Strategy and Implementation of Safety Climate Questionnaire for Manufacturing Industries

Satnam Singh[1], Ankur Bahl[2], Amit Kumar Dhir[3]

[1,2]Associate. Professor, Department of Mechanical Engineering, Lovely Professional University, Jalandhar.

[3]Asst. Professor, Department of Civil Engineering, Lovely Professional University, Jalandhar

Abstract

Safety climate is the employee's perceptions of policies, procedures, and practices regarding safety in an organization. The purpose of this study is to develop and explore the content and face validity and internal consistency of the safety climate questionnaire for manufacturing sector in India. The questionnaire is developed through literature review and discussions with experts. Panel of seven experts who consist of safety officers, professionals have vast experience of manufacturing sector in India. Content validity was measured by content validity index (CVI) and a modified kappa index. A pilot study was conducted to test the internal consistency of the questionnaire by calculating Cronbach's alpha. Thirty out of forty five items showed excellent content validity, six items showed good content validity, eight items showed fair content validity, and one item showed poor content validity. The average content validity of the questionnaire was .80 and ranged from .79 to .92 for the six subscales. The face validity was good with no major remarks were given. We conclude that questionnaire showed good content validity and this questionnaire seems to be an acceptable tool to evaluate safety climate.

Keywords: Manufacturing Industries; Occupational Safety; Safety of workers.

1. Introduction

Safety is a big concern for industries now days because it is a source of heavy direct and indirect losses. In recent times, when India tries to increase their manufacturing activities to boost the manufacturing sector in India, the numbers of accidents in India have increased surprisingly. According to the data of Directorate General of Factory Advice service &Labour Institutes (DGFASLI) which is the government organization to look after the safety and health in factories in India, there are around 1383 and 28441 fatal and non fatal injuries occurred in India in 2012.This was a government data but according to International Labour Organization (ILO) there are around 4, 03,000 people die every year due to work related problems in India. The Bhopal gas tragedy that occurred in India in 1984 was one of the biggest and deadly industrial accidents that occurred in the world. With over 40 million belonging to the working population, India has a very large population base engaged in industrial activity. Manufacturing holds a key position in Indian economy, Accounting for nearly 16 percent of the Gross Domestic Production (GDP) and employing about 12 percent of India's Labour force.

1.1 Safety Climate

Recently, there has been a movement away from safety measures purely based on retrospective data or 'lagging indicators' such as accident rates, injury rates, lost time measurement to 'leading indicators' such as safety audits, measurement of safety climate or culture. The shift of focus was due to the awareness that organizational, management, and human factors are main causes of injuries and accidents rather than technical failures. Safety climate can be defined as employees' share perceptions regarding how safety practices, policies, and procedures are prioritized and implemented. It can be viewed as snapshot of state of safety in an organization at particular point in time which may change with time [1], [2], [3], [4], [5]. Number of studies found that safety climate was directly or indirectly related to safety outcomes such as safety behavior of workers, number of accidents occurred.

A number of studies established that safety climate was fundamental and ultimate solution for improving occupational safety in various industries. A number of researchers [6], [7], [8], [9], [10], [11], established that improved safety climate were associated with lower occupational accidents and injuries. Zohar found that safety climate was directly linked to safety condition of an organization; by analyzing safety climate perceptions of employee's organizations could identify the key areas that require reforming. Safety climate was associated with organizational injury rate underreporting. [12] Found in their study that there was underreporting of OSHA eligible injuries at organizational level. Organizations with poor safety climate had significantly higher rates of underreporting as compared to organizations with good safety climate. Organizations with poor safety climate failed to report 81% of eligible injuries whereas organizations with good safety climate failed to report 47% of the eligible injuries.

A recent Meta analytical review showed that safety climate offer strong predictions of the occurrence of occupational injuries and better self reported safety performance across industries and countries [13], [14]. Safety climate was related to safety behavior of workers. Safety compliance and safety participation are the two components of the safety climate. [6] Found in their study that safety was related to individual safety behavior. They found that safety climate was more strongly related to safety behavior of workers than organizational climate. They also found that safety knowledge and safety motivation act as mediators between safety climate and safety behavior of workers. Safety climate was related to negative effects of job insecurity. [15] Established in their study that organizational safety climate as a potential moderator between job insecurity and safety outcomes. They found that organizational safety climate would attenuate the negative effects of job insecurity on safety outcomes such as safety compliance, accidents, and injuries. There is underreporting of accidents among employees due to which organizations are not able to find out the root causes of these accidents or incidents and take corrective measures.[16] Found in their study that the number of unreported accidents was significantly higher than number of reported accidents. There was an average 2.48 unreported accidents for every reported accident. Underreporting of accidents was higher in organizations which has poorer organizational safety climate.

Safety climate is related to occupational injuries. [17] Meta analytically reveled that there is relationship between injuries and safety climate and also found that injuries were more predictive of organizational safety climate than organizational safety climate was predictive of injuries. They found that injury →safety climate relationship was not as strong for psychological climate as for organizational safety climate. Risk is the key factor of early research on safety climate. [18] Found risk as one the factor of their three factor model that they established in a US production sample. [19] Found that management commitment which was the key dimension of safety climate was strongly related to risk taking behavior of workers and knowledge and training mediated this relationship.

To the authors' awareness, this study is the first one to build up and to validate a safety climate questionnaire for manufacturing industry in India. Because of distinctive character of safety climate in countries, industries, companies, and even different sector of organization, we found developing a novel questionnaire to observe safety climate in Indian manufacturing industry is required. In this study, we developed a new safety climate questionnaire and also examine its validity.

2. Methodology

2.1 Development of questionnaire

A literature review performed and a sum of 345 safety climate items produced from the on hand questionnaires in the published articles and the documents. The number of items condensed to 45 after discussing with experts associated to manufacturing industry. We identified five dimensions of the safety climate and those dimensions are management commitment, safety training, safety communication, safety knowledge and compliance, work pressure.

2.2 Content validity

Content validity is the degree to which a scale has an appropriate sample of items to represent the construct of interest that is whether the domain of content for the construct is adequately represented by the items [20, 21]. [22] Advocated a two stage process for estimating content validity for new instruments. The first stage is the development stage which identifies the domain of content through a comprehensive literature review followed by generation of instrument items. The second stage is the Judgment/Quantification stage in which a panel of content experts rates each item of the scale as relevance to the domain of content.

2.2.1 Content validity index (CVI)

Content validity index or proportion agreement is one of the quantitative methods to find out the content validity of an instrument/questionnaire. It allows two or more raters to independently review and evaluate the relevancy of each item of an instrument. To check the relevancy a Linkert type, ordinal scale with four responses is used. The responses include a rating of 1= not relevant, 2= somewhat relevant, 3= quite relevant, 4= highly relevant. The CVI is the proportion of items that received a rating of 3or 4 by the experts. We use seven experts to find out the content validity of the questionnaire.

2.3 Modified Kappa Coefficient (k*)

Modified kappa coefficient is mainly used to test interrater agreement among observers who rate dichotomous categories of data [23, 24]. To compute the modified kappa, first we have to calculate probability of chance agreement: P_c = [N! /A! (N-A)!]*0.5^N where N is the number of experts and A is the number of experts give rating 3 or 4. k* was calculated with formula k* = [I-CVI - P_c]/[1 - P_c] [25] .Finally standard values described in [26, 27] were applied to evaluate whether the K value was fair, good, excellent. Kappa values range from +1.00 to -1.00, with a positive kappa specifying interrater agreement occurring more often than would be expected by chance.

Table 1: Evaluation of content validity of safety climate questionnaire

S .No	Items	Total no. of Experts	Number of experts give rating 3 or 4	I-CVI [a]	Pc [b]	K*[c]	Evaluation [d]
1	My company responds quickly to safety concerns [1]	7	7	1	0	1	Excellent
2	My company provides safety information [1]	7	7	1	0	1	Excellent
3	My company investigates safety related problems [1]	7	4	0.57	0.273	0.4	Fair
4	My company provide enough & good safety equipment's [1]	7	7	1	0	1	Excellent
5	My company emphasizes safe working conditions [1]	7	6	0.85	0.054	0.84	Excellent
6	Safety inspections are carried our regularly [1]	7	4	0.57	0.273	0.4	Fair
7	Management considers safety to be equally important as production [1]	7	5	0.71	0.164	0.65	Good
8	Safety is given high priority by the management [1]	7	4	0.57	0.273	0.4	Fair
9	Management accepts advice about safety [1]	7	4	0.57	0.273	0.4	Fair
10	Management is concerned about our well-being. [1]	7	6	0.85	0.054	0.84	Excellent
11	Management maintains proper records about worker's safety [1]	7	6	0.85	0.054	0.84	Excellent
12	Management have clear & useful safety policy [1]	7	7	1	0	1	Excellent
13	I have been offered enough training in PPE [2]	7	5	0.71	0.164	0.65	Good
14	Safety training given to me is adequate to enable me to assess hazards in work areas [2]	7	7	1	0	1	Excellent
15	Newly recruits are trained adequately to learn safety rules and procedures [2]	7	6	0.85	0.054	0.84	Excellent
16	Safety training programs help prevent accidents [2]	7	6	0.85	0.054	0.84	Excellent
17	I have been offered regular and useful safety training [2]	7	5	0.71	0.164	0.65	Good
18	Training about new procedures and	7	7	1	0	1	Excellent

	equipment's [2]						
19	Training plan decided jointly with workers [2]	7	5	0.71	0.164	0.65	Good
20	Safety issues are given high priority in training programs [2]	7	6	0.85	0.054	0.84	Excellent
21	There is open communications about safety issues in this work place [3]	7	7	1	0	1	Excellent
22	Management consults with employees regularly about work place health and safety issues [3]	7	6	0.85	0.054	0.84	Excellent
23	Communication with supervisors regarding safety matters is easy [3]	7	6	0.85	0.054	0.84	Excellent
24	There is sufficient opportunity to discuss and deal with safety issues in meetings [3]	7	7	1	0	1	Excellent
25	Do you generally avoid talking about safety issues with your supervisor [3]	7	4	0.57	0.273	0.4	Fair
26	I know how to perform my job in a safe manner [4]	7	7	1	0	1	Excellent
27	I use all necessary safety equipment's to do my job [4]	7	7	1	0	1	Excellent
28	I know how to use safety equipment's and standard work procedures [4]	7	4	0.57	0.273	0.4	Fair
29	I carry out my work in a safe manner [4]	7	3	0.42	0.273	0.2	Poor
30	I know how to reduce the risk of accidents and incidents in the workplace [4]	7	7	1	0	1	Excellent
31	I know what are the hazards associated with my job and the necessary precautions to be taken while doing my job [4]	7	7	1	0	1	Excellent
32	Use a tool to adjust a dangerous part of a machine [4]	7	5	0.71	0.164	0.65	Good
33	I believe there is sometimes pressure to put production before safety [5]	7	7	1	0	1	Excellent
34	Rules relating to personal safety sometimes make it difficult to keep with production target [5]	7	7	1	0	1	Excellent
35	My health has been negatively affected by my work [5]	7	5	0.71	0.164	0.65	Good
36	We're just running around all the time from one job to another, not completing them	7	4	0.57	0.273	0.4	Fair

	properly [5]						
37	I have unachievable deadlines [5]	7	4	0.57	0.273	0.4	Fair
38	I have to work very intensively [5]	7	6	0.85	0.054	0.84	Excellent
39	I have to neglect some tasks because I have too much to do [5]	7	7	1	0	1	Excellent
40	I am unable to take sufficient breaks [5]	7	6	0.85	0.054	0.84	Excellent
41	Sufficient fire exists in case of fire [6]	7	6	0.85	0.054	0.84	Excellent
43	Enough space b/w machines [6]	7	6	0.85	0.054	0.84	Excellent
44	Proper lighting of work area [6]	7	7	1	0	1	Excellent
45	Maintain proper temperature & humidity of work area [6]	7	7	1	0	1	Excellent

Scale 1 'Management Commitment': S-CVI $_{ave}$ = 0.79, Scale 2 'Safety Training': S-CVI $_{ave}$ = 0.83, Scale 3 'Safety Communication': S-CVI$_{ave}$ = 0.85, Scale 4 'Safety Knowledge & Compliance': S-CVI $_{ave}$ = 0.81, Scale 5 'Work pressure': S-CVI $_{ave}$ = 0.81, Scale 5 'Workplace layout': S-CVI $_{ave}$ = 0.92.
The shaded values shows the items with an item content validity index of less than 0.78
[a]I-CVI (item content validity index) = number giving a rating of 3 or 4/number of experts.
[b] P_c (probability of a chance occurrence) = [N!/A!(N-A)!]*0.5N where N = number of experts and A = number agreeing on good relevance.
[c]K* = kappa designating agreement on relevance: k* = (I-CVI - p_c)/(1 -p_c).
[d]Evaluation criteria for kappa: fair = k of 0.40–0.59; good = k of 0.60–0.74; and excellent = k > 0.74.
S-CVI Ave (average scale content validity index) = mean of I-CVI

3. Results

3.1 Validation of items by experts

From the literature review we identified 45 items related to different factors according to the working culture and nature of SME in India. Seven experts evaluated each of these items. Thirty out of 45 items showed excellent validity (I-CVI ≥ 0.78 and k*> 0.74), 6 items showed good content validity (I-CVI < 0.78 and 0.60 ≤ k*≤ 0.74), 8 items showed fair content validity (I-CVI < 0.78 and 0.4 ≤k*≤0.59), and 1 item showed poor content validity (I-CVI < 0.78 and k*<0.4). Item 29 which showed poor content validity was considered content invalid. The average scale content validity is 0.79below the cutoff of 0.90.

S-CVI Ave of the six scales were 0.79 for 'management commitment', 0.83 for 'safety training' and 0.85 for 'safety communication', 0.81 for 'safety knowledge & compliance', and 0.81 for 'work pressure', 0.92 for 'workplace layout'. Although a good CVI, a smaller number of experts (n=2) found a few items are not according to the working culture or nature of small and medium industries in India (e.g. item 9, 19, 25). Some of the items were considered not related to safety climate and worker safety (e.g. item 39). Some of the items found of low content validity because the link b/w item content and safety climate was not clear.

4. Conclusion

It is concluded that this questionnaire showed excellent validity for most of the items. The pilot study which we conducted showed that questionnaire has good overall reliability. The reliability of some of the subscales was low. The reliability should be checked in future with larger sample size. Some of items of the questionnaire should be evaluated in future studies and may have to be modified or removed from

questionnaire. This questionnaire can be used to evaluate the safety climate in small and medium manufacturing units.

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