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Safety climate practice in Korean manufacturing industry

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Abstract

Safety climate survey was sent to 642 plants in 2003 to explore safety climate practices in the Korean manufacturing plants, especially in hazardous chemical treating plants. Out of 642 plants contacted 195 (30.4%) participated in the surveys. Data were collected by e-mail using SQL-server and mail. The main objective of this study was to explore safety climate practices (level of safety climate and the underlying problems). In addition, the variables that may influence the level of safety climate among managers and workers were explored. The questionnaires developed by health and safety executive (HSE) in the UK were modified to incorporate differences in Korean culture. Eleven important factors were summarized. Internal reliability of these factors was validated. Number of employees in the company varied from less than 30 employees (9.2%) to over 1000 employees (37.4%). Both managers and workers showed generally high level of safety climate awareness. The major underlying problems identified were inadequate health and safety procedures/rules, pressure for production, and rule breaking. The length of employment was a significant contributing factor to the level of safety climate. In this study, participants showed generally high level of safety climate, and length of employment affected the differences in the level of safety climate. Managers' commitment to comply safety rules, procedures, and effective safety education and training are recommended.

Keywords: Safety climate; Health and safety executive questionnaire; Predictor; Korean manufacturing plant; Chemical hazards

1. Introduction

Safety climate has been recently recognized as a fundamental and ultimate solution for improving workplace safety in various industries including manufacturing industries such as chemical plants. Cullen [2] emphasized that, during the Piper Alpha inquiry, it is essential to create a corporate atmosphere or culture in which safety is the number one priority. Fennell [4] stated that, following the Kings Cross fire, a cultural change in management is required throughout the organization. Peterson [13] demonstrated that culture is to a large degree behind human-caused catastrophes. Zebroski [14] found 11 attributes which have had medium to large degree of commonality in the basis for the TMI-2, Chernobyl, Challenger, and Bhopal events.

There have been attempts to improve safety culture and climate among industries as well as government agencies in Korea. But the safety climate study has not been done in Korean manufacturing industries. There has been a general agreement to create a safety climate in Korean manufacturing industries, but few validated tools exist to measure important elements of a safety climate. We explore the validity of HSE [6–8] instruments in Korean industry to measure safety climate. Furthermore, factors that may influence the workers' safety culture and climate were explored.

2. Methods

HSE [6–8] used four pre-conditions for measuring safety climate:

(i) An adequate safety management system.
(ii) Technical failures are not causing the majority of accidents.
(iii) The plant is compliance with health and safety law.

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(iv) Safety is not driven by the avoidance of prosecution but by the desire to prevent accidents.

Current survey was adopted from HSE [6–8]. Underlying constructs, management commitment to safety (M1), Merits of the health and safety (H&S) procedures, instructions, and rules (M2), accidents and near-misses (M3), training and competence (W1), job security and satisfaction (W2), pressure for production (W3), communications (W4), perceptions of personal involvement in H&S (W5), perceptions of organizational and management to H&S (W6), rule breaking (W7), workforce view on state of safety and culture (W8)) and associated hypotheses are discussed below. Constructs M1, M2, and M3 are the manager's role in promoting safety and W1 through W8 are the role of worker's in promoting safety in work place.

Following hypotheses were tested:

- H1: safety climate differs by the size of a plant (number of employees).
- H2: safety climate is associated with length of employment.

2.1. Questionnaire and sample

Managers (34 items) or workers (53 items) from each company were asked to answer each question using a five five-point Likert-scale ranging from '1: Strongly agree' to '5: Strongly disagree.' Some of the items were expressed negatively and these items were reversed as necessary so that a low score equals a positive orientation of safety. Three managers' safety climate index and eight safety climate index for workers were constructed by adding scores for each item measuring safety climate in the questionnaire. Six hundred forty-two plants targeted in this study include petrochemical, chemical, electric, and steel industries, which may have potential major accidents such as fire, explosion, and toxic release. Out of 642-targeted plants, 195 plants (30.4%) participated in this study.

2.2. Assessment of measurement tool

Prior to data analysis, internal-scale reliability was assessed to ensure the consistency of the items in each construct. Internal-scale reliability is applied to groups of items that are thought to measure different aspects of the same concept [1,9,10]. It is important that a group of items clearly focus on the constructs and the accepted level of the results, Cronbach's α of 0.7 [1]. Measures of internal-scale reliability range from 0.61 to 0.95. The Cronbach's α obtained for each construct is listed in main diagonal of Tables 1 and 2. The lowest Cronbach α alpha for 'W3: Pressure for production' was 0.61. Rest of the constructs showed satisfying Cronbach alpha. Cronbach alpha and correlations (Pearson's r) among managers and workers are presented in Tables 1 and 2, respectively.

Table 1
Correlations among managers' safety ratings

Factors	M1	M2	M3
M1	0.88		
M2	0.38	0.69	
M3	0.62	0.59	0.72

All correlations significant at 0.01 level; Cronbach's α shown in main diagonal. M1: management commitment to safety; M2: merits of the H&S procedures, instructions, and rules; M3: accidents and near-misses.

Table 2
Correlations among workers' safety ratings

Factors	W1	W2	W3	W4	W5	W6	W7	W8
W1	0.86							
W2	0.71	0.70						
W3	0.42	0.65	0.61					
W4	0.73	0.71	0.48	0.93				
W5	0.63	0.59	0.34	0.70	0.83			
W6	0.64	0.78	0.63	0.81	0.64	0.87		
W7	0.41	0.45	0.68	0.32	0.31	0.39	0.95	
W8	0.63	0.60	0.41	0.69	0.64	0.68	0.29	0.67

All correlations significant at 0.01 level; Cronbach's α shown in main diagonal. W1: training and competence; W2: job security and satisfaction; W3: pressure for production; W4: communications; W5: perceptions of personal involvement in H&S; W6: perceptions of organizational and management to H&S; W7: rule breaking; W8: workforce view on state of safety and culture.

3. Results

A total of 195 managers and 173 workers responded (Table 3). Mean age of the managers was 41.1 (S.D.: 6.9; range: 25–57 years old) and workers were 37.6 (S.D.: 6.4; range: 25–55 years old). Thirty-seven percent (37.4%) were employed at 'more than 1000 employees', 27% for 'between 100 and 499 employees', and 15% were working for '30–99 employees' sized plant.

Table 3
Distribution of responded managers, by plant size (number of employees)

	n (%)	
	Manager	Worker
Plant Size		
Less than 30	18 (9.2)	–
30–99	29 (14.9)	–
100–499	53 (27.2)	–
500–999	7 (3.6)	–
More than 1000	73 (37.4)	–
No response	15 (7.7)	–
Length of employment at current work place		
Less than 1 year	9 (4.9)	4 (2.3)
1–3 years	16 (8.7)	27 (15.6)
4–9 years	68 (37.0)	61 (35.3)
More than 10 years	91 (49.5)	81 (46.8)
Total	195 (100)	173 (100)
		Age: mean (S.D.)
Manager		41.1 (6.8)
Worker		37.6 (6.4)

Number does not add up due to missing responses.

Table 4
Means and standard deviations for safety climate constructs

Constructs	Mean (total)	S.D.	Relative rank (%)
M1	22.6 (80)	6.6	1 (28.3)
M2	16.6 (40)	4.8	3 (41.5)
M3	17.0 (50)	5.0	2 (34.1)
W1	18.2 (50)	6.4	4 (36.4)
W2	17.4 (40)	4.6	6 (43. 6)
W3	9.11 (20)	3.2	7 (45.5)
W4	20.2 (60)	7.7	2 (33.6)
W5	18.3 (55)	6.9	1 (33.3)
W6	14.1 (40)	5.5	3 (35.4)
W7	20.4 (40)	7.0	8 (50.9)
W8	27.5 (65)	4.6	5 (42.4)

M1: management commitment to safety; M2: merits of the H&S procedures, instructions, and rules; M3: accidents and near-misses; W1: training and competence; W2: job security and satisfaction; W3: pressure for production; W4: communications; W5: perceptions of personal involvement in H&S; W6: perceptions of organizational and management to H&S; W7: rule breaking; W8: workforce view on state of safety dand culture.

Sixty-eight percent ($n = 133$) of the managers were working for large plants, more than 100 employees. Majority of respondents worked for more than 4 years (managers: 86.5%; workers: 82.1%) at current work place.

3.1. Level of safety climate

Descriptive statistics for the level of safety climate index in plant level and individual level are given in Table 4. In the survey to managers, the mean value of the construct ranged from 17.0 to 22.6, where low score implying high level of safety climate. M1 (28.3%) was the highest rated construct among workers. The average percentage of workers' safety climate indices was lower than managers. W4 (33.6%) and W5 (33.3%) were the most positive safety climate constructs (mean value of 20.2 and 18.3) and W2 (43.6%), W3 (45.5%), W7 (50.9%), and W8 (42.4%) were low rated constructs.

3.2. Size and length of employment

Descriptive statistics for the level of safety climate by plant size are given in Table 5. Among managers, the level of safety climate were not different by plant size.

Descriptive statistics for the safety climate in workers level by length of employment are given in Table 6. Among workers, responses to the W1, W2, W3, W5, and W8 were differed by length of employment at current workplace. W1 (training and competence) decreased with years of employment increased. Safety constructs W2 (job security and satisfaction), W3 (pressure for production), W5 (perceptions of personal involvement in H&S), and W8 (workforce view on state of safety and culture) were lowest in 1–3 years of employment.

Table 5
Means for safety climate constructs by plant size

Constructs	Number of employees		
	<99	100–999	>999
M1	22.5	23.4	23.0
M2	15.7	17.0	16.3
M3	16.6	17.8	16.9

M1: management commitment to safety; M2: merits of the H&S procedures, instructions, and rules; M3: accidents and near-misses.

Table 6
Means for safety climate constructs by length of employment

Constructs	Significance	Length of employment			
		<1 year	1–3 years	4–9 years	≥10 years
W1	*	19.5	17.4	17.7	15.2
W2	*	18.3	15.8	16.6	17.4
W3	**	9.3	7.6	8.5	11.2
W4	–	21.3	18.2	19.7	19.3
W5	**	20.8	15.0	16.2	16.1
W6	–	15.0	12.4	13.2	14.6
W7	–	20.9	18.7	19.1	22.3
W8	**	28.2	24.8	27.9	28.4

W1: training and competence; W2: job security and satisfaction W3: pressure for production; W4: communications; W5: perceptions of personal involvement in H&S; W6: perceptions of organizational and management to H&S; W7: rule breaking; W8: workforce view on state of safety and culture; F-Test p-value *<0.05; **<0.01.

4. Conclusions

Correll and Andrewartha [12] analyzed the benchmark safety culture scores for survey sample and concluded that plant size bears no relationship to safety culture score. Gillen et al. [11] evaluated injured construction workers' perceptions of workplace safety climate, physical job demands, decision latitude, and coworker support, and the relationship of these variables to the injury severity sustained by the workers. The purpose of this study was to explore the level of safety climate in Korean manufacturing industry. Especially the targeted plants spent relatively more time to safety awareness than others because of potential major accidents caused by hazardous chemicals. So these plants satisfied with the pre-conditions for measuring safety climate suggested by HSE [7]. 'Management commitment to safety (M1)' was the highest among managers and 'Merits of the H&S procedures, instructions, and rules (M2)' recorded the lowest. On the other hand, among workers, 'Rule breaking (W7)' showed the highest, which was followed by pressure for production (W3), job security and satisfaction (W2), and workforce view on state of safety and culture (W8). Perceptions of personal involvement in H&S (W5) recorded the lowest level. These results are a little different to the results from Correll and Andrewartha [12]. Studies showed that workers were not satisfied with their jobs, and perceived positively on organizational and management commitment to safety. In this study, plant size (number of employees) had no relationship to the level of safety climate, as in Correll and Andrewartha [12].

In this study, managers actively committed to safety and health of their employees but less in the H&S procedures, instruments, and rules. This may be due to the nature of hazardous characteristics in these plants. These plants tend to do some effort for continuous safety improvement from day-to-day practice. Among workers pressure for production and rule breaking was more serious problems than other constructs. These two worst problems are closely inter-related so that it is highly recommended to build a culture of not-accepting the violating behaviors of the regulatory laws and rules, and their health and safety procedures in any circumstance. The level of safety climate showed S-type distribution (high–low repeatedly) with the length of employment. So it would be beneficial to have regular and systematic continuing education and training for employees to reinforce safety at workplace.

In conclusion, two recommendations for Korean manufacturing plants to improve their safety climate would be more management commitment to compliance safety and health rules and procedures, and efficient (regular and systematic) safety and health education and training.

There is a need of further study which includes affecting variables such as age, gender, work area, etc. which were considered by Lee and Harrison [9].

4.1. Limitations and research implications

DeJoy et al. [3] assessed the affecting variables (communication, organizational support, safety policy, and programs) of safety climate using four control variables such as age, gender, tenure, and hours worked per work, but the result just indicated that the three affecting variables made significant contributions to safety climate, and these control variables would not affect to those affecting variables. On the other hand, Lee and Harrison [9] identified that four variables (gender, age, shifts/days, and work area) were correlated with accident, but admitting these variables as affecting ones to safety climate could not possible. Even though this study found the affecting variable (length of employment) in individual worker level, too little affecting variables to differentiate the safety climate were applied to represent sufficient empirical data.

Generally, the possibility of safety management improvement in any plant could be identified by measuring safety climate but it can be significant consideration, as argued by Grote [5], in inspection by regulatory authorities and audit from qualified organizations, that the respondents could write, talk, or behave more positively than normal conditions for measuring safety climate by using questionnaire, interview, or behavior observation methods. Most of all, relatively late-started effort for measuring and improving safety climate have been done in Korea, this study could be a little value as an initiative to do active elaboration on safety climate/culture. Despite those limitations above, this study revealed practical findings for the industry.

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