternative measurement and evaluation systems in OHS on employee safety performance and to determine the importance of adapting interventions according to training levels. For this purpose, a survey consisting of thirty questions was applied to the personnel working in the construction of the 1915 Çanakkale Bridge. The data obtained was analyzed with SPSS and in light of the results, suggestions were made regarding the criteria that would increase employee safety performance. It was also compared with similar research results in the literature. This research is limited to the opinions of employees working in the bridge construction sector in Çanakkale province. Therefore, research limitations should be considered when generalizing the findings.

MATERIALS AND METHODS

Purpose and Model of the Research

This study aimed to determine the effect of measurement and evaluation systems applied after OHS pieces of training on employee safety performance, and it was designed as a real experimental model with pre-test and post-test control group [16]. Research data were collected between 01.08.2022-31.12.2022.

This study has been approved by the Ethics Committee of Çanakkale Onsekiz Mart University Graduate Education Institute with the approval number E-84026528-050.01.04-2200116793 on June 13, 2022.

Population and Sample Selection

The population of the study consists of all personnel (N=220) working in bridge construction in Çanakkale province, Turkey. In determining the sample group, according to the Krejcie and Morgan [17] population-sample table for a confidence interval of 95% and a significance level of 5%, the sample size of the study with a population of 220 should be 140 individuals. According to the research model, seventy individuals were classified as the control group, and seventy individuals as the experimental group. The convenient sampling method was used in selecting individuals.

Data Collection Tools

The questionnaire expressions applied to the employees are the expressions used in the studies available in the literature [18-20]. It was adapted to this study area in line with expert opinions, considering variables such as sample and sector. The first five statements of the scale are purposed at determining the type of employees (gender, marital status, age, professional experience, and educational status).

The 30-item 5-point Likert scale's purpose is to evaluate employee safety performance. After the pilot application with 70 employees, the reliability of the scale was ensured by the Cronbach alpha internal consistency coefficient, its validity was ensured by factor analysis, and no revision was required. Various opinions exist in the literature regarding the sample size calculation for pilot studies. It has been reported in studies available in the literature that 30-50 participants representing the target group are sufficient for pilot studies [21-25]. The questionnaire was conducted face-to-face with the employees and was filled out a total of 280 times before and after the implementation. The Safety Performance Scale (SPS) statements applied in the study are given in Appendix 1.

Data Processing and Analysis

Reliability and Exploratory Factor Analyses (EFA) were conducted using the Statistical Package for the Social Sciences (SPSS) 22, while confirmatory factor analyses were performed using the AMOS 21 program in this study. Normality assumptions of the data were checked by Kolmogorov-Smirnov and Shapiro-Wilk tests and by checking for skewness and kurtosis values. Parametric analysis methods were used for variables that met the normality assumption [26]. The results of the analysis were evaluated with a confidence level of 95% and a significance level of 5%. Cohen's (d) and eta-squared (η^2) effect size coefficients were calculated to define the level of relationship between variables with significant differences [27]. Correlation analysis was preferred in examining the relationship between scale factors [28]. A significance level of 1% was used as a guide for interpreting the results of the correlation analysis [29-31].

RESULTS AND DISCUSSION

The percentages (%) of participants' personal typical are given below. 6.43% of the total participants are female and 93.57% are male. 54 participants 38.57% are married, and 61.43% are single. When the age variable is examined, the group with the highest rate of 38.57% is the age range of 26-35. There are no participants over 65 years of age in the study sample. The group with the highest rate in the variable of professional experience period is between 1-5 years with 35%. 44 participants (%31.43) had primary education, 53 (%37.86) had high school education, 21 (%15.00) had associate degrees, and 22 (%15.71) had bachelor's degrees.

The reliability coefficient of the SPS is found to be α=0.880, which is highly reliable [32]. Before the reliability and EFA, the Kaiser-Meyer-Olkin (KMO) and Bartlett tests were performed to determine the adequacy of the sample size for analysis. As a result of the analysis, the KMO value was found to be 0.683 and the significance value was 0.000. The obtained KMO value agrees with the literature for good factor analysis [33.34]. The data for SPS factors are given in Table 1.

According to the results of EFA, the SPS was found to have a 5-factor structure. The total variance explanation rate

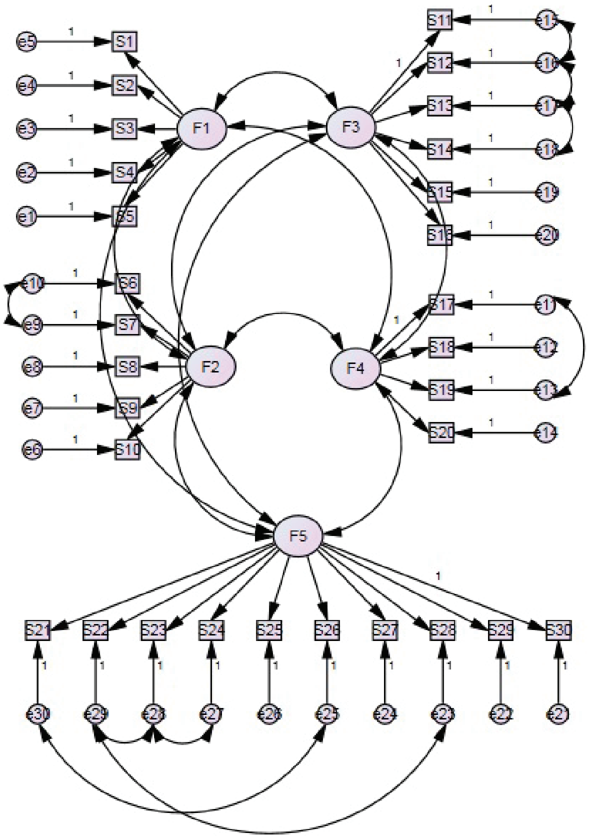

Figure 1. Structural equation model of Safety Performance Scale with plotted covariances.

Table 1. Statistics of Safety Performance Scale Factors

Code	Item	Factor	α	Eigenvalue	Variance	$\bar{X}$	df	S.E.mean
F-1	5	Participation in OHS Rules	0.744	7.203	24.010	3.69	0.76	0.09
F-2	5	Compliance with OHS Rules	0.857	2.991	9.968	3.73	0.96	0.11
F-3	6	OHS Training	0.799	2.820	9.400	3.75	0.69	0.08
F-4	4	OHS Risk Perception	0.713	2.488	8.294	3.15	0.69	0.08
F-5	10	OHS Awareness	0.833	1.630	5.434	3.12	0.65	0.07

Note: α = Cronbach alpha reliability coefficient, $\bar{X}$= Mean, df= Degree of freedom, S.E.mean= Standard Error Mean of the 5 factors is 57.10%, which is sufficient for explaining the measuring tools [35]. To evaluate the suitability of the factors obtained from EFA, Confirmatory Factor Analysis (CFA) was performed. The Structural Equation Model (SEM) of the SPS, which shows the covariances drawn because of the analysis, is given in Figure 1.

As a result of the SEM created, the results of the CFA are given below.

- Relative Chi Square Index (CMIN/DF): 1.565
- Goodness of Fit Index (GFI): 0.896
- Normed Fit Index (NFI): 0.887
- Comparative Fit Index (CFI): 0.909
- Root Mean Square Error of Approximation (RMSEA): 0.060

The results of the CFA conducted in the SEM are within the accepted values in the literature [36-40]. Because of the analyses, it was defined that SPS is appropriate for measuring with 30 items and five factors (sub-dimensions). The Independent Samples' t-test results of the pre-test score averages and the post-test and pre-test difference mean of the control and experimental groups are given in Table 2.

Accordingly, in Table 2, the pre-test scale mean of the control group participants is $\bar{X}$=3.45 ± 0.49, and the pre-test scale mean of the experimental group participants is $\bar{X}$=3.46 ± 0.52. Accordingly, in the Independent Samples t-test results, there is no statistically significant difference between the pre-test scale means of the control and experimental groups (t=0.132, p>0.05). This finding supports that the pre-test scale means the control and experimental groups are not statistically different from each other. A statistically significant difference was found in the pre-and post-test difference averages between the control and experimental group participants in favor of the experimental group (t=3.231, p<0.05). The effect of the significant difference detected is of moderate level according to the effect size coefficient (d=0.54) [41]. The one-way analysis of variance (ANOVA) results for the OHS Training (F-3) and the education status variable with the pre-test and post-test difference averages are presented in Table 3.

According to Table 3, there is a significant difference between the pre-and post-application mean scores of the OHS Education factor and the educational level variable [$F_{(3,136)}$= 3.740, p<0.05]. A significant difference was found in favor of the primary education level compared to high school, associate degree, and bachelor's degree levels. It was determined that the effect of the OHS Education factor on the education level variable was moderate (η^2=0.07). Pearson Correlation analysis results between the SPS factors are given in Table 4.

According to Table 4, there is a moderate positive correlation between participation in OHS rules and compliance with OHS rules, as well as OHS training factors. There is also a moderate positive correlation between OHS risk perception and compliance with OHS rules and OHS awareness factors.

In a study investigating the effects of alternative evaluation tools on the success scores and knowledge retention of individuals in measuring OHS training, it was reported that exams conducted with a 3D hazard detection poster increased both the success score and knowledge retention of individuals [42]. Similarly, in this study, it was determined that the mean score of the experimental group to

Table 2. Independent Samples t Test results of research groups

	Groups	f	$\bar{X}$	df	S.E.Mean	t	p	d
Pre-test	Control Group	70	3.45	0.49	0.05	0.132	0.895	-
	Experimental Group	70	3.46	0.52	0.06			
Post-test and pre-test difference	Control Group	70	0.71	0.67	0.08	3.231	0.002*	0.54
	Experimental Group	70	1.02	0.44	0.05			

Note: f= Frequency, $\bar{X}$= Mean, df= Degree of Freedom, S.E.mean= Standard Error Mean, *=p<0.05, d= Cohen d Effect Size Coefficient

Table 3. ANOVA results between the OHS Training factor post-test and pre-test difference mean and the educational status variable

Groups	f	$\bar{X}$	df	S.E.	F	p	η^2	Difference
Primary Education	44	0.90	0.87	0.13	3.740	0.013*	0.07	1>2-3-4
High School	53	0.50	0.77	0.10				
Associate's Degree	21	0.48	0.91	0.19				
Bachelor's Degree	22	0.23	0.75	0.15				

Note: f= Frequency, $\bar{X}$= Mean, df= Degree of Freedom, S.E.= Standard Error, *=p<0.05, η^2= Eta-Square Effect Size Coefficient, 1= Primary Education, 2= High School, 3= Associate's Degree, 4= Bachelor's Degree

Table 4. Correlation analysis results between Safety Performance Scale factors

		F-1	F-2	F-3	F-4	F-5
F-1	r	1				
	p	-				
F-2	r	0.367	1			
	p	0.002**	-			
F-3	r	0.391	0.287	1		
	p	0.001**	0.016	-		
F-4	r	0.212	0.306	0.050	1	
	p	0.077	0.010**	0.680	-	
F-5	r	0.203	0.267	0.147	0.470	1
	p	0.091	0.025	0.225	0.000**	-

Note: r= Pearson Correlation Coefficient (two-tailed), *= p<0.05, **= p<0.01, F1= Participation in OHS Rules, F2= Compliance with OHS Rules, F3= OHS Training, F4= OHS Risk Perception, F5= OHS Awareness

which the alternative assessment and evaluation system was applied was higher than the mean score of the control group to which the multiple-choice exam was applied. In studies on safety performance measures available in the literature, it has been reported that no significant difference was found between the demographic characteristics of the participants and safety performance and factors [43]. However, in this study, a significant difference was found between the level of education and the OHS Training factor, in favor of primary school graduates.

In a study examining the effect of organizational factors on safety performance in the oil and gas sector in Nigeria, it was stated that safety training had a significantly positive relationship with both safety compliance and safety participation [44]. In research aimed at developing a model for predicting safety performance in the construction sector, it was reported that feedback on safety-related data, the effectiveness of OHS training, and management support factors would be supported as leading indicators [45]. In a study examining the factors affecting safety performance among employees of 30 construction companies in three major cities in Iran, it was stated that there is a positive relationship between employee competence and OHS training and safety performance [46]. In research conducted with data collected from 128 companies across Turkey, it was reported that the OHS training factor directly and positively affected employee participation and compliance factors [47]. In a study examining the factors affecting safety performance among healthcare providers in Jordan, management commitment and OHS training were reported as primary factors [48]. In this study, it was determined that the compliance with OHS rules factor, compliance with OHS rules and OHS training factors, as well as the factors of OHS risk perception and OHS risk awareness, had a positive effect at a moderate level. It was determined that these findings were different from those of the studies in the construction and steel sectors in the literature [49, 50, 51].

CONCLUSION

In the evaluation of training provided in OHS, the significant positive effects of alternative evaluation tools on safety performance were determined and reported.

The distinctive contribution of this study from others is the necessity of providing mandatory OSH training to primary school graduate employees, as well as the importance of customizing OHS training programs to meet the specific needs of those in this demographic. To optimize the effectiveness of the OSH training planned to be given, it should be adapted to different training levels.

There is a positive relationship between adherence to OSH regulations and safety performance, with increased compliance contributing to a safer working environment. The use of an alternative assessment tool in evaluating OHS training resulted in higher mean scores compared to traditional multiple-choice exams.

It has been reported that effective factors that may affect the evaluation results of OHS training, such as inequalities in question content, individual attitudes towards evaluation tools, and the examination environment, should be taken into consideration.

It is recommended to conduct tests on the Safety Performance Scale devised for this study, as well as alternative measurement tools specifically tailored for Occupational Health and Safety training across diverse sectors and samples. The results obtained from such assessments should be systematically compared with analogous studies, thereby enhancing the overall efficacy of the system.

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AUTHORSHIP CONTRIBUTIONS

Main Idea/Planning: Mehmet Pişkin, Hatice Dalyan, Orkun Dalyan, Data collection/Processing: Mehmet Pişkin, Hatice Dalyan, Orkun Dalyan, Erdal Canpolat, Ömer Faruk Öztürk, Data analysis and interpretation: Mehmet Pişkin, Orkun Dalyan, Literature review: Mehmet Pişkin, Hatice Dalyan, Orkun Dalyan, Written by: Mehmet Pişkin, Orkun Dalyan, Review and correction: Mehmet Pişkin, Hatice Dalyan, Orkun Dalyan, Erdal Canpolat, Ömer Faruk Öztürk, Consultancy: Mehmet Pişkin, Ömer Faruk Öztürk, Erdal Canpolat.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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