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Development and psychometric evaluation of an occupational health and safety performance tool for manufacturing companies

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A R T I C L E I N F O

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A B S T R A C T

Background: The occupational health and safety (OHS) performance of organizations maybe affected by internal and external factors. According to a literature review, standardized tools for studying these factors are limited. Therefore, the main aim of this study was to examine psychometric properties of a tool for evaluating OHS performance. The tool was used to investigate the relationship between the identified OHS performance influencing factors and occupational injury.
Methods: The questionnaire developed through conducting a literature review about the OHS performance and constructing a question pool. The number of items was reduced to 93 after performing a screening process. Sixteen OHS scholars offered feedback on the tool's phrasing and applicability to check face and content validity. Test-retest reliability was examined through intraclass correlation coefficients. 850 questionnaires were distributed at 12 manufacturing companies in the West Azerbaijan province in Iran, 600 valid questionnaires were returned. Exploratory and confirmatory factor analysis were conducted to assess construct validity. Criterion validity was investigated by measuring agreement between its OHS performance scores and occupational injury. A set of regression analyses examined the variables associated with OHS influencing factors.
Results: Validity analysis revealed that 93 items had an excellent content validity ratio (>0.79) and content validity index (>0.47). The exploratory factor analysis resulted in eleven OHS performance factors. Thirty-three items were removed because of inadequate reliability. The result of confirmatory factor analysis showed that the OHS performance model is satisfactory. The final 60-item scale's reliability score was 0.96. The safety system was identified as the main influencing factor (3.54 ± 0.65). Participants with more safety training reported more injuries. Safety training and injury experiences, company size, and occupational health and safety management system (OHSMS) adoption affected OHS performance influencing factors. Occupational injuries were linked to company size (OR = 1.39, CI = 1.06–1.82), whereas the absence of OHSMS was connected with an increased risk of occupational injury (OR = 0.09, CI = 0.02–0.55).
Conclusions: The developed tool had satisfactory psychometric properties for assessing OHS performance in manufacturing companies. OHS performance could be improved by implementing safety systems and focusing more on incentive programs. Implementing the requirements of an OHSMS may improve the OHS performance and decrease occupational injuries.

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1. Introduction

Nowadays, the workforce's health and safety are among the top priorities of many developed societies and organizations. Failure to address this critical issue can endanger employees and result in human and financial losses. International Labor Organization (ILO) estimates that 2.9 million employees die annually due to work-related accidents and disease, and approximately 360 million non-fatal occupational accidents happen with more than four days of absences from work each year [1]. Studies show that the number of occupational incidents and consequently their human and financial losses in developing countries are much higher than in developed countries [2]. This indicates that the developing communities failed to manage occupational health and safety (OHS) performance in workplaces. Therefore, identifying the factors that influence OHS performance in the workplace and recommending countermeasures may help reduce future incidents and their losses.

In developing countries like Iran, incident prevention and safety management must be improved through measurement and evaluation of OHS performance. Evaluation of OHS performance provides data on the quality of occupational health and safety management systems (OHSMSs). Traditional performance evaluation uses reactive indicators such as number of injuries and illnesses, accident frequency, and severity rates [3]. Reactive indicators are simple, cheap, and easy to interpret [4]. They provide a view of a company's actual OHS performance [5]. OHS performance evaluation using only reactive indicators is incomplete [6]. They can't identify short-term change. Under-reporting injuries limits their precision, and they don't capture near-misses or all non-fatal accidents [4]. They don't provide a current view to predict future performance [7]. Critics also assert that because they don't determine the causes of system failures, which would lead to system improvement, they have little predictive value [8,9]. According to Choudhry (2014), traditional performance indicators concentrated on after-the-fact analysis but ignored factors including safety climate and behavior [10].

Prospective OHS performance indicators provide information missing from incident-based measurement and keeps up with organizational and safety management trends. Prospective indicators show how well a company prevents injuries and illness. These activities include safety management system, employee, supervisor, and management activities. These indicators encourage strong safety and health performance through reward and not blame, focusing on identifying and correcting problems to maintain the spirit of achieving performance targets and continuing development [11]. Given the advantages and drawbacks of the performance indicators, it seems that both indicators are required to properly evaluate the OHS performance of a company.

Previous studies have found that the implementation and maintenance of OHS principles have received less attention in developing countries, as well as limited research was conducted in this area [12]. Although a significant proportion of the global workforce is employed in these countries, they have limited access to OHS services [13]. Lack of OHS training, poverty, lack of reliable OHS data, illiteracy, cheap labor, lack of OHS experts, the mushroom growth of industries, and inadequate implementation of existing OHS legislation have been identified as factors influencing OHS performance [12,13,14]. Developing countries could not significantly change OHS performance in their work environments due to the need to adapt macro-strategic plans at the national level. In addition, several factors influencing OHS performance in the workplace have been identified and their primary sources are found within organizations. Management commitment to OHS, supportive environment, OHS training, safety attitude, risk perception, workload, time pressure, measurement of OHS performance, safety communication, safety participation, safety culture, and motivation are some of these factors [15,16,17]. Identifying factors that influence OHS performance can be beneficial in developing control measures to improve an organization's current OHS performance.

Studies were conducted to develop a standard tool for the evaluation of OHS performance in various industries. For instance, the Construction Safety Index (CSI) [18], Construction Site Risk Assessment Tool (CONSRAT) [19], and a safety performance index assessment tool were developed to evaluate and improve construction safety performance [20]. Lingard et al., (2011) also proposed a model using a combination of lagging (outcome) and leading (process) indicators and a safety climate survey to measure OHS performance in the construction industry [5]. Reinhold et al., (2015) proposed a flexible risk assessment (FRA) tool for identifying occupational hazards in the industrial enterprises [21]. Prognostic risk assessment tool (PgRA) developed for the quantitative investigation of the effects of human, organizational, and technical/technological factors on occupational risks, particularly for the manufacturing industry [22]. Many tools have been proposed to measure safety performance in the construction industry, but few tools have been developed in the manufacturing industry, especially in developing countries.

Given the high rate of occupational incidents in developing countries, it is necessary to identify factors affecting OHS performance to prevent incidents. Although the internal and external factors affecting OHS performance have been identified, the frequency of occupational incidents remains high, especially in manufacturing companies [23,24], and the OHS performance in developed countries is still poor. On the other hand, industries and organizations differ in structure and management, and hence many factors can affect their OHS performance. Therefore, new studies must be conducted to identify the factors influencing OHS performance and attempt to manage them in the workplace. In addition, the authors' search for a standard tool for identifying factors influencing OHS performance in manufacturing companies yielded no results. Ghahramani and Salminen reported that OHS has received insufficient attention in Iran and OHS regulations have not been properly implemented in manufacturing companies [25]. Additionally, the systems for registering and reporting workplace incidents are unsatisfactory in developing countries to evaluate the safety performance of manufacturing companies using incident indicators [26]. Safety efforts are inadequate to predict prospective safety performance [27]. Therefore, this study was carried out in order to examine psychometric properties of a tool for evaluating OHS performance and to investigate the association between the OHS performance factors and occupational injury in manufacturing companies.

2. Materials and methods

2.1. Questionnaire development

The available literature was reviewed and factors influencing OHS performance and items were identified [16,28,29,30,31,32,33,34,35]. The preliminary questionnaire consisted of 134 items about the OHS performance. Then the items were screened to develop the initial questionnaire. The number of items reduced to 93 after conducting a screening process for redundancy and the general aim of our study. The translation of the questionnaire from English to Persian was performed by a bilingual translator who was one of the researchers of this study. Then, other researchers check the translation and revised the questionnaire. After that, the questionnaire was reviewed by an occupational health expert and necessary modifications were made based on the provided feedback. The validity and reliability of the questionnaire was investigated by using an expert panel and manufacturing employees.

After screening, translation, validity and reliability analysis, the final questionnaire was divided into two parts. The first part was created to gather background information about the participants, such as age, gender, and their injury experience as well as participation in safety training courses. The influencing factors on OHS performance were presented in the second part. All of the questions were scored on a 5-point Likert scale, with verbal responses of 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The anonymity and confidentiality of the data were promised to the respondents.

2.2. Validity analysis

The initial questionnaire was sent to 16 OHS scholars (3 lecturers, 9 assistant professors, and 4 associate professors) for feedback and to assess the face and content validity. These participants had ages ranging from 29 to 45 years (mean = 36.81). The participants had a minimum of two years and a maximum of fifteen years of work experience (mean = 8.49).

For face validity, the participants were requested to assess the items in terms of difficulty of understanding, deficiencies in the meanings of phrases and words, to use of words and placement of items in the scale, degree of fitness and their relationship with dimensions of scale and to give comments about grammar. In the quantitative assessment of content validity, the experts were asked to respond to the items on necessity, relevance, simplicity, and clarity of items. The content validity of the questionnaire was assessed through the calculation of content validity ratio (CVR) and content validity index (CVI).

CVR was calculated for each item of the questionnaires [CVR = (ne-N/2)/(N/2)]. The mean of item CVRs was computed to calculate the CVI [36]. We conducted Exploratory Factor Analysis (EFA) to identify the OHS performance underlying factors. Then ▣Confirmatory Factor Analysis (CFA) was performed to confirm the identified dimensional structure of the scale. Furthermore, the association between the OHS performance and occupational injuries was investigated to test the criterion validity.

2.3. Reliability analysis

Test-retest reliability was investigated to measure the reproducibility of the questionnaire. Twenty-five employees completed the questionnaire twice within 1 month (15 to 29 d). Etiologies of employees included production (N = 10), maintenance and repair (N = 15). The majority (96.2%) of the employees were male. Most of these employees were aged 40–49 years and they had >10 years of working experience. Intraclass correlation coefficients (ICCs) were utilized to determine test-retest reliability. The coefficient of Cronbach's α was calculated to evaluate the internal consistency of the scale.

2.4. Feasibility of study

The present study was conducted over five months, from December 2019 to April 2020 in private manufacturing companies in the West Azerbaijan province in Iran. Thirty active companies were contacted, and after explaining the study objectives to their senior managers, 12 companies agreed to cooperate. Manufacturing activities of the companies included power generation and production of construction materials, food and beverage, auto parts, gloves, and metal equipment. A total of 850 questionnaires were distributed among the participants. The participants were randomly selected from all units of the companies to fill out the questionnaires. Verbal consent was obtained from all subjects before participating in this study. Following data collection and verification, statistical analysis was performed on 600 (70.58%) correctly completed questionnaires.

The participants were asked about their experience of occupational injury during the past 3 years. In addition, the recorded occupational injuries in the companies for the year of study were obtained.

A large number of participants is more satisfactory for conducting factor analysis. The recommendations for absolute sample sizes vary from a minimum of 50 participants to 300 or more, while other recommendations are framed in terms of ratios such as a five-to-one or a twenty-to-one ratio of participants to-variables [37]. Other researchers have suggested conducting factor analysis with a sample size of 200 to 300 [38]. Since a large number of self-reported questionnaires recommended for factor analysis, more than 50 questionnaires were distributed in each medium-sized company.

We employed descriptive statistics to describe the individual characteristics of the participants. Pearson's r coefficient was used to determine the relationships between background variables and OHS influencing factors. Hierarchical multiple regression analysis was applied to identify the predictive factors associated with OHS performance. In the first step, the demographical control variables of gender, age, marital status, education, job, recruitment, experience, and job tenure were entered. In the next step, the organizational factors of the company, having the OHSMS in place as well as injury and OHS training experiences were added to the regression equation. Binary logistic regression analysis was used to identify the factors that probably influenced injury experience. The logistic regression model estimated the odds ratio (OR) and 95% confidence interval (CI). Poisson regression was used for modeling the influencing factors on registered occupational injuries. The statistical analyses were performed using SPSS software (V.20) and AMOS (V.18) was used for conducting CFA.

Normality was tested using the skewness and kurtosis. Because our sample sizes were greater than 300, we employed the histograms and the absolute values of skewness (larger than 2) and kurtosis (larger than 7) [39]. Before starting data analysis, all of the completed questionnaires ($N = 616$) were checked to systematic response patterns to ensure that no more than 5% of the items were missing [40,41]. A total of 16 questionnaires were excluded from the study because they contained missing patterns at unacceptable levels. It was found that the distribution of missing data in 600 questionnaires was random and less than 5%. Prior to statistical analysis, the median score for the item was used to fill in all missing data. The ceiling and floor effects per item ranged from 4.0 to 26.2% to 2.0 to 21.8%, respectively.

2.5. *Ethics statement*

This investigation was performed based on the Helsinki statement and ethical aspects of human research. The present study was approved by the Ethics Committee of Urmia University of Medical Sciences, Iran (IR.UMSU.REC.1395.593). The participants were assured that the data would remain anonymous and confidential. Informed consent was obtained from all participants.

3. Results

459 (76.5%) of the participants were married and the majority of them, 453 (75.5%), were male. 384 (64%) of them were working in production units of the companies, and 412 (68.7%) had high school or university education. Most of the participants, 243 (40.5%), were between the ages of 31 and 39, and all had a temporary employment contract. 208 (34.7%) participants had 6–10 years of work experience, while 206 (34.3%) had 1–5 years of job tenure. Thirty-nine (6.5%) of the study participants had experienced at least one occupational injury in the past three years and 298 (49.7%) of them had received OHS training (Table 1).

The questionnaire's validity analysis revealed that 93 of the 134 items (69.40%) had an excellent validity. Eleven items had unacceptable CVR, and thirteen items had a low CVI. The acceptable level of CVR for 16 experts is > 0.47 [36] and for the CVI is < 0.79 [42]. Seventeen items had both unacceptable CVR and CVI. Therefore, 41 items were kept out from the initial questionnaire. Participants made minor suggestions to improve the clarity of the wording.

The EFA using principal component analysis with varimax rotation method resulted in the retention of eleven factors, but one was removed due to the few items (less than 3). The sampling adequacy index (KMO) was greater than 0.7 and Bartlett's test of sphericity result was significant [43–45]. The result of CFA showed that the OHS performance model is satisfactory ($\chi2 = 14145.1$, $df = 2804$, $p = 0.001$, $RMSEA = 0.08$, $RMR = 0.013$). Although the result of dividing the $\chi2$ value by df was greater than the acceptable value of 2 and the Root Mean Square Error of Approximation (RMSEA) value was greater than the acceptable value (<0.06), but the Root Mean square Residual (RMR) index showed an acceptable value (≤ 0.05), which indicates the fit of the model [46, 47] (see Table 2).

Test-retest reliability analysis using Spearman's rank-order correlation showed a strong and positive statistically significant correlation (r [25] = 0.75, $p = 0.001$). The intraclass correlations of the test–retest survey for full scale was 0.88 (CI: 0.83–0.92) and for all factors was more than 0.70. The Cronbach's α for the whole scale was 0.96. Thirty-three items were removed from the scale because of low reliability. Thus, nine factors (60 items) were retained for the final questionnaire.

The OHS performance influencing factors are ranked in descending order of their mean score in Table 2. The safety systems (3.54) and the OHS incentives (2.91) gained the highest and lowest scores, respectively. The reliability measure for the final scale was 0.96, and the reliability coefficients of the factors ranged from 0.70 to 0.93 (Table 3).

Table 4 represents the mean, standard deviation, and correlation coefficient of the variables. OHS influencing factors showed significant positive correlations with gender ($r = 0.21$, $p < 0.01$), injury experience ($r = 0.11$, $p < 0.01$), and OHSMS ($r = 0.10$, $p < 0.05$), whereas OHS influencing factors had significant negative correlations with marital status ($r = -0.12$, $p < 0.01$), job ($r = -0.09$, $p < 0.05$), job tenure ($r = -0.08$, $p < 0.05$), and training experience ($r = -0.19$, $p < 0.01$).

Table 1
Demographic characteristics of the participants.

Variable	N (%)	Variable	N (%)	Variable	N (%)
Gender		Age (years)		Educational level	
Female	147 (24.5)	<30	190 (31.7)	Elementary	66 [11]
Male	453 (75.5)	30–39	343 (40.5)	Secondary	122 (20.3)
Marital Status		40–49	140 (23.3)	High-school	225 (37.5)
Married	141 (23.5)	50–59	26 (4.3)	University	187 (31.2)
Single	459 (76.5)	≥60	1 (0.2)	**Nature of job**	
Working Experience (years)		**Job tenure (years)**		Production	384 (64)
<1	65 (10.8)	<1	108 (18)	Maintenance	141 (23.5)
1–5	183 (30.5)	1–5	206 (34.3)	Office	52 (8.7)
6–10	208 (34.7)	6–10	192 (32)	Warehouse	13 (2.2)
>10	144 (24)	>10	94 (15.7)	Other	10 (1.7)

Table 2
The results of the exploratory factor analysis.

Factors/Items	Factor loading	Variance explained (%)	Cumulative variance explained (%)
1. Management Commitment		**18.09**	**18.09**
The operational concerns and processes that affect OHS are well-understood by management.	**0.83**		
OHS is a key priority for the company's management.	**0.80**		
My workplace's managers are seriously concerned about OHS.	**0.79**		
OHS policies are strictly followed by managers.	**0.79**		
The company is very cautious about its employees' safety.	**0.79**		
Employees who do their duties safely get respect from their managers.	**0.79**		
Management of safety is equally as important as management of production.	**0.77**		
Adequate resource management is dedicated to OHS.	**0.77**		
Managers acts quickly and decisively when it comes to OHS.	**0.73**		
I always have the tools and equipment I need to execute my job safely.	**0.57**		
I believe that management has a tendency to neglect safety regulations because of increased production.	**0.47**		
2. OHS Communication and consulting		**9.67**	**27.77**
The company is interested in my opinions on OHS.	**0.78**		
Employees can openly discuss safety concerns with supervisors and managers.	**0.75**		
My manager/supervisor does not always inform me of current safety concerns and issues.	**0.75**		
I always report OHS problem to management if I notice it in the company.	**0.74**		
Managers and supervisors regularly consult with workers on OHS.	**0.73**		
Personnel are consulted on determining training needs.	**0.72**		
Employees are given positive feedback on OHS proposals.	**0.72**		
Regular short-term OHS sessions are common in my workplace.	**0.64**		
Employees are properly informed on changes in operating processes and the work environment, as well as their implications for OHS.	**0.52**		
Safety and health information (results of safety sessions, causes of accidents/events, etc.) is promptly disseminated to the appropriate personnel.	**0.51**		
Employees are uninformed of the company's OHS performance's macro and micro goals.	**0.43**		
Our company lacks a hazard reporting system that allows employees to report hazards before incidents occur.	**0.41**		
3. OHS Training		**4.10**	**31.88**
Workers who are newly hired are given proper training on OHS procedures.	**0.73**		
Workers receive comprehensive OHS training from the company.	**0.71**		
Personnel receive adequate OHS training at regular periods to retrain and upgrade their knowledge.	**0.68**		
OHS is a top priority when it comes to participation in training programs.	**0.67**		
The company's safety training equips employees with the necessary skills and experience to conduct operations safely.	**0.57**		
I will receive appropriate training when new procedures and equipment are introduced.	**0.57**		
I am not trained enough to respond to emergencies at work.	**0.45**		
4. OHS Regulations		**3.63**	**35.52**
OHS authorities put a number of statutory restrictions on manufacturing companies.	**0.61**		
OHS authorities offer good incentive programs such as insurance discounts, taxes or financial assistance for manufacturing companies with good OHS performance.	**0.60**		
OHS authorities have good reward system in place for well-behaved employees.	**0.60**		
OHS regulations are properly enforced in our country.	**0.58**		
Manufacturing companies must follow OHS legal requirements, which are closely monitored by OHS authorities.	**0.55**		
OHS authorities can offer advice on how to follow OHS rules and regulations.	**0.54**		
Existing OHS rules and regulations meet our company's OHS needs.	**0.51**		
5. Safety systems		**3.41**	**38.93**
People interested to report accidents, near-accidents, and potentially unsafe conditions.	**0.74**		
It is quite easy to communicate concerns related to working with the safety unit in this company.	**0.72**		
Managers are seriously considered safety suggestions.	**0.71**		
Emergency preparedness is good in this company.	**0.61**		
High-risk operations are always carefully evaluated before starting.	**0.50**		
The safety unit is performing its job well.	**0.46**		
6. Participation		**3.37**	**42.30**
I help with the development and revision of workplace OHS policies and procedures.	**0.78**		
I involve in risk assessments, safety inspections, and accident investigations.	**0.74**		
Employees involve in making decisions that affect their workplace's safety.	**0.59**		
I endeavor to make my workplace a safer environment.	**0.56**		
I voluntary participate in initiatives that help to promote safety.	**0.51**		
My unit manager is intimately involved in safety activities.	**0.49**		
7. Physical environment		**2.90**	**45.20**
Employees work in areas with adequate lighting.	**0.75**		
Employees work in conditions that are comfortable in terms of temperature and humidity.	**0.75**		
Employees work in environments with an appropriate level of noise.	**0.55**		

(*continued on next page*)

Table 2 (*continued*)

Factors/Items	Factor loading	Variance explained (%)	Cumulative variance explained (%)
Employees work in conditions that are free of pollutants (free of pollution).	**0.49**		
Harmful agents (such as noise, lighting, air pollution, and so on) are examined on a regular basis in my workplace.	**0.42**		
8. Supportive work environment		**2.79**	**47.99**
I am strongly encouraged to report unsafe conditions or OHS problems.	**0.74**		
All members of my team are fully committed to OHS.	**0.70**		
My coworkers are seriously treating persons who violate OHS principles.	**0.64**		
9. Incentives			
Workers are encouraged to provide OHS suggestions.	**0.64**	**2.55**	**50.54**
Workers are encouraged to work in a safe manner.	**0.57**		
Safe behavior is a key factor when it comes to promoting employees.	**0.41**		

Table 3
Mean, standard deviation and Cronbach's alpha for factors affecting OHS performance.

Factors	Number of items	Mean	SD	ICC	CI	Cronbach α
Safety systems	6	3.54	0.65	**0.83**	**0.71–0.91**	0.72
Management commitment to OHS	11	3.44	0.91	**0.91**	**0.85–0.95**	0.93
Employee participation	6	3.35	0.67	**0.85**	**0.75–0.92**	0.73
OHS training	7	3.34	0.77	**0.87**	**0.79–0.94**	0.83
Supportive environment	3	3.26	0.92	**0.71**	**0.49–0.85**	0.70
OHS communications and consultation	12	3.15	0.68	**0.87**	**0.79–0.93**	0.84
Physical environment	5	3.10	0.90	**0.77**	**0.62–0.89**	0.80
OHS regulations	7	2.94	0.78	**0.92**	**0.86–0.96**	0.84
Incentives	3	2.91	0.99	**0.83**	**0.70–0.91**	0.85

The results of hierarchical multiple regression analysis revealed that training experience ($\beta = -0.37$, $t = -7.35$, $p < 0.01$) and company ($\beta = -0.04$, $t = -3.58$, $p < 0.05$) negatively affected the OHS performance (see Table 5). In contrast, gender ($\beta = 0.29$, $t = 4.23$, $p < 0.01$), injury experience ($\beta = 0.25$, $t = 2.52$, $p < 0.05$), and OHSMS ($\beta = 0.27$, $t = 3.08$, $p < 0.01$) positively affected the OHS performance. In step 1, the demographic variables accounted for 4% of OHS performance [F (8, 591) = 27.77, $p < 0.01$]. In step 2, the participants' injury and training experiences as well as the organizational variables of the company and OHSMS accounted for 14% OHS performance [F (4, 594) = 16.36, $p < 0.01$].

Logistic regression was performed to ascertain the effects of gender, age, marital status, education, job, recruitment, work experience, job tenure, training experience, company size, OHSMS, and OHS performance on the likelihood that participants had injury experience or not. The regression model was statistically significant, χ^2 (19) = 52.36, $p < 0.001$. The model explained 22% (Nagelkerke R^2) of the variance in injury experience and correctly classified 84% of the cases. The size of the company was associated with an increased likelihood of experiencing an occupational injury (OR = 1.39, CI = 1.06–1.82), but the lack of OHSMS in the company was associated with the experience of occupational injury (OR = 0.09, CI = 0.02–0.55). Participants who had received more safety training reported having more injury experience (see Table 6).

Poisson regression was run to predict the rate of registered occupational injuries in the year of study based on the OHS performance. The Poisson model was significant [$\beta = 0.95$, χ^2 (1) = 27.92, (95% CI, 0.59 to 1.30), $p < 0.001$].

4. Discussion

In the present study, a questionnaire was developed to evaluate OHS performance in manufacturing companies. The findings showed that the designed tool had acceptable validity and reliability. Using the 9-factor questionnaire, participants from the companies determined the main factors influencing OHS performance in their work environments. Previous research have also highlighted the factors identified in the current investigation as important factors affecting OHS [15,16,25,48,49,50]. However, the factors affecting OHS performance may vary from industry to industry and from company to company. We offer the developed questionnaire as a valid and practical tool to evaluate OHS performance in manufacturing companies, especially in developing countries. One of the main advantages of this method is collecting quick information to measure OHS performance in manufacturing companies. It can be an acceptable method to check OHS performance in the absence or lack of confidence in the results of reactive indicators.

We developed a standard tool that measures the OHS performance with good psychometric properties. The potential items were gathered through literature reviews, which supported the content validity of the scale. The application of a nine-factor model for assessing OHS performance is supported by the CFA findings. The significant association between OHS performance and occupational injury well as the registered occupational injuries revealed good criterion validity of the developed tool. Each factor of the developed tool showed acceptable internal consistency and repeatability. The current findings are acceptable when compared to other questionnaires such as safety climate scales [32,51]. The high rate of participation and low percentage of missing values point to the validity of our scale. The scale is an acceptable survey tool for evaluating OHS performance in Iranian manufacturing companies because all items had negligible ceiling or floor effects.

Table 4
Means, standard deviations, and correlation coefficients among the variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Gender	–																				
2. Age	−0.14**	–																			
3. Marital Status	−0.28**	0.38**	–																		
4. Education	−0.09*	0.13**	−0.09*	–																	
5. Job	−0.14**	0.16**	0.12**	0.12**	–																
6. Recruitment	−0.72	0.06	−0.02	−0.05	−0.02	–															
7. Experience	−0.37**	0.72**	0.34**	0.38	0.24**	0.47	–														
8. Job tenure	0.33**	0.63**	0.29	−0.01	0.19**	0.04	0.87**	–													
9. Injury experience	0.12**	−0.06	−0.06	0.34	0.01	−0.01	−0.16**	−0.16**	–												
10. Training experience	0.28**	−0.06	−0.08*	0.17**	−0.02	−0.04	−0.15**	−0.16**	0.02	–											
11. Company	0.37	−0.16**	−0.05	−0.36**	−0.15**	0.03	−0.35**	−0.29**	0.09*	0.09*	–										
12. OHSMS	0.39**	−0.11**	−0.10*	−0.49**	−0.26**	−0.04	−0.42**	−0.38**	0.06	0.08*	0.76*	–									
13. OHS regulation	0.08*	0.01	−0.04	−0.05	−0.04	−0.01	0.005	0.02	0.07	−0.15**	−0.06	−0.03	–								
14. Management Commitment	0.39**	0.02	−0.13**	−0.13**	−0.08*	−0.06	−0.11**	−0.12**	0.10*	−0.04	−0.11**	0.19**	0.62**	–							
15. OHS Participation	−0.19**	0.09*	−0.01	−0.03	0.03	0.04	0.17**	0.12**	−0.03	−0.40**	−0.12**	−0.15**	0.41**	0.43**	–						
16. OHS Communication & Consultation	−0.16**	0.05	−0.002	−0.02	0.06	0.06	0.11**	0.07	−0.006	−0.40**	−0.03	−0.10**	0.48**	0.44**	0.71**	–					
17. OHS training	0.30**	−0.002	−0.13**	−0.25**	−0.09*	−0.03	−0.10*	−0.10*	0.13**	−0.22**	0.05	0.27**	0.56**	0.75**	0.50**	0.55**	–				
18. Safety systems	0.08*	−0.01	−0.07	−0.02	−0.03	0.003	−0.02	−0.05	0.07	−0.17**	0.04	0.10**	0.44**	0.56**	0.47**	0.61**	0.59**	–			
19. Physical Environment	0.31**	−0.07	−0.09*	−0.10*	−0.13**	−0.02	−0.17**	−0.17**	0.16**	0.02	0.18**	0.26**	0.44**	0.53**	0.21**	0.29**	0.55**	0.50**	–		
20. OHS incentives	0.21**	−0.12**	−0.13**	−0.01	−0.07	−0.02	−0.11**	−0.12**	0.12**	−0.07	−0.02	0.02	0.56**	0.61**	0.40**	0.48**	0.64**	0.53**	0.67**	–	
21. Supportive environment	0.25**	−0.06	−0.16**	−0.03	−0.09*	−0.03	−0.09*	−0.12**	0.07	−0.07	−0.10*	0.07	0.53**	0.67**	0.44**	0.46**	0.66**	0.55**	0.54**	0.73**	–
22. OHS factors	0.21**	−0.02	−0.12**	−0.09*	−0.07	−0.01	−0.06	−0.08*	0.11**	−0.19**	−0.02	0.10*	0.73**	0.82**	0.63**	0.70**	0.84**	0.74**	0.71**	0.84**	0.83**

*$p < 0.05$; **$p < 0.01$.

Table 5
Results of the hierarchical multiple regression analysis for factors influencing OHS performance.

Step	Step 1		Step 2	
Variables	B	t	β	T
Gender	0.30**	5.27	0.29**	4.23
Age	0.008	0.19	0.02	0.53
Marital Status	−0.06	−1.6	−0.08	−1.99
Education	−0.07	−1.9	0.008	−0.17
Job	−0.04	−1.07	−0.03	−0.81
Recruitment	−0.01	−0.09	−0.001	−0.03
Experience	0.01	0.40	0.009	−0.20
Job tenure	−0.01	−0.38	−0.04	−0.98
Injury experience			0.25*	2.52
Training experience			−0.37**	−7.35
Company			−0.04**	−3.58
OHSMS			0.27**	3.08
R^2	0.04		0.14	
F	27.77**		16.36**	
ΔR^2	0.04		0.09	

*p < 0.05; **p < 0.01.

According to the results, our participants rated the safety system and safety incentives as the factors with the most and least influence on OHS performance of the manufacturing companies. The safety system includes supervision, procedures, permits, working environment, and personnel. The presence of these elements is necessary in an organization to better management of OHS [52]. The positive effect of financial and moral incentives in improving OHS performance was confirmed [53,54]. It is believed that incentives encourage and promote safety behavior and ultimately improve safety performance [55]. However, critics argue that safety incentive programs do not lead to long-term safety improvements [56]. Therefore, it may be prudent to use the implementation of incentive programs and in conjunction with other safety programs, to help improve safety performance within the organization.

Attention to safety in organizations can have a positive effect on improving safety performance. By prioritizing safety in an organization, workers may adopt more safety practices, leading to improved performance. It is preferable to create the right safety mindset among manufacturing company personnel through proper safety training [57]. In addition, safety issues should be detected through routine investigations to establish effective controls and preventive policies.

Previous research has found that implementing OHSMS in organizations led to beneficial changes in the management of OHS, and that their success was mostly related to management commitment to OHS, and employee participation [16,58,59,60]. The current study found that participants in OHSMS certified companies experienced fewer injuries, which is in line with the findings of a previous study [61]. However, it should be noted that having an OHSMS certification in an organization does not guarantee the improvement of OHS performance. Previous studies have also indicated that larger firms perform better in OHS than smaller ones because they have better human, financial, and technological resources. In this study, participants from larger companies reported fewer injuries, which

Table 6
Logistic regression analyses for injury experience.

Variables	Estimated coefficient	Estimated standard error	Wald statistic (W)	Exp(B)	95% confidence limits	
					Lower	Upper
Gender	1.24	0.89	1.92	3.47	0.60	20.15
Age	0.06	0.30	0.04	1.07	0.58	1.94
Marital status	−0.06	0.57	0.01	0.94	0.30	2.86
Education	0.26	0.22	1.51	1.31	0.85	1.99
Job	0.24	0.28	0.73	1.27	0.73	2.18
Work experience	−0.40	0.42	0.92	0.69	0.29	1.52
Job tenure	−0.32	0.33	0.98	0.72	0.38	1.37
Training experience	−0.04	0.43	0.01	0.96	0.41	2.22
Company	0.33	0.14	5.86*	1.39	1.06	1.82
OHSMS	−2.37	0.91	6.76**	0.09	0.02	0.55
Factor 1	−0.07	0.28	0.07	0.93	0.53	1.61
Factor 2	0.40	0.36	1.18	1.49	0.72	3.05
Factor 3	−0.55	0.40	1.84	0.58	0.26	1.27
Factor 4	−0.86	0.51	2.84	0.42	0.15	1.14
Factor 5	1.42	0.47	9.07**	4.14	1.64	10.42
Factor 6	0.10	0.34	0.09	1.11	0.57	2.16
Factor 7	0.30	0.28	1.10	1.35	0.77	2.36
Factor 8	−0.16	0.31	0.26	0.85	0.46	1.56
Factor 9	−0.21	0.28	0.54	0.81	0.46	1.41
Constant	3.05	2.64	1.33	21.13		

*p < 0.05; **p < 0.01.

is consistent with findings from previous research [62]. As a result, our participants who worked for smaller companies or companies that did not adopt an OHSMS reported more occupational injuries.

If safety training is tailored to the unique needs of each organization's employees, it has the potential to improve employees' attitudes and knowledge regarding safety; otherwise, it will have little impact on the organization [63,64,65]. Effective safety training can help employees change their behavior, resulting in fewer incidents. But our participants who had previously undergone safety training sessions reported more injuries. It seems that the training of these participants was inefficient or may did not meet their needs and led to negligible change in their safety attitudes. Of course, since these employees knew better about their reporting position, they could have reported all the incidents rather than cover them up. In addition, different factors can affect the safety performance of organizations, with the positive or negative outcome represented in OHS performance indicators such as the number of occupational injuries. These factors include safety culture, investments, commitment, and training [58,66,67]. The current study confirmed previous findings by showing a significant relationship between occupational injuries and factors affecting OHS. Therefore, the performance of OHS in organizations can be enhanced by performing appropriate actions such as effective safety training to better management of OHS influencing factors.

The failure of reactive OHS performance indicators to recognize short-term change and determine the causes of system failures has led to criticism of these indicators. Given the challenges associated with these indicators, the developed tool can assist manufacturing companies in evaluating their OHS performance. To our knowledge, this is among the first studies to develop a standard tool to evaluate OHS performance in manufacturing companies in developing countries. The scale's questions were derived from multiple scientific sources, and its content validity was quantitatively evaluated using the opinions of OHS experts. Furthermore, the relationship between different factors of the questionnaire and the experience of occupational injury as well as the registered occupational injuries may justify the use of the tool to study the factors affecting OHS performance.

It is a useful tool to evaluate OHS performance and identify important factors that have a significant impact on OHS performance in manufacturing companies. The proposed method can provide managers valuable information on the factors influencing OHS performance by emphasizing factors with a low score. Then the managers of the companies should make sufficient efforts to solve the problems in the field of related factors.

Measuring OHS performance, especially using reactive indicators, is a complex and time-consuming task. In some companies, there is no reliable system for reporting and recording occupational incidents [26]. Reactive assessments of OHS performance will be impossible in these companies. Along with reactive indicators, this measurement can be useful in evaluating OHS performance. Therefore, in order to obtain a more comprehensive view of the organization's OHS performance, it is recommended that manufacturing companies employ the method provided in this study to prospectively measure OHS performance in conjunction to the use of reactive indicators. However, this tool still requires improvement and testing. Considering that several factors may affect OHS status of an organization, employing the developed tool in subsequent research and after carrying out additional investigations can be very beneficial in obtaining a comprehensive tool for measuring OHS performance in manufacturing companies.

This study had limitations, including the fact that the data required for analysis came from a cross-sectional survey. The present study was only investigated criterion validity by measuring agreement between its OHS performance scores and occupational injury. The self-reporting of measures is another limitation that may raise concerns about bias. Of course, because one of the researchers was often present at the study sites, the concerns and queries of the participants were addressed. Furthermore, the relatively high number of returned questionnaires helped to alleviate some of the issues mentioned. However, it should be noted that due to the limited research funding, additional questionnaires could not be completed. It should also be noted that obtaining the permission and cooperation from the manufacturing companies and their employees to participate in the current study was not an easy process.

5. Conclusion

The result of this study showed that the developed scale had satisfactory validity and reliability. The scale was developed in response to the need for developing a tool for measuring OHS performance in manufacturing companies in Iran. We recommend re-examining the validity and the reliability of the scale with a larger and more diverse sample of manufacturing employees. It is recommended that in the next validation studies using this tool, the findings also compare with the findings of studies using standard safety climate and behavior questionnaires. Such examination will be warranted for the validity and reliability of the scale across various companies. The development of safety systems and a renewed emphasis on the execution of incentive programs in the workplace could have a substantial impact on OHS. Implementing the requirements of an OHSMS may have a positive influence on OHS performance and result in fewer employee injuries. Increasing OHS training also can help manufacturing organizations improve their OHS performance.

Author contribution statement

Abolfazl Ghahramani: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.
Mahbob Ebrahimi: Performed the experiments; Contributed reagents, materials, analysis tools or data.
Mohammad Hajaghazadeh: Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e17343.

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