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Research paper

Factors Related to Safety Climate in Production Line Workers of Food Manufacturing

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Abstract

Developing and encouraging a safety culture is an important factor to achieve a safe workplace with low injury rates. Safety climate can be an indicator of the status of an occupational health and safety management system in an organization. It can provide a snapshot of the safety culture. The Thai version of Nordic Occupational Safety Climate Questionnaire is used to evaluate the safety climate in the food manufacturing industry in Songkhla, Thailand. The results can also be used as a guideline in the development and safety management in the future. The response rate was great. The employees who participated were 14.7% male and 85.3% were female. Most subjects were 41-50 years-old and most had a 1- to 5-year working experience. The highest safety climate score of the workers was the dimension of "workers' trust in the efficacy of safety systems" (3.29) while the lowest score was the dimension of "workers' safety priority and risk non-acceptance" (2.89). For the leaders, the highest safety climate score was the dimension of "workers' safety commitment" (3.44) and the lowest score was the dimension of "management safety empowerment" (3.10). The factors related to accident occurrence were the differences in the organizations and the mean score of the safety climate dimension of "worker's safety priority and risk non-acceptance".

Keywords: *Food Manufacturing; Occupational Health and Safety Management; Safety Climate.*

1. Introduction

An occupational health and safety (OSH) management system is implemented within an organization to prevent or control health risks and safety in the workplace which consists of safety policies, procedures and practices (Crutchfield, 2014). To predict the current situation in an occupational health and safety management system in an organization, a safety climate analysis was conducted (Zanko, 2012). A safety climate involves many factors which influence the safety behavior of workers at the individual, group and organizational levels. A 'safety climate' can be defined as the employees' shared perception towards safety policies, procedures and practices, as well as the overall importance and the true priority of safety at the workplace (Neal, 2000). Therefore, a safety climate provides a snapshot of the safety culture and indicates the status of the occupational health and safety management system in an organization (Huang 2007). Zohar (2000) indicated that a safety climate predicts the employees' motivation for a safe workplace which affects the employees' safety behavior and subsequent experience of occupational injuries or incidents at the workplace. Moreover, a study by Liu et al., (2015) found that the associations between different safety climates and safety behaviors in the workplace were related to the occurrence of injuries in Chinese manufacturing industries. It was said that improving the safety climate and safety behavior may decrease the number of injuries in the workplace.

A safety climate is a tool that many previous studies have used to evaluate the perceptions of workers in high risk industries (Mohamed, 2002). One study noted that the food industry was a lower risk industry than the petroleum industry but the workers were essentially at risk of occupational injuries or accidents in the workplace (Punlamai, 2007). This current study included three large food manufacturing companies in Songkhla Province, Thailand to evaluate the safety climate situations and factors related to the injury rate of workers in the food manufacturing industry in Southern Thailand.

2. Methodology

In this study, safety climate is defined as the participants' perceptions of how the leaders and workers deal with safety in the workplace.

2.1. Questionnaire

The questionnaire chosen for the study was the NOSACQ-50-THAI which was recently developed from the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50, 2012; Kines et al., 2011) and translated by Choosong and Siriluk (2016). The Thai version (NOSACQ-50-THAI) was provided online as permitted by the NORDIC team. There were 50 items across seven dimensions with a four-point Likert-type scale (1 = strongly disagree to 4 = strongly agree) and contained positively and negatively formulated items. The seven dimensions were: (1) management safety priority, commitment and competence (9 items); (2) management safety empowerment (7 items); (3) management safety justice (6 items); (4) worker's safety commitment (6 items); (5) worker's safety priority and risk non-acceptance (7 items); (6) safety communication, learning and trust in co-worker's safety competence

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(8 items); and (7) worker's trust in the efficacy of safety systems (7 items). The Cronbach's alpha of each dimension was 0.80, 0.75, 0.78, 0.75, 0.75, 0.84, and 0.82, respectively. Then the results of each dimension were presented as mean scores and separated into two groups of workers and leaders.

In addition to the general characteristics and occurrences of injury, a separate questionnaire included gender, year of birth, current position (worker/manager), education level, working experience, work-related injuries in the past 6 months, time of injury occurrences and the outcomes.

2.2. Sampling and Data Collection

This cross-sectional survey study was conducted in the food manufacturing industry in Songkhla Province of Thailand from September 2015 to August 2016.

2.2.1. Study area

The study areas were food packaging factories that employed more than 500 Thai workers with an established occupational health and safety system such as the Thai Industrial Standards, TIS 18001; Occupational Health and Safety Assessment Series, OHSAS 18001; or Occupational Safety, Health and Environment (the OSH Act) 2011 was established. Three large food manufacturing companies were specifically selected for this study. Overall there are approximately 26,000 workers employed in food packaging factories in Songkhla Province. The NOSACQ-50-THAI questionnaire was distributed to 1,000 workers randomly selected from the 4,455 workers in these three companies.

2.2.2. Study subjects

All workers and leaders in all of the study areas who had work experience of more than 6 months and were aged 18 years voluntarily participated in this study. A worker was defined as an employee who worked at the production lines whereas a leader was defined as the head of those workers in their production lines or other departments. Finally, a total of 1,014 employees participated in this study.

2.3. Data Analysis

The data collected through the general characteristics, injury frequency and safety climate scores were analyzed using R statistics software version 3.1.1. The data are herein presented as mean with standard deviation (SD) and percentage. The differences of the mean scores of each safety climate dimension between worker and leader and the difference between the general characteristics of the participants were tested by the chi-square t-test and one-way ANOVA. The factors related to occurrences of injury were assessed by negative binomial regression.

3. Results and Discussion

In total, 1,014 response questionnaires were returned: 327 questionnaires (32.25%) from Company A, 362 questionnaires (35.70%) from Company B, and 325 questionnaires (32.05%) from Company C. More demographic data of the participants in each of the companies are shown in another study (Yangok and Choosong, 2018). The injury/accident frequency of Company B (4.4%) was lower than Company C (6.5 %) and Company A (8.9%) (Table 1). In addition, the injury frequency rate (IFR) of companies A, B and C were 19.87, 10.12 and 16.92 times per 200,000 person hours in the previous 6 months, respectively. However, there were no significant differences of IFR among those companies. These results were contrasted with the Jarukkhamool and Chaikliang (2014) study, which found that the IFR of construction sites was 31.25 times per 1,000,000 person hours while Suwankarn (2016) found that the IFR of medical personnel from sharp objects was 42.77 times per 200,000 person hours.

Table 1: Age and accident data of the participants (companies A, B and C)

Variable	Worker	Leader
Age* (Mean±SD)		
Company A	40.17±9.69	41.85±9.69
Company B	38.73±9.43	42±4.69
Company C	38.65±9.67	47.29±4.57
Accident occurrence, (%)		
Company A		
Yes	29 (9.9)	-
Never	264 (90.1)	34 (100)
Company B		
Yes	16 (4.5)	-
Never	342 (95.5)	4 (100)
Company C		
Yes	20 (6.3)	1 (14.3)
Never	298 (93.7)	6 (85.7)
Accident frequency within 6 months		
Company A	39	-
Company B	22	-
Company C	32	1

* **P-value < 0.05**

The mean scores of the seven dimensions among the employees in the three companies are shown in Figure 1 and Table 2. The workers in Company A had significantly the lowest rating scores ($p<0.001$) in all dimensions of safety climate while the leaders of Company C had significantly higher scores ($p<0.05$) than Company A or Company B. However, Company B and Company C had higher safety climate scores than Company A for both the worker and leader groups. In addition, the safety climate score of Dim 5 'worker's safety priority and risk non-acceptance' were the lowest score in both workers and leaders. The highest safety climate score of workers was Dim 7 'worker's trust in the efficacy of safety system' while the highest safety climate score of leaders was Dim 4 'worker's safety commitment'. These results might be that Company B and Company C were established and continuously maintained the OSH management system for more than 10 years in their organizations while the company A did not established the TIS 18001 system. These results were consistent with the Bergh et al. (2013) study which found that the mean scores of the "management safety priority, commitment and competence" dimension of the safety climate of the workers were significantly different between plant A and plant B. The managers/supervisors had significantly higher safety climate scores than the workers in all dimensions except the "worker's safety commitment" dimension which was not significantly different. In addition, the safety climate factors and different levels of safety climate were different between organizations (Vinodkumar, 2009) and depended on leadership styles (Huang, 2007).

The mean scores for each dimension of the workers and leaders are shown in Figure 2. The workers' perceptions on safety climate (ranged from 2.89-3.29) were significantly lower than the leaders (ranged from 3.11-3.44) in all safety climate dimensions except Dim 2 'management safety empowerment'. These results were consistent with the Huang et al. (2014) study which found that the mean scores of the safety climate of the leaders were significantly higher than the scores of the workers because the leaders received the policies directly from the top management and applied those policies to theirs subordinators while the workers had limited opportunities to interact with top management and followed those policies.

Table 2: Mean and SD of safety climate scores in workers and leaders (companies A, B and C)

Safety climate dimension	Workers			p-value*	Leaders			p-value*
	Company A	Company B	Company C		Company A	Company B	Company C	
Dim 1	2.91±0.32	3.07±0.37	3.09±0.32	<0.001	3.03±0.37	3.44±0.27	3.59±0.39	<0.001
Dim 2	2.90±0.37	3.09±0.40	3.03±0.38	<0.001	3.01±0.38	3.43±0.42	3.43±0.40	0.004
Dim 3	2.93±0.40	3.10±0.47	3.04±0.40	<0.001	3.10±0.43	3.38±0.44	3.62±0.38	0.003
Dim 4	3.09±0.41	3.35±0.37	3.35±0.35	<0.001	3.35±0.43	3.66±0.39	3.79±0.23	0.006
Dim 5	2.78 ±0.35	2.90±0.39	2.97±0.39	<0.001	3.03±0.34	3.29±0.54	3.72±0.25	<0.001
Dim 6	3.09±0.33	3.21±0.36	3.22±0.33	<0.001	3.24±0.33	3.41±0.40	3.59±0.34	0.012
Dim 7	3.13±0.36	3.37±0.38	3.35±0.33	<0.001	3.33±0.35	3.64±0.25	3.75±0.32	0.002

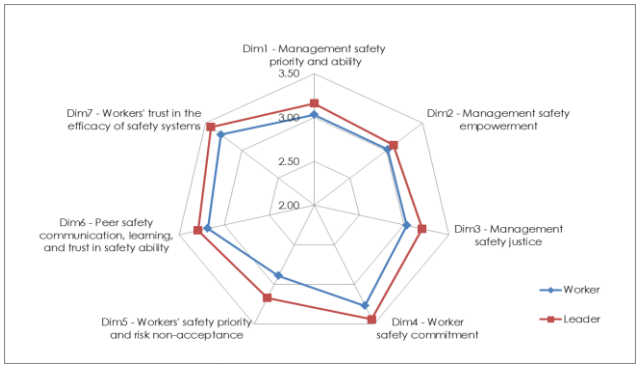


Fig. 1: Mean scores for each dimension between worker and leader.

The mean scores for each dimension of the workers and leaders are shown in Figure 2. The workers' perceptions on safety climate (ranged from 2.89-3.29) were significantly lower than the leaders (ranged from 3.11-3.44) in all safety climate dimensions except Dim 2 'management safety empowerment'. These results were consistent with the Huang et al. (2014) study which found that the mean scores of the safety climate of the leaders were significantly higher than the scores of the workers because the leaders received the policies directly from the top management and applied those policies to theirs subordinators while the workers had limited opportunities to interact with top management and followed those policies.

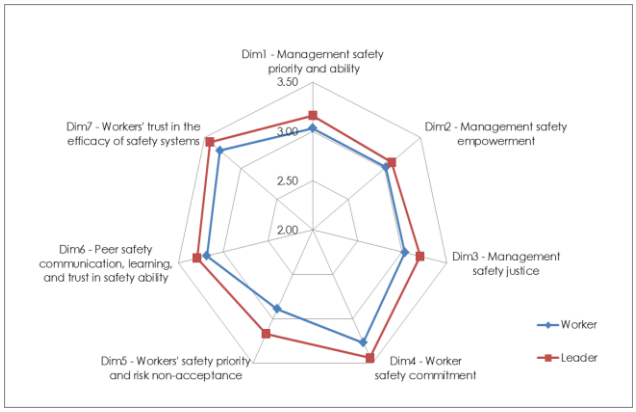


Fig. 2: Mean scores for each safety climate dimension between workers and leaders.

The factors related to safety climate and accident occurrence of each company are shown in Table 3. Company C found that males were at significantly higher risk of accident than females (adjusted IRR: 3.64, 95%CI: 1.00-13.44), while companies A and B had no significant difference. The higher levels of education were associated with accident rate, especially workers in Company B who had graduated from high school or had some level of post-secondary education (adjusted IRR: 6.46, 95%CI: 1.28-52.8). Other factors examined had no significant association with accident occurrences in all companies. Gender is often an important factor when considering accident rates, as many studies have found that males had higher injury rates than females (Yoon, 2013; Varonen and Mattila, 2000). These might be those workers work at the production line and maintenance section. For the safety climate score, the increased scores of dimension of "worker's safety priority and risk non-acceptance" of workers of Company B was significantly reduced occurrence of injury (adjusted IRR = 0.19, 95%C.I. = 0.03-0.91). While the increased score of "worker's trust in the efficacy of safety systems" was significantly associated with occurrence of injury (adjusted IRR = 1.09, 95%C.I. = 1.47-105.54). The others safety climate dimensions were not significantly associated with the injury occurrence in all companies.

As Table 4 shows, the injury frequencies were significantly different in all study areas, with Company B showing the best injury rate (IRR = 0.05, 95%CI = 0.25-1.00 and adjusted IRR = 0.37, 95%CI =0.16-0.81, p<0.001). This possibly occurred because Company B had a safety officer team that consisted of 4 safety officers at the professional level and 2 safety officers at the technical level, and thus the safety policies and implementation of the OSH Act and TIS 18001 were continuously monitored. Wachter and Yorio (2014) found that the effectiveness of a safety management system and its practices were strongly related to the levels of safety-focused cognitive and emotional worker engagement, and such engagement resulted in reduced accident rates. Yoon et al. (2013) found that the implementation of the OHS management system in a construction company decreased the accident rates and fatalities. Bergh et al., 2013 reported that the perception levels of safety climate were different by type of industry, accident experience, and job characteristics.

The "worker's safety priority and risk non-acceptance" dimension had a significant association (IRR 0.45, 95% CI 0.21-0.91; adjusted IRR 0.43, 95% CI 0.17-1.01) with the occurrence of injuries while the other dimensions did not. This result indicated that higher scores in the "worker's safety priority and risk non-acceptance" dimension were associated with significantly reduced occurrence of injury, while increased scores in dimensions 2, 3, 6 and 7 were associated with no significant increases in occupational injury. In contrast, the Vinodkumar (2009) study pointed out that the safety climate scores had significantly negative associations with self-reported accident rates, especially in the dimensions of "management commitment and actions for safety", "workers' knowledge and compliance to safety", "workers' participation and commitment to safety", and "emergency preparedness in the organization and priority for safety over production". On the other hand, Voronen and Mattila (2000) found that the safety climate dimensions of "organization responsibility" and "company safety precautions" had significantly negative correlations with accident rates. In addition, Gyekye and Haybatollahi (2015) reported that the job satisfaction, relationship, compliance with safety management policies and accident frequency were positively linked between organizational justice and organizational safety climate while Voronen and Mattila (2000) found the low accident rate related to the safety climate in dimension of "organizational responsibility", and "company safety precaution.

Table 3: Multivariate analysis of factors related to safety climate and accident occurrence of each company

Variable	Incidence Rate Ratio: IRR*					
	Company A (n=327)		Company B (n=362)		Company C (n=325)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Gender						
- Female	1		1		1	
- male	0.81	0.25-2.37	1.34	0.21-7.05	3.64	1.00-13.44
Age	0.98	0.93-1.04	0.98	0.94-1.00	1.02	0.93-1.02
Education	1		1		1	
- Primary School	0.91	0.32-2.60	6.46	1.28-52.8	0.81	0.21-3.43
- High School and Certificate					-	-
-Bachelor's degree & above	1.09	0.10-9.47	9.09	0.74-129.35		
Experience, Years						
- > 10	1		1		1	
- 6 - 10	1.55	0.62-7.00	0.63	0.91-3.43	2.25	0.43-5.81
- 1 – 5	1.92	0.41-4.29	0.50	0.10-2.34	3.24	0.74-9.75
Safety climate dimension**						
- Dim1	0.33	0.04-2.30	1.14	0.14-9.33	3.53	0.42-29.34
- Dim2	2.73	0.44-2.30	1.99	0.19-22.83	0.25	0.44-1.44
- Dim3	0.47	0.09-2.14	1.73	0.28-11.58	2.98	0.46-19.32
- Dim4	0.91	0.21-3.89	0.25	0.03-1.62	2.53	0.38-16.67
- Dim5	0.79	0.19-3.19	0.19	0.03-0.91	0.62	0.13-2.84
- Dim6	1.09	0.16-7.35	2.03	0.22-20.76	1.49	0.81-12.31
- Dim7	0.72	0.14-3.58	1.09	1.47-105.54	0.60	0.81-4.47

Dim 1, management safety priority, commitment and competence; Dim 2, management safety empowerment; Dim 3, management safety justice; Dim 4, worker's safety commitment; Dim 5, worker's safety priority and risk non-acceptance; Dim 6, safety communication, learning and trust in co-worker's safety competence; and Dim 7, worker's trust in the efficacy of safety system

* Negative Binomial Regression

** The lower score of each dimension was the reference value

Table 4: Factors related to the safety climate and accident occurrence

Variable	Incidence Rate Ratio (IRR)*				
	IRR	95% CI	Adjusted IRR	95% CI	p-value
Gender					
- Female	1		1		
- male	2.21	1.13-4.43	1.91	0.92-4.02	0.07
Age	0.97	0.95-1.01	1.00	0.96-1.04	0.78
Position					
- Leader	1		1		
- Worker	4.31	0.68-83.53	5.87	0.85-120.24	0.11
Company					
- Company A	1		1		
- Company B	0.50	0.25-1.00	0.37	0.16-0.81	0.009
- Company C	0.85	0.44-1.62	0.76	0.37-1.54	0.44
Education					
- Primary School	1		1		
- High School and Certificate	1.79	0.96-3.39	1.70	0.82-3.58	0.13
- Bachelor's degree & above	2.11	0.58-7.90	2.01	0.47-8.48	0.34
Experience, Years					
- >10	1		1		
- 6 - 10	1.40	0.62-3.13	1.15	0.49-2.68	0.73
- 1 - 5	1.78	0.94-3.41	1.21	0.54-2.73	0.62
Safety climate dimension**					
- Dim1	0.67	0.32-1.37	0.94	0.29-3.05	0.91
- Dim2	0.81	0.40-1.59	1.13	0.37-3.52	0.79
- Dim3	0.96	0.49-1.86	1.58	0.61-4.23	0.30
- Dim4	0.63	0.30-1.27	0.71	0.24-2.01	0.46
- Dim5	0.45	0.21-0.91	0.43	0.17-1.01	0.04
- Dim6	0.82	0.38-1.72	1.09	0.32-3.69	0.87
- Dim7	0.89	0.43-1.85	1.83	0.62-5.53	0.21

Dim1, management safety priority, commitment and competence; Dim2, management safety empowerment; Dim3, management safety justice; Dim4 worker's safety commitment; Dim5, worker's safety priority and risk non-acceptance; Dim6, safety communication, learning and trust in co-worker's safety competence; and Dim7, worker's trust in the efficacy of safety system

* Negative Binomial Regression

** The lower score of each dimension was the reference value.

4. Conclusion

The workers had significantly lower ratings in the scores of safety climate than the supervisors in all dimensions. Differences in the organizations, especially regarding the continuous implementation of an OSH management system, significantly influenced occupational injuries and the levels of safety climate. The workers' safety priority and risk non-acceptance was significantly and mainly related to injury occurrence. Therefore, the food manufacturing industry should improve the workers' safety awareness by using effective and continual safety activities. The results of this study can be used also as a guideline in the development of an OSH management system in various manufacturing industries.

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