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Original Article

Development and Validation of a Safety Climate Scale for Manufacturing Industry

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A B S T R A C T

Background: This paper describes the development of a scale for measuring safety climate.
Methods: This study was conducted in six manufacturing companies in Iran. The scale developed through conducting a literature review about the safety climate and constructing a question pool. The number of items was reduced to 71 after performing a screening process.
Results: The result of content validity analysis showed that 59 items had excellent item content validity index ($\geq$ 0.78) and content validity ratio (> 0.38). The exploratory factor analysis resulted in eight safety climate dimensions. The reliability value for the final 45-item scale was 0.96. The result of confirmatory factor analysis showed that the safety climate model is satisfactory.
Conclusion: This study produced a valid and reliable scale for measuring safety climate in manufacturing companies.

1. Introduction

Safety climate is an important indicator of safety performance, and it is used for predicting safety related outcomes such as safety behavior and occupational accidents/injuries [1,2]. The existence of a valid scale for measuring the safety climate is very important and it can facilitate the collection of accurate data [3,4]. Validity test of a safety climate scale is considered as a real test to reveal the safety level in an organization, and the test aims to improve the quality of required data [5]. The assessment of reliability only describes the level of measurement errors of a scale.

Many studies have investigated the construction of the safety climate in organizations. However, they have not reached a common agreement on safety climate dimensions [6–9]. The review of previous studies showed that management commitment to safety is a common dimension for safety climate [10–13]. Seo et al [3] indicated that the safety climate dimensions can be categorized into five themes: management commitment to safety, supervisor safety support, coworker safety support, employee participation in safety decision making and activities, and competence level of employee with regard to safety. A review of 18 safety climate surveys by Flin et al [5] revealed that safety system, management/supervision, risk, work procedure, and competence were the most frequent dimensions. Flin et al [11] also identified work pressure as another frequently used dimension. Safety communication, safety training, supportive and supervisory environments, in addition to safety rules and procedures were found as other dimensions of the safety climate [10,12,13].

Several methods are typically used to assess the validity of a measurement instrument. The content validity of an instrument can be examined in development and judgment stages. The development stage is usually carried out through performing a comprehensive literature review or conducting interviews with focus groups. The judgment stage is accomplished through the application of either quantitative or qualitative methods. The quantitative analysis of the content validity is determined by the application of statistical methods. The qualitative approach only depends on the opinion of experts. Several studies have

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investigated the content validity analysis by reviewing the literature and by using an expert panel [3,13]. Many researchers have examined the content validity of safety climate scales using a qualitative method. However, few of them presented enough evidence for the analysis of the content and the construct validity [3]. Therefore, the quantitative examination of the content validity is not a common method for analysis of the safety climate scales. In addition, experts conduct the face validity analysis through the review of an instrument. They check the instrument to ensure it measures what it is supposed to measure [14]. The construct validity is examined using statistical methods. A large number of researchers have employed the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to evaluate the construct validity of the safety climate scales [15–18].

Many instruments have been developed to measure the safety climate in various industries worldwide. To the authors' knowledge, this study is the first one to develop and to validate a safety climate scale for manufacturing industry in Iran. Because of the unique nature of safety climate and context culture in countries, industries, companies, and even different sectors of an organization [19,20], we found a need to develop a new scale to examine the safety climate. Kudo et al [21] identified the necessity to produce a standard safety climate questionnaire to collect appropriate data. The authors also recognized the need for specific safety climate dimensions for each occupation. Therefore, it is important to develop an original scale to measure the safety climate in Iranian manufacturing companies. In this study, we developed a new safety climate scale and explored the validity and the reliability of the scale.

2. Materials and methods

The present study was conducted to test the validity and the reliability of a newly developed scale for measuring safety climate in the manufacturing industry. A total of 50 people participated in the content and the face validity analyses. The first group of participants were faculty members ($n = 14$) who researched occupational health and safety (OHS) and worked at two universities in Tehran (the capital city) and Urmia (the capital of the west Azerbaijan province) in Iran. The second group were OHS officers ($n = 10$) who worked at manufacturing companies in Urmia. The last group were employees ($n = 26$) who worked at three manufacturing companies in Urmia. Other group of employees ($n = 26$) from the companies participated in a test–retest reliability study, and they refilled questionnaires after a 3-week period. The employees were randomly chosen for the validity and the reliability analyses. A total of 269 employees participated in this study who worked in six manufacturing companies in the West Azerbaijan Province in Iran to collect required data for performing EFA, CFA, and final reliability analysis. The authors obtained written permission from the companies to conduct this study and asked respondents to participate voluntarily in the survey.

A literature review was conducted and a total of 662 safety climate items were generated from the available questionnaires in the published articles [7,8,10,17,18,22–37]. The number of items reduced to 71 after conducting a screening process for redundancy and the general aim of our study. This 71-item scale was translated to the Farsi language (the official language in Iran). Then, we examined the validity and reliability of the translated scale. All safety climate items were rated on a 5-point Likert-type scales with phrases of strongly disagree and strongly agree on Point 1 and Point 5 to conduct the reliability analysis and EFA.

The content and the face validity of the scale were examined by the OHS experts (faculty members and OHS officers) and by the employees. We used a different measurement criteria for examining the content validity. The criterion for measuring the content validity by the OHS experts included three categories: (1) essential; (2) useful, but not essential; and (3) not necessary [38]. Further, we asked the OHS experts to write their comments about the ambiguity and the clarity of the items to evaluate the face validity. A different criterion was used for the employee sample [39]. The employees were asked to rank each of the safety climate items for relevancy, clarity, and simplicity using a 4-point Likert-type arrangement: (1) not relevant (clear or simple); (2) item needs some revision; (3) relevant (clear or simple) but need minor revision; and (4) very relevant (clear or simple).

We employed descriptive statistics to describe the individual characteristics of the participants and to examine the content validity of the scale. Content validity ratio (CVR) was calculated for each item of the questionnaires, which filled out by the OHS experts [$CVR = (n_e - N/2)/(N/2)$]. The mean of item CVRs was computed to calculate the content validity index (CVI) [38]. For each item of the questionnaires, which were filled out by the employees, we calculated an item content validity index (I-CVI) as the number of "3" and "4" responses/number of experts $\times$ 100 [39]. After that, the scale content validity index (S-CVI) was calculated for whole items of each questionnaire through obtaining the average of all I-CVIs. We conducted EFA to identify the safety climate' underlying dimensions. Intraclass correlation coefficient (ICC) and Cronbach α were calculated. Then, CFA was performed to confirm the identified dimensional structure of the scale. The statistical analyses were performed using SPSS version 21 software (SPSS Inc., Chicago, IL, USA), and AMOS version 21 (IBM) was used for conducting CFA.

3. Results

Fifty people participated in the content and the face validity analyses of the safety climate scale. As shown in Table 1, the majority of the faculty members (92.9%) of employees (84.2%) were male. The age pattern revealed that most respondents of the three groups of the participants were aged 30–39 years. Most of the OHS experts had 1–5 years of working experience and most of the employees (36.4%) had 6–10 years of working experience. The majority (96.2%) of the employees who participated in the test–retest reliability analysis were male. Most of these employees were aged 40–49 years, and 34.6% of them had > 20 years of working experience.

Table 1

Demographics of the participants in the content validity and the reliability analyses

Variables	Validity analysis			
	Faculty members ($n = 14$)	OHS officers ($n = 10$)	Employees ($n = 22$)	Reliability analysis ($n = 26$)
Gender				
Male	13 (92.9)	5 (50)	18 (81.8)	25 (96.2)
Female	1 (7.1)	5 (50)	4 (18.2)	1 (3.8)
Age (y)	40.7 (10.7)*	32.7 (7.00)*	35.5 (10)*	41.85 (8.05)*
< 30	2 (14.3)	4 (40)	5 (22.7)	3 (11.5)
30–39	6 (42.9)	4 (40)	16 (72.7)	5 (19.2)
40–49	3 (21.4)	2 (20)	—	14 (53.8)
50–59	2 (14.3)	—	2 (4.5)	4 (15.4)
≥ 60	1 (7.1)	—	—	—
Working experience (y)	10.6 (9.5)*	8 (6.05)*	11.6 (7.70)*	15.73 (7.65)*
< 1	1 (7.1)	1 (10)	—	1 (3.8)
1–5	6 (42.9)	4 (40)	5 (22.7)	4 (15.4)
6–10	2 (14.3)	2 (20)	8 (36.4)	3 (11.5)
11–15	—	2 (20)	1 (4.5)	2 (7.7)
15–20	1 (7.1)	1 (10)	6 (27.3)	7 (26.9)
> 20	4 (28.6)	—	2 (9.1)	9 (34.6)

Data are presented as n (%), unless otherwise indicated.

* Mean and standard deviation in years provided for age and working experience of the participants.