Research Article
Volume 10:2, 2025

International Journal of Public Health and Safety

ISSN: 2736-6189 Open Access

Development of Perceived Workplace Safety Scale for the Chemical Industry

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Abstract

The chemical industry is inherently associated with various risks and hazards, making workplace safety a critical concern. A comprehensive workplace safety scale is needed to accurately measure and evaluate the perceived level of safety in this industry. This study aims to develop such a scale by considering ten key dimensions: Personal Protective Equipment's (PPEs) and others, fire protection, chemical safety, safety training, safety motivation, safety personnel, participatory management, service and maintenance, emergency preparedness, and work infrastructure.

Each dimension represents a crucial aspect of workplace safety, addressing factors such as the availability and proper utilization of PPEs, fire prevention and response measures, safe handling of chemicals, comprehensive safety training, employee motivation towards safety, dedicated safety personnel, employee involvement in decision-making processes, equipment maintenance, emergency preparedness, and the quality of work infrastructure.

By incorporating these dimensions into the workplace safety scale, this study aims to provide a comprehensive and multidimensional assessment of perceived workplace safety in the chemical industry. Such a scale will enable organizations to identify areas of improvement, implement targeted safety interventions, and foster a culture of safety that protects the well-being of employees and minimizes the potential risks associated with chemical operations.

The development of a perceived workplace safety scale in the chemical industry will contribute to enhancing safety practices, reducing accidents, and promoting the overall well-being of employees within this sector. This scale will serve as a valuable tool for organizations to evaluate their safety performance, make informed decisions, and continuously improve safety measures to create a safer working environment in the challenging context of the chemical industry.

Keywords: Workplace safety • Perceived safety • Chemical industry • Safety dimensions • Personal Protective Equipment (PPEs) • Fire protection • Chemical safety • Safety training • Employee • Chemical hazards

Introduction

The chemical industry plays a critical role in the global economy, producing a wide range of products and substances that are essential for various sectors. However, the handling and processing of hazardous chemicals pose significant risks to employees' health and safety in this industry. To ensure a safe working environment, measuring and understanding employees' perceptions of workplace safety is essential. Therefore, the purpose of this study is to develop a perceived workplace safety scale specifically tailored for the chemical industry. Perceived workplace safety refers to employees' subjective assessment and evaluation of the safety conditions, practices, and policies within their work environment. It encompasses their beliefs, attitudes, and perceptions regarding the effectiveness of safety measures and the overall safety climate. By developing a scale to measure perceived workplace safety, researchers and organizations can gain valuable insights into employees' perspectives and identify areas for improvement in safety practices. While several workplace safety scales exist in general industries, they may not fully capture the unique aspects and challenges of the chemical industry. The chemical industry involves specific hazards, such as exposure to toxic substances, flammability risks, and potential explosions. Therefore, it is crucial to develop a scale that encompasses these industry-specific factors and provides a comprehensive assessment of perceived

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Received: 25 October, 2023, Manuscript No. IJPHS-23-118293; **Editor assigned:** 30 October, 2023, PreQC No. IJPHS-23-118293 (PQ); **Reviewed:** 14 November, 2023, QC No. IJPHS-23-118293; **Revised:** 17 January, 2025, Manuscript No. IJPHS-23-118293 (R); **Published:** 24 January, 2025, DOI: 10.37421/2736-6189.2025.10.434

workplace safety for chemical industry employees. This study aims to follow a rigorous methodology to develop and validate the perceived workplace safety scale for the chemical industry. The scale will be designed to measure various dimensions related to workplace safety, including hazard identification and communication, safety training and awareness, personal protective equipment usage, emergency preparedness, and overall safety climate. The scale's development will involve a thorough literature review of existing safety measures and scales, interviews with industry experts, and pilot testing with a sample of chemical industry employees. The final scale will be assessed for reliability and validity through statistical analyses and comparisons with established measures of workplace safety. The outcomes of this study will have significant implications for both research and practice in the chemical industry. Researchers can utilize the scale to measure perceived workplace safety and examine its relationships with other variables, such as job satisfaction, turnover intentions, and safety performance. Organizations within the chemical industry can use the scale to assess their safety climate, identify areas of concern, and develop targeted interventions to enhance workplace safety. In summary, the development of a perceived workplace safety scale specifically designed for the chemical industry will fill a critical research gap and provide a valuable tool for assessing employees' perceptions of safety. This study aims to contribute to the advancement of knowledge in the field of workplace safety while promoting safer working conditions in the chemical industry.

Ensuring workplace safety is of paramount importance in the chemical industry. To effectively measure and evaluate the perceived level of safety within this industry, it is essential to consider multiple dimensions that contribute to a safe working environment. This study aims to develop a comprehensive workplace safety scale that encompasses ten key dimensions: Personal Protective Equipment (PPEs) and others, fire protection, chemical safety, safety training, safety motivation, safety personnel, participatory management, service and maintenance, emergency preparedness, and work infrastructure. Each dimension represents a crucial aspect of workplace safety in the chemical industry. Personal Protective Equipment (PPEs) and others involve the availability and proper utilization of protective gear and equipment to safeguard employees from chemical hazards. Fire protection focuses on systems and measures implemented to prevent, detect, and respond to fire incidents. Chemical Safety emphasizes the safe handling, storage, and disposal of chemicals to prevent accidents and environmental damage.

Safety training dimension underscores the importance of comprehensive safety training programs that educate employees on safe work practices, hazard recognition, and emergency response protocols. Safety motivation considers factors that influence employees' motivation and commitment towards safety practices. Safety personnel dimension acknowledges the role of dedicated safety professionals who enforce safety regulations and standards, conduct risk assessments, and ensure compliance. The participatory management dimension emphasizes the active involvement of employees in decision-making processes, promoting a culture of shared responsibility and ownership for safety. The service and maintenance dimension highlights the significance of regular inspection, maintenance, and repair of equipment, infrastructure, and safety systems. Emergency preparedness dimension focuses on the preparedness, response, and mitigation strategies in the event of emergencies or hazardous incidents. Lastly, work infrastructure dimension recognizes the importance of well-designed and maintained physical facilities, equipment, and operational processes that support a safe working environment.

By developing a workplace safety scale that incorporates these ten dimensions, this study aims to provide a comprehensive and multidimensional assessment of perceived workplace safety within the chemical industry. Such a scale will enable organizations to identify areas of improvement, prioritize safety interventions, and ultimately enhance the overall safety culture and well-being of employees.

The specific objectives of the study are as follows:

- To identify the various dimensions of workplace safety in chemical industry.
- To develop and validate a multi-dimensional workplace safety scale to measure the perception of workplace safety practices among employees working in chemical industry.

Literature Review

The issue of Occupational Health and Safety (OHS) is widely discussed and significant. Despite the progress made in safeguarding workers from occupational injury, a significant number of employees still succumb to injuries or death every year. Globally, there are approximately 2 million fatalities caused by work-related accidents or diseases annually. In order to implement health and safety at work, we must create conditions, capabilities, and habits that will enable workers and their organizations to work efficiently and avoid events that could harm them [1]. A positive safety climate can help a company select, train, and support its employees, which leads to safe behaviours and fewer accidents and injuries [2]. According to Guastello, Harrell, Smith et al., employees that perceive their jobs as safe are less likely to be involved in accidents. A study by the International Labour Organization (ILO) indicates that fatal occupational injuries are nearly twice as common in developing countries as in developed countries, suggesting a potential link between advancement level and fatality rates [3]. The concept of risk is generally defined as the "expecting loss or damage associated with a possible undesired event" [4]. In a production process, accidents and injuries are adverse events. In a controlled environment, different types of energy interactions occur. There are times, however, when control is lost, and energy is transferred uncontrollably, resulting in an accident. Several studies use the terms accident and injury interchangeably. It is important to remember, however, that not every accident results in injury, rather every injury is caused by an incident [5]. Burke and Hutchins define safety behaviour as the actions or behaviours employees exhibit to promote the health and safety of co-workers, clients, the public, and the environment. Training the

employees on safety is the most significant safety management practice pertaining to safety performance factors [6]. In order to maximize safety motivation and safety knowledge, the company can choose, train, and support its staff by creating a positive safety climate [7]. Safe behaviours result from this, which reduces accidents and injuries. Due to the significance of personal safety in extremely risky situations, safety training tends to influence safety-related knowledge acquisition when working conditions are more hazardous [8]. An organization's total safety performance may be improved by a commitment to safety unifying safety-related human resource practices [9]. The psychological traits of workers in different nations may vary due to geographic influences brought on by cultural differences [10]. Additionally, it's crucial to consider the demographics of the trainees because these could have an impact on STT [11]. Given that there are probably varying safety intervention levels for enhancing safety behavior depending on the characteristics of workers, further study would need to be done in poor nations [12]. Additionally, it's probable that the sort of organisation the employees work for influences their learning styles and aptitudes, which could lead to differences in their performance and comprehension of safety [13].

Work diligently and with safety as a top priority. PPEs play a vital role in minimizing occupational injuries and accidents which otherwise result in substantial human sufferings and financial losses due to lowered production, hefty fines, health and insurance claims, and absenteeism [14]. Chemical exposure is a major risk to employees handling the chemicals as well as the surrounding environment, communities and environment. Zohar found perceived importance of safety training programs as an important dimension of safety climate in industrial organizations.

An effective maintenance management in a chemical company is a critical feature of plant operation to establish safe operating conditions. In a chemical industry, it is efficient and safer to transition to preventive maintenance rather than reacting when problems with equipments emerge or accidents occur [15].

Methodology

Scale development

The study adopted the conventional scale development paradigm which involved qualitative research, item generation, data collection, exploratory and confirmatory factor analysis to develop a reliable and valid workplace safety measure in the context of chemical industry.

Item generation

An initial list of items was generated using both inductive and deductive approaches. The inductive approach involved open-ended interviews with 20 employees working in various chemical companies in SIPCOT to qualitatively explore the various aspects of workplace safety essential in chemical industry. The sample of interviewees selected based on purposive sampling technique such that they were knowledgeable and experienced in their job in chemical companies. The interviewees were asked about their job experience, roles and responsibilities, safety knowledge, hazards, risks, past accidents and near misses in their chemical company. The interview content was used to generate an initial list of scale items. In the deductive approach, few items were adopted from literature based on their relevance to this study context. A total of 58 items were generated whose content validity was evaluated by two university professors. Redundant and irrelevant items were removed retaining 52 items for further study. A structured questionnaire was designed using these 52 items which were evaluated using the 5-point Likert scale (where 1–strongly disagree; 5–strongly agree).

Sampling procedure

This study adopted the multi-stage sampling technique which is often regarded as an extended version of cluster sampling. Multistage sampling is a method of obtaining a sample from a population by dividing a population into smaller and smaller groups and taking samples of individuals from the smallest resulting groups.

The first stage involved selecting the SIPCOT industrial complexes, the second stage involved shortlisting the chemical companies in the selected SIPCOT industrial complexes, and the third stage involved choosing employees working in these selected chemical companies for data collection. There are 20 SIPCOT industrial complexes/parks presently operating in various places in Tamil Nadu. In the first stage, three SIPCOT industrial parks were selected through purposive sampling technique such as that they are spread across Tamil Nadu and housed large chemical companies. The three SIPCOT complexes were Gummidipoondi industrial complex located in the northern region of Tamil Nadu near Chennai, Cuddalore SIPCOT industrial complex located in the eastern region of Tamil Nadu and Tuticorin SIPCOT industrial complex situated in the southern part of Tamil Nadu. These three SIPCOT industrial complexes housed some of the major chemical companies in the state. In the second stage, chemical companies were selected from each of these three SIPCOT industrial complexes through purposive sampling technique based on the criterion that the permanent employee strength was at least 50. The list of chemical companies selected in the second stage is presented in Table 1.

SIPCOT industrial complex	Company name	Year of establishment	Approx. employee size
Gummidi-poondi	SRF Ltd.		600
	Shinsung Petrochemicals Pvt. Ltd.	2009	130

	Xmold Polymers Pvt. Ltd.	1993	60
Cuddalore	Tanfac Industries Ltd.	1972	250
	Chemplast Cuddalore Vinyls Ltd.	2009	300
	Tagros Chemicals	1992	100
	Clariant Chemicals		100
Tuticorin	VV Titanium pigments eastern bulk lime products Pvt. Ltd.	1994	900

Table 1. List of selected SIPCOT industrial complexes and chemical companies.

After selecting the SIPCOT industrial complexes and chemical companies, the third stage involved selecting employees from these companies. For this, the researcher employed convenience sampling technique, a non-probability sampling method which focuses on collecting data from respondents (sample) who are convenient for the researcher to access. Since gaining access and permission to interact with the employees in the premises of chemical companies was not feasible, the researcher adopted the convenience sampling which involved intercepting employees coming out of the company after their shift as well as contacting them in their residential places.

Data collection procedure

During the data collection process, the researcher approached the employee one by one, explained them the study and asked if they were interested to participate anonymously. If yes, they were requested to fill the questionnaire. Participation of the employees was completely voluntary and there were no incentives. The data were collected over a period of four months from May to August 2022 in the three SIPCOT locations *i.e.*, Gummidipoondi, Cuddalore and Tuticorin.

Sample size

A total of 353 questionnaires were administered of which 324 valid responses were obtained for further data analysis. The distribution of the sample of respondents based on the SIPCOT industrial complex and chemical companies they were employed in is presented in Table 2.

SIPCOT and chemical companies	Number of respondents	Percent
Gummidipoondi SIPCOT	111	34.3
SRF Ltd.	57	17.6
Shinsung Petrochemicals Pvt. Ltd.	39	12
Xmold Polymers Pvt. Ltd.	15	4.6
Cuddalore SIPCOT	150	46.3
Tanfac Industries Ltd.	65	20.1
Chemplast Cuddalore Vinyls Ltd.	44	13.6
Tagros Chemicals	28	8.6
Clariant Chemicals	13	4
Tuticorin SIPCOT	63	19.4
VV Titanium Pigments	51	15.7
Easternbulk Lime Products Pvt. Ltd.	12	3.7
Total	324	100

Table 2. Distribution of respondents based on SIPCOT industrial complex and chemical companies.

The distribution of the sample of respondents based on their job and demographic characteristics is presented in Table 3.

Characteristics	Number of respondents	Percent
Cadre		
Management	103	31.8
Staff	221	68.2
Monthly income		
Below Rs. 25,000	87	26.9
Rs. 25,000 to 50,000	134	41.4
Rs. 50,001 to 75,000	68	21
Above Rs. 75,000	35	10.8
Age		
25 years or below	72	22.2
26 to 35 years	126	38.9
36 to 45 years	89	27.5
Above 45 years	37	11.4
Education		
Diploma/ITI	76	23.5
Graduation or above	248	76.5
Total	324	100

Table 3. Characteristics of the respondents.

Analysis and interpretation

Exploratory factor analysis: The 52 items were subjected to Exploratory Factor Analysis (EFA) using SPSS Statistics v26 using principal components method and varimax rotation to determine the number of factors [16]. A ten-factor solution was obtained where seven items with low factor loadings (<0.4) and high cross-loadings (>0.4) were eliminated [17]. The remaining items were subjected to EFA which yielded a ten-factor solution with 45 items. The factor solution explained 80.85 percent of the total variance and exhibited KMO measure of 0.82 indicating data suitability for factor analysis.

The validity and reliability of the factor structure was assessed using factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's Alpha reliability coefficient. The factor loadings of the items anged from 0.625 to 0.893. The AVE representing the amount of variance explained by the factors ranged from 0.455 to 0.754 which were above the minimum limit of 0.4. The CR values of the factors ranged from 0.769 to 0.939 and the Cronbach's alpha coefficients ranged from 0.830 to 0.961 which were above the prescribed threshold of 0.7 [18]. The EFA results have been summarized in Table 4.

The discriminant validity of the factor structure was assessed by comparing the AVE estimates of factors and their correlations with other factors using correlation matrix as presented in Table 5. Since the square root of AVE estimates (diagonal elements) were significantly greater than their corresponding correlation coefficients (non-diagonal elements), the factors were considered to exhibit adequate discriminant validity [19]. Thus, the EFA yielded a ten-factor solution with adequate validity and reliability.

Statements	Factor loadings	Cronbach's alpha	Average variance extracted	Composite reliability
My company offers all necessary PPEs for my job such as safety goggles, gloves, helmets, gas masks and hearing protectors.	0.807	0.94	0.665	0.908
I am satisfied with the quality of PPEs issued by my company.	0.832			
I can easily obtain the PPEs as and when required.	0.836			

The PPEs are comfortable and easy to use.	0.764			
I am satisfied with the checking and replacement policy of worn-out PPEs.	0.836			
Fire extinguishers and sand buckets are readily available at required locations.	0.799	0.933	0.652	0.882
Fire hydrants and hose are provided at convenient locations.	0.749			
Employees have knowledge on the location and usage of fire protection equipments.	0.857			
My company has adequate smoke detectors, alarm systems, sprinklers and fire suppression system.	0.82			
All chemical raw materials and products are safely stored, processed and transported.	0.768	0.842	0.66	0.886
The chemical substances and their composition are clearly marked.	0.792			
The chemical exposure of employees is regularly checked to avoid any health issues and occupational diseases.	0.808			
My company has efficient chemical spill prevention and control plans.	0.877			
I am satisfied with the quality of training provided by my company.	0.872	0.961	0.701	0.921
Trainings are provided regularly to keep employees up-to-date and safety-conscious.	0.832			
All employees are required to attend their job-specific safety trainings in my company.	0.805			
The employees can give feedback and suggestions to improve the training sessions.	0.839			
My company conducts regular assessments to evaluate employees' safety knowledge and behavior.	0.837			
Safety incentives are given to employees for accident-free man hours.	0.825	0.921	0.697	0.902
Employees with best safety practices and outcomes are rewarded once a year.	0.821			
My company conducts various contests frequently to promote importance of safety.	0.859			
Safety slogans and posters are displayed everywhere in the company to motivate employees.	0.833			
All employees are encouraged to give suggestions on safety policies and procedures.	0.73	0.939	0.561	0.864

Every employee of my company is concerned about the safety of other employees.	0.752			
My company includes employees in safety committee meetings to seek their safety suggestions.	0.738			
My company consults the concerned employees in case of hazard analysis, internal audit or any modifications.	0.775			
Near misses and accident precursors are discussed with employees to prevent accidents.	0.748			
Safety officer in my company reviews and signs permits before taking up any job.	0.875	0.924	0.754	0.939
Safety officer visits the workplace frequently to check and teach healthy practices.	0.842			
Safety department in my company has adequate, well-qualified safety personnel.	0.859			
Safety personnel constantly communicate safety-related updates to the employees.	0.893			
Safety personnel treat unsafe practices seriously and take correction action immediately.	0.872			
All utilities and machines such as boilers, compressors, coolers, condensers, etc. processing chemicals are well maintained.	0.625	0.83	0.455	0.769
Stepladder and safety belts are provided to employees for higher access.	0.69			
Equipment's that need maintenance, repair or replacement are identified in advance and addressed.	0.717			
My company conducts regular shutdown and maintenance services to ensure everyone's health and safety.	0.663			
A thorough onsite and offsite emergency preparedness plan is maintained by the company.	0.794	0.934	0.58	0.873
Safety and fire drills are conducted on a regular basis.	0.741			
Fire-engines, first-aid kits and ambulance are readily available in case of emergencies.	0.799			
Risk assessment and emergency preparedness plan is conceived at the start of every new project.	0.785			
My company has adequate, well-maintained access and egress (entry and exit paths) and safe zones.	0.683			
The company has proper exhaust and ventilation system (toxic vapours such	0.805	0.877	0.706	0.905

as carbon monoxide and other solvents).	
There is sufficient lighting in all areas in the company.	0.803
I am satisfied with the level of hygiene and housekeeping in my company.	0.874
My workspace is in good condition, smooth and free from obstacles.	0.875

Table 4. Exploratory factor analysis results.

Factors	1	2	3	4	5	6	7	8	9	10
1	**0.815**									
2	0.521	**0.807**								
3	0.184	0.14	**0.812**							
4	0.472	0.467	0.064	**0.837**						
5	0.329	0.492	0.062	0.331	**0.835**					
6	0.473	0.466	0.145	0.633	0.414	**0.749**				
7	0.133	0.078	0.147	0.041	0.008	0.085	**0.868**			
8	0.478	0.456	0.005	0.595	0.363	0.594	0.16	**0.675**		
9	0.53	0.449	0.052	0.514	0.445	0.644	0.058	0.529	**0.762**	
10	0.157	0.083	0.038	0.124	0.245	0.197	0.063	0.184	0.24	**0.84**

Note: Diagonal elements in bold are square root of AVEs and non-diagonal elements are correlations between the dimens

Table 5. Exploratory factor analysis discriminant validity.

Confirmatory factor analysis: The Confirmatory Factor Analysis (CFA) was conducted for thorough examination of scale's psychometric properties. Based on the EFA results, a 45-item ten-factor measurement model was built as presented in Figure 1 and estimated using Maximum Likelihood (ML) method in SPSS AMOS v26. The evaluation of the measurement model fit revealed that the fit indices were above the acceptable thresholds ($\chi^2(887)=2144.11$, p=.000; CMIN/df=2.417; GFI=.843; CFI=.945; NFI=.905; IFI=.946; RMSEA=.049) indicating adequate model fit [20]. The CFA results showed that the items' factor loadings ranged from 0.613 to 0.983 and Squared Multiple Correlations (SMCs) ranged from 0.375 to 0.965. Hence, no items were removed.

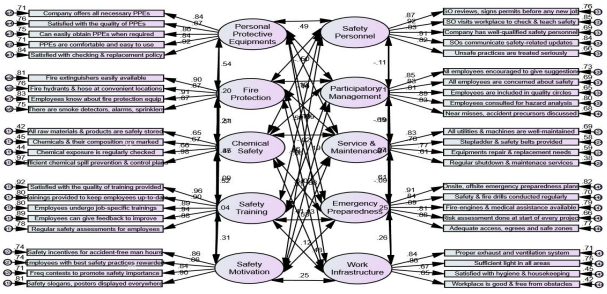

Figure 1. Confirmatory factor analysis–measurement model.

Similar to EFA, the validity and reliability of the scale was tested using CR and AVE estimates and its comparison with inter-factor correlations. As presented in Table 6, the CR estimates of the factors/ dimensions ranged from 0.833 to 0.963 and the AVE estimates ranged from 0.558 to 0.839. The square root of AVE estimates of all dimensions was found to considerably higher than their correlations with other dimensions exhibiting adequate discriminant validity as presented in Table 6.

Dimensions	CR	PPEs	FP	CS	ST	SM	SP	PM	SMN	EP	WI
PPEs	0.938	**0.867**									
FP	0.936	0.54	**0.886**								
CS	0.837	0.199	0.209	**0.755**							
ST	0.963	0.505	0.471	0.095	**0.916**						
SM	0.922	0.347	0.525	0.035	0.31	**0.864**					
SP	0.924	0.494	0.501	0.102	0.687	0.455	**0.842**				
PM	0.94	0.141	0.104	0.184	0.062	0.014	0.105	**0.872**			
SMN	0.833	0.545	0.505	0.022	0.637	0.411	0.712	0.186	**0.747**		
EP	0.937	0.562	0.462	0.021	0.531	0.478	0.692	0.066	0.611	**0.865**	
WI	0.846	0.187	0.078	0.129	0.118	0.252	0.239	0.091	0.248	0.26	**0.763**

Note: Diagonal elements in bold are square root of AVEs and non-diagonal elements are correlations between the dimensions; PPEs: Personal Protective Equipment's; FP: Fire Protection; CS: Chemical Safety; ST: Safety Training; SM: Safety Motivation; SP: Safety Personnel; PM: Participatory Management; SMN: Service and Maintenance; EP: Emergency Preparedness; WI: Work Infrastructure

Table 6. Confirmatory factor analysis–validity and reliability results.

Results and Discussion

Perceived workplace safety scale for chemical industry

The ten dimensions of workplace safety obtained from scale development process were appropriately termed based on the items' content, literature and experts' consultation. The operationalization of the scale/measure is presented in Table 7. Each of these safety dimensions are explained below:

Personal Protective Equipments (PPEs): This safety dimension represents the employees' perception of and satisfaction with the Personal Protective Equipments (PPEs) offered by their chemical company. It includes statements related to provision of all necessary PPEs, their quality, ease of use, maintenance, checking and replacement policy followed by the company. According to Occupational Safety and Health Administration, Personal Protective Equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs), hard hats, respirators, and full bodysuits. Use of PPEs is an important component of health and safety practices which plays a vital role in the safety and well-being of workers.

According to Justus and Sunitha, PPEs are the last line of defence where employees by themselves maximize their safety precaution. In workplaces where health risk is unavoidable or processes cannot be improved, use of appropriate PPE can be an effective measure to protect the health of workers. Non-use of PPEs can expose workers to many safety and health hazards and risks which ultimately can cause serious health implications. Past popular instruments measuring safety climate and culture have generally not conceptualized PPEs as their distinct dimension. However, Glendon et al. and Glendon and Litherland conceptualized PPEs as a distinct factor of safety climate. Other researchers such as Ahmad et al. and Lugah et al. only assessed employees' perception of PPEs as a safety aspect at workplace in the small industries and hospital context respectively, but did not validate it as part of a safety instrument. However, this study specifically focusing on chemical industry identified PPEs as a significant workplace safety dimension during scale development process.

Dimension	Statements
Personal protective equipment's	My company offers all necessary PPEs for my job such as safety goggles, gloves, helmets, aprons, gas masks, boots and hearing protectors.
	I am satisfied with the quality of PPEs issued by my company.
	I can easily obtain the PPEs as and when required.
	The PPEs are comfortable and easy to use.
	I am satisfied with the checking and replacement policy of worn-out PPEs.
Fire protection	Fire extinguishers and sand buckets are readily available at required locations.
	Fire hydrants and hose are provided at convenient locations.
	Employees have knowledge on the location and usage of fire protection equipment's.
	My company has adequate smoke detectors, alarm systems, sprinklers and fire suppression system.

Chemical safety	All chemical raw materials and products are safely stored, processed and transported.
	The chemical substances and their composition are clearly marked.
	The chemical exposure of employees is regularly checked to avoid any health issues and occupational diseases.
	My company has efficient chemical spill prevention and control plans.
Safety training	I am satisfied with the quality of training provided by my company.
	Trainings are provided regularly to keep employees up-to-date and safety-conscious.
	All employees are required to attend their job-specific safety trainings in my company.
	The employees can give feedback and suggestions to improve the training sessions.
	My company conducts regular assessments to evaluate employees' safety knowledge and behaviour.
Safety motivation	Safety incentives are given to employees for accident-free man hours.
	Employees with best safety practices and outcomes are rewarded once a year.
	My company conducts various contests frequently to promote importance of safety.
	Safety slogans and posters are displayed everywhere in the company to motivate employees.
Participative management	All employees are encouraged to give suggestions on safety policies and procedures.
	Every employee of my company is concerned about the safety of other employees.
	My company includes employees in safety committee meetings to seek their safety suggestions.
	My company consults the concerned employees in case of hazard analysis, internal audit or any modifications.
	Near misses and accident precursors are discussed with employees to prevent accidents.
Safety personnel	Safety officer in my company reviews and signs permits before taking up any job.
	Safety officer visits the workplace frequently to check and teach healthy practices.
	Safety department in my company has adequate, well-qualified safety personnel.
	Safety personnel constantly communicate safety-related updates to the employees.
	Safety personnel treat unsafe practices seriously and take correction action immediately.
Service and maintenance	All utilities and machines such as boilers, compressors, coolers, condensers, etc. processing chemicals are well maintained.
	Stepladder and safety belts are provided to employees for higher access.
	Equipments that need maintenance, repair or replacement are identified in advance and addressed.
	My company conducts regular shutdown and maintenance services to ensure everyone's health and safety.
Emergency preparedness	A thorough onsite and offsite emergency preparedness plan is maintained by the company.
	Safety and fire drills are conducted on a regular basis.
	Fire-engines, first-aid kits and ambulance are readily available in case of emergencies.
	Risk assessment and emergency preparedness plan is conceived at the start of every new project.
	My company has adequate, well-maintained access and egress (entry and exit paths) and safe zones.
Work infrastructure	The company has proper exhaust and ventilation system (toxic vapours such as carbon monoxide and other solvents).
	There is sufficient lighting in all areas in the company.

	I am satisfied with the level of hygiene and housekeeping in my company.
	My workspace is in good condition, smooth and free from obstacles.

Table 7. Perceived workplace safety measure with dimensions and statements.

Fire protection: This safety dimension represents the employees' perception of fire protection solutions and capabilities of the company. It includes statements related to presence of fire extinguishers, sand buckets, fire hydrants and hose at required locations, adequate smoke detectors, alarm systems, sprinklers and fire suppression system and employees having knowledge on the location and usage of fire protection equipment.

Fire losses can be one of the greatest threats to an industrial organization in terms of financial losses, loss of life, loss of property, and property damage. Therefore, industrial fire protection and prevention are crucial components of every industry and safety professional's job. Earlier, fire protection was only a side activity in large chemical companies. Fire prevention was seen oftentimes as a task of the fire brigade department and not as cornerstone of process safety work. However, recent research identified that fire is one of the major causes for life and infrastructure loss in chemical factories. Huda and Ahmad identified in their study on garment factory workers that considerable number of fatalities occurred due to fire incidents and lack of proper fire protection equipments and fire management practices.

However, the existing popular safety climate or perception instruments do not incorporate fire protection as a distinct dimension. Safety professionals recognize that fire prevention will never be completely successful. Therefore, it is necessary to plan and design to mitigate damages when fire occurs and this process is fire protection. Fire-protection strategies are those activities designed to minimize the extent of the fire. Analogous to this notion, the fire protection dimension in this study includes reducing fire hazards by inspection, layout of facilities and processes, and design of fire detection-and-suppression systems.

Chemical safety: This safety dimension represents employees' perception of chemical safety followed by the company which involves all those policies, procedures and practices designed to minimise the risk of exposure to potentially hazardous chemicals. This dimension includes statements related to safe storage, processing and transportation of all chemical raw materials and products, marking or labelling chemical substances and composition, regularly checking chemical exposure and presence of chemical spill prevention and control plans.

According to Wehmeier and Mitropetros, release of chemical and combustible substances is the cause of more than 50 percent of major accidents in chemical industries. Chemicals used in chemical industry and research have a range of properties which make them inherently hazardous to life and property. According to OSHA, Chemical Process Safety Management standard aims to eliminate or minimize the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. Ahmad et al. assessed employees' perception of chemical exposure in small industries in Saudi Arabia, but did not conceptualize or validate it as part of a safety perception instrument. Besides, none of the existing safety climate measures include chemical safety or exposure as a distinct factor. However, this study identified chemical safety as a vital and unique dimension of workplace safety in chemical industry.

Safety training: This safety dimension represents employees' perception of the extent to which the workplace safety training is effective. Safety training describes the set of activities aimed at providing workers with the knowledge and skills to perform their duties safely and effectively. This dimension includes statements related to quality and frequency of training provided, job-specific trainings, employees giving feedback about training and regular assessment to evaluate employees' safety knowledge and behavior.

Past research on workplace safety has established the importance of employee safety training for effective implementation of safety practices. Due to its significance, safety training is conceptualized as a distinct factor of few safety climate instruments. Lin et al. and Milijic et al. validated the 27-item safety climate measure which yielded seven distinct factors with safety training as one of them. Varonen and Mattila in their study on safety climate in wood processing companies found that employees perceived safety training as one of the three factors describing company safety practices. In accordance with the past research, the scale development process in this study also identified safety training as a crucial dimension of workplace safety in chemical industry.

Safety motivation: This safety dimension represents the employees' perception of the extent to which they are motivated to follow safety practices at workplace. Safety motivation refers to an individual's willingness to engage in safety behaviours and the value attached to those behaviours. This dimension includes statements related to safety incentives, rewards for best safety practices, contests, safety slogans and posters to promote safety given to employees.

Past research on workplace safety has highlighted the importance of employee safety motivation in reducing occupational injuries and accidents. According to Ying et al., safety motivation enhances employees' adherence to safety practices which ensures not only their own safety, but also that of the organization and society. Williamson et al. in their study to develop a safety climate measure conceptualized safety motivation as one of the distinct safety climate aspects representing the attitudes and perception relating to the influences motivating safe or unsafe behaviour. Few researchers hypothesized employees' safety motivation as a consequence of their perceived safety climate of the organization. However, this study identified safety motivation representing the extent to which the company intrinsically and extrinsically motivates its employees to follow safety practices as a distinct dimension of workplace safety.

Safety personnel: This safety dimension represents the employees' perception of the effectiveness of safety personnel in the company. Safety personnel includes all employees such as safety manager, safety officers, safety foreman, firemen, etc. who work exclusively for the safety of the employees and the company. These set of employees are responsible for planning, implementing and overseeing company's employee safety at work. This dimension includes statements related to safety officer reviewing and signing permits before any job, safety officer visiting workplace to check and teach healthy safety practices, company having adequate well-qualified safety personnel, safety personnel constantly communicating safety-related updates and correcting unsafe practices.

Safety personnel and officers have good knowledge of all chemical processes and activities along with the associated risks to employees' health and safety in a chemical industry. They play the mediating role between the employees and the management. Safety department and its employees are the main pillar of a strong safety and health management system. It is responsible for monitoring and managing the health and safety risks and hazards in the workplace. Their job is to advise managers and workers on how best to minimise or eliminate these risks and hazards. They are trained in health and safety regulations and they work with government legislation to ensure that a workplace is safe for all staff. Employing safety personnel with proper training who can facilitate the correct health and safety procedures at workplace is imperative to protect the health and wellbeing of employees. Despite its significance, none of the existing safety instruments include safety personnel as a distinct safety aspect. However, this study identified safety personnel as a crucial dimension of workplace safety during the scale development process.

Participatory management: This safety dimension represents the employees' perception of the extent to which the top management empowers employees to participate in the decision-making process of safety-related policies and procedures. This definition is derived from literature where participatory management is defined as the practice of empowering members of a group, such as employees of a company or citizens of a community, to participate in organizational decision making. It includes statements related to all employees being concerned about each other's safety, employees being encouraged to give suggestions on safety policies, employees being included in safety committee meetings, consulting employees regarding hazard analysis, near misses and accident precursors.

Past research has established the advantages of participatory management over classical vertical management structure, which is less effective as employees are less involved and interested due to lack of recognition of their effort or opinion. The participatory model is not just about employees being able to recommend changes, but reflecting a belief that authority should be transferred to and shared with employees. Safety is the most important aspect of chemical industry which requires the participatory approach. However, the existing measures on safety climate and perceptions does not incorporate participatory management as a distinct dimension. The scale development process in this study yielded participatory management as a unique aspect of workplace safety in chemical industry.

Service and maintenance: This safety dimension represents the employees' perception of the efficiency with which the service and maintenance activities are carried out for everyone's safety in the company. While maintenance refers to scheduled routine activities, service involves fixing or repairing something specific that's outside the regular maintenance schedule. This dimension includes statements related to maintaining all utilities and machines, identifying and fixing equipments that need maintenance, repair or replacement and conducting regular shutdown and maintenance services. Maintenance department is recognized as caretaker of company and must be integrated with safety initiatives such as safety messages, procedures, meetings, checks, equipment, training and permits, etc. The overall objective of the maintenance process is to reduce downtime, increase Mean Time between Failures (MTBF), prevent deterioration of equipment and ensure that there are no accidents in the workplace due to mechanical failures. In their study on workplace safety in small industries in Saudi Arabia assessing the employees' perception of workplace safety practices, Ahmad et al. incorporated service and maintenance as a distinct safety aspect indicating if the various equipments and machines such as gas cylinders, compressors, tanks, spark plug, lifting equipments are serviced and maintained in a good condition. The work safety scale developed by Hayes et al. has a general 'management safety practices' dimension which incorporates wide range of safety practices such as training, motivational rewards, safe working conditions, clean work area and providing safe equipments. However, it does not incorporate maintenance as a separate dimension. Likewise, none of the existing safety scales conceptualize effective maintenance distinctly despite its significance. The scale development process in this study identified service and maintenance as a crucial and distinct aspect of workplace safety in chemical industry.

Emergency preparedness: This safety dimension represents the employees' perception of the extent to which the company has precautionary measures in the face of potential disasters. Emergency preparedness encompasses the process of risk assessment, planning and response to disasters. A disaster is defined by the World Health Organization (WHO) as a sudden phenomenon of sufficient magnitude to overwhelm the resources of a hospital, region, or location requiring external support. Chemical industry being inherently dangerous may pose grave risk to the employees, organization and its surroundings in case of any industrial accident. Hence, emergency preparedness is imperative for the health and safety of the everyone in and around the chemical plant. This dimension includes statements related to maintenance of thorough onsite and offsite emergency plans, conducting safety and fire drills, availability of fire engines and first-aid kits, preparation of risk assessment plan at the conception of every project and presence of adequate access, egress and safe zones.

Past research on accidents in chemical industry have reiterated the importance of emergency planning and preparedness to reduce life, environmental and property damage. In their study on workplace safety practices in small industries in Saudi Arabia, Ahmad et al. included emergency preparedness as a distinct safety aspect and

assessed employees' perception of its implementation. Their statements included prominent display of emergency contact numbers, availability of clear access and egress, and first-aid kits. Vinodkumar and Bhasi identified emergency preparedness in the organization as a safety climate factor in their study of chemical industry in Kerala, India. Overall, the review shows that most existing popular safety-based instruments do not incorporate emergency preparedness as a distinct dimension. However, the scale development process in this study found emergency preparedness to be a vital and unique aspect of workplace safety in chemical industry.

Work infrastructure: This safety dimension represents the employees' perception of safety in terms of the overall physical infrastructure of their chemical plant and workplace. The infrastructure includes the basic physical facilities such as the plant construction, buildings, warehouses, roads, pipelines, electrical, water and power supply, etc. which form the immovable property of the chemical company. This dimension includes statements related to company having proper exhaust and ventilation system, sufficient lighting, good hygiene, housekeeping and good workspace.

The fundamental infrastructure of a chemical company is a major determinant of the health and safety of its employees and surroundings. Hence, many company managements, especially major accident hazard industries are ready to invest more in building strong infrastructure and upgrade it regularly. However, the existing safety-based instruments do not focus on the physical infrastructure as a distinct safety dimension. However, the scale development process in this study identified work infrastructure as a unique aspect of workplace safety in chemical industry.

The perceived workplace safety scale is specifically designed for chemical industry; however, most of its dimensions can be employed in other industrial contexts. This scale encapsulates the employees' perception of various aspects of workplace safety which quantitatively measures the extent to which they feel safe at workplace.

Conclusion

This study is a first-of-its-kind to propose a development of perceived workplace safety scale for chemical sector offering a range of research and managerial implications. The proposed scales on workplace safety consists of ten dimensions of workplace safety obtained from scale development process were appropriately termed based on the items' content, literature and experts' consultation dimensions; Personal Protective Equipment's (PPEs) and others fire protection, chemical safety, safety training, safety motivation, safety personnel, participatory management, service and maintenance, emergency preparedness, work infrastructure, the perceived workplace safety scale is specifically designed for chemical industry; however, most of its dimensions can be employed in other industrial contexts. This scale encapsulates the employees' perception of various aspects of workplace safety which quantitatively measures the extent to which they feel safe at workplace. The first three dimensions are integrated fire protection, Personal Protective Equipment (PPE), and training are all essential components of workplace safety. The relationship between these three elements can be summarized as follows: Fire protection measures are put in place to prevent and control fires, while PPE is used to protect individuals from various hazards, including fire-related risks. However, even with these preventive measures, accidents can still occur. Therefore, proper training ensures that employees understand the risks, know how to respond in emergencies, and are proficient in using the provided fire protection systems and personal protective equipment. safety motivation acts as a vital dimension of workplace safety in the chemical industry. It fosters increased safety awareness, promotes compliance with safety procedures, encourages proactive safety behaviours, and drives continuous learning and improvement. By nurturing a culture of safety motivation, organizations can significantly enhance their safety performance, mitigate risks, and safeguard the well-being of their employees in the challenging and hazardous environment of the chemical industry. safety personnel are a vital dimension of workplace safety in the chemical industry. Their knowledge, expertise, and dedication to maintaining a safe environment contribute to preventing accidents, minimizing risks, and protecting the well-being of employees, communities, and the environment. By actively addressing safety concerns, safety personnel help builds a culture of safety and ensure the sustainable operation of chemical facilities. safety personnel act as first responders in case of emergencies or accidents involving chemicals. They are trained to effectively handle and contain spills, leaks, or other hazardous situations, minimizing the potential harm to individuals and the environment. participatory management is a valuable dimension for workplace safety in the chemical industry. By involving employees in safety decision-making, fostering collaboration, and promoting a culture of shared responsibility, participatory management enhances hazard identification, risk assessment, and the implementation of safety initiatives. Ultimately, it leads to a safer work environment, improved safety outcomes, and the well-being of employees and the surrounding community. services and maintenance are crucial dimensions for workplace safety in the chemical industry. Through regular maintenance activities, infrastructure upkeep, and the availability of essential safety systems and support services, services and maintenance personnel contribute to accident prevention, risk mitigation, and the overall safety of the workplace. Their expertise and dedication ensure the proper functioning and integrity of equipment, structures, and systems, ultimately protecting the well-being of employees, the community, and the environment. emergency preparedness is a critical dimension for workplace safety in the chemical industry. By conducting risk assessments, developing comprehensive emergency response plans, establishing effective communication systems, providing training to employees, and conducting regular drills and evaluations, organizations can mitigate the impact of emergencies, protect lives, and safeguard the environment. A proactive and well-executed emergency preparedness program enhances the overall safety and resilience of the chemical industry. While workplace safety scales are valuable tools for assessing and measuring safety practices in the chemical industry.

Limitations

There are certain limitations and areas for future research that should be considered. These limitations and implications for future research can help refine and enhance workplace safety scales in the chemical industry context. Here are some considerations:

- Sample representativeness: Many workplace safety scales rely on self-report data from employees. However, the representativeness of the sample can be a limitation, as it may not capture the perspectives of all employees, especially those who are less inclined to participate or have different experiences and perceptions of safety. Future research could explore ways to ensure diverse and representative samples to enhance the validity and generalizability of the findings.
- Cultural and contextual factors: Workplace safety is influenced by cultural and contextual factors that may vary across different regions and countries. Future research could examine how cultural differences impact safety practices and attitudes within the chemical industry. This research could help develop culture-specific workplace safety scales or adapt existing scales to different cultural contexts.
- Long-term safety outcomes: Workplace safety scales often focus on immediate safety behaviors and perceptions. However, long-term safety outcomes, such as injury rates or accident severity, are also important indicators of safety performance. Future research could explore the relationship between safety scale scores and objective safety outcomes to establish stronger validity and reliability of the scales.
- Organizational factors: Workplace safety scales typically focus on individual-level factors. However, organizational factors, such as safety culture, leadership commitment, and organizational policies, also significantly influence safety outcomes. Future research could incorporate organizational-level factors into workplace safety scales to provide a more comprehensive understanding of safety practices within the chemical industry.
- Technological advancements: The chemical industry is constantly evolving, and new technologies and processes are being introduced. Future research could investigate the impact of emerging technologies, such as automation, robotics, and artificial intelligence, on workplace safety. This research could explore how these advancements affect safety practices, identify potential risks, and develop appropriate measures to ensure safety in the context of technological advancements.
- Psychosocial factors: Workplace safety scales often focus on physical safety aspects, but psychosocial factors, such as job stress, worker engagement, and organizational support, also play a significant role in safety outcomes. Future research could incorporate psychosocial factors into workplace safety scales to provide a more comprehensive assessment of safety practices and their impact on employee well-being.
- Intervention effectiveness: Workplace safety scales can be used to evaluate the effectiveness of safety interventions and programs. Future research could focus on assessing the sensitivity of workplace safety scales to measure changes in safety practices and attitudes resulting from intervention programs. This would provide valuable insights into the effectiveness of different interventions and guide the development of evidence-based safety interventions within the chemical industry.

In conclusion, while workplace safety scales are valuable tools for assessing safety practices in the chemical industry, there are limitations that need to be addressed. Future research should aim to enhance the representativeness of samples, consider cultural and contextual factors, explore long-term safety outcomes, incorporate organizational factors, investigate the impact of emerging technologies, incorporate psychosocial factors, and assess intervention effectiveness. Addressing these areas will contribute to the development of more robust and context-specific workplace safety scales in the chemical industry.

work infrastructure is a critical dimension for workplace safety in the chemical industry. Properly designed and maintained infrastructure, including buildings, safety systems, storage facilities, and operational processes, creates a safe working environment. It supports the implementation of safety measures, facilitates efficient response during emergencies, and minimizes risks associated with chemical operations. Investing in robust work infrastructure is crucial for ensuring the well-being of employees, protecting the environment, and sustaining safe and productive operations within the chemical industry.

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How to cite this article: Nandhini D. "Development of Perceived Workplace Safety Scale for the Chemical Industry." *Int J Pub Health Safe* 10 (2025): 434.