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Exploratory Analysis of the Nordic Safety Climate Questionnaire-Thai Version and Safety Climate among Thai Employees

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ABSTRACT

Introduction: High death and injury rates at work are continually reported by the Ministry of Labour, Thailand, despite the promotion of the occupational safety, health, and environment (OSHE) management system across all enterprises. To identify the gap between OSHE and workers' perception in terms of safety climate in Thai organizations, the Nordic Safety Climate Questionnaire-Thai Version (T-NOSACQ) was used in this study.

Methods: The content validity index of the T-NOSACQ was assessed and this tool was employed to examine workers in six manufacturing firms and a tertiary care hospital between October 2015 and December 2016. Exploratory and confirmatory factor analysis was performed on the total dataset to justify the final questionnaire. Multiple regression analysis was performed to determine the factors related to the safety climate score.

Results: The final T-NOSACQ included 5 dimensions with a total of 42 items. The internal consistency of each subscale was in the range of 0.73–0.89. There were 1191 participants, including 88.9% workers and 11.1% leaders, who voluntarily responded to the questionnaire. The lowest safety climate score was obtained on the dimension 'employees' risk acceptance', especially at factory A (2.67±0.45 and 2.92±0.45 for the worker and leader groups, respectively). The highest score was obtained on the dimension 'employees' engagement to safety, especially at factory F (3.30±0.33 and 3.46±0.42 for the worker and leader groups, respectively).

Conclusion: The safety climate in both leader and workers groups can be predicted by T-NOSACQ. Thai employees exhibited a positive perception of safety engagement. However, the OSHE management system in Thailand, especially employees' risk acceptance, should be improved.

Key words: leader, occupational safety, perception, safety climate, worker,

INTRODUCTION

Although the occupational safety, health, and environment management (OSHE) system is implemented worldwide in manufacturing, a total of 94,934 cases pertaining to work-related injuries were reported in Thailand in 2018. The highest incidence of death at work was due to car accidents (44.91%) and falling from a height (17.84%), as reported by the Office of the Permanent Secretary, Ministry of Labour, Thailand (2019).[1] OSHE management may consist of environmental health and safety policy, safety operating procedures, and accident investigation.[2,3] The current efficacy of the OSHE management system may be predicted by using the number or severity of injuries, or losses in workdays.[4] However, these outcomes cannot directly provide information about the gaps in OSHE management or the link between safety perception and risk prevention at work, even if sufficient behavioral data is collected. [5]

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The safety climate can be identified by the current situation of the OSHE management system in an organization because it provides information about the norms and values of organizational culture. [6] However, identifying the gaps in safety climate across organization levels can present an opportunity to improve workplace safety and health. [7] Organizations may exhibit differences in the form of traditions, the internal environment of members, behavior, and characteristics.[6] Zohar (2000) indicated that a safety climate predicts employees' motivation for a safe workplace, which affects their safety behavior and subsequent incidence of occupational injuries or accidents at the workplace.[8] In addition, Liu et al. (2015) reported that improving the safety climate and safety behavior of workers may decrease the number of injuries in the workplace. [9]

At present, there are many available safety climate questionnaires and instruments.[6,10,11,12,13] The Nordic Safety Climate Questionnaire (NOSACQ-50) is a tool that can be used to measure the safety climate in all types of manufacturing companies including both low- and high-risk manufacturing, and has been translated into other languages such as Persian.[14,15] A previous pilot study used the original version of the NOSACQ-50 to report the mean scores of safety climate in the dimensions of workers' safety priority and risk non-acceptance related to accident occurrences (Adjusted IRR = 0.43; 95% CI = 0.17-1.01).[16] This original Thai version of the NOSACQ-50 included 7 dimensions and 50 questions, as in the original English version. The Cronbach's alpha of all dimensions was higher than 0.7. However, problems were found in the translation of questions from the English version of the NOSACQ-50 to the Thai version.

In order to predict the safety climate in Thai organizations, this study implemented the NOSACQ-50 questionnaire and tested its validity by using exploratory and confirmatory factor analysis. In addition, the gap between OSHE and workers' perception of the safety climate in Thai organizations was investigated. Therefore, the perception levels of safety climate between the leader and worker groups were determined by using the validated T-NOSACQ questionnaire.

METHODS

A total of 1191 employees from three rubber glove manufacturing factories (Factories A, B & C), two beverage manufacturing factories (Factories D & E), one canned food manufacturing factory (Factory F), and one university hospital (hospital) voluntarily participated in this study. The employees were divided into 2 groups: workers and leaders. The leader group comprised employees who worked in the position of supervisor, manager, or director. All participants signed the consent form (EC. No. 58-332-09-2) before responding to the questionnaire and then sent the questionnaire back to the safety officer of their manufacturing factory. All questionnaires were subsequently returned to the Faculty of Medicine, Prince of Songkla University for further analysis.

Forward and backward translation of the NOSACQ-50 questionnaire

The NOSACQ-50 was translated into Thai and back-translated into English by different linguists following the NORDIC protocol.[14] After obtaining the translated version of the T-NOSACQ-50 questionnaire, three experts in the domain of occupational health and safety examined the content validity and revised the questionnaire to ensure the language was easy to understand for the respondents. There were 50 items and 7 dimensions in the NOSACQ-50-English master version. The Cronbach's alpha for all dimensions of the NOSACQ-50-English master version was higher than 0.71. The responses were rated on a five-point Likert scale (strongly disagree, disagree, either agree or disagree, agree, and strongly agree). The structure of the T-NOSACQ-50 version was the same as the master version. In this study, the safety climate scoring was calculated based only on the completed data. The positive formulated items included were nos. 1, 2, 4, 6, 7, 10, 11, 12, 14, 16, 17, 19, 20, 22, 23, 24, 27, 33, 36, 37, 38, 39, 40, 42, 43, 44, 46, 48, and 50, while the reversed formulated items were nos. 3, 5, 8, 9, 13, 15, 18, 21, 25, 26, 28, 29, 30, 31, 32, 34, 35, 41,45, 47, and 49.[14]

Descriptive statistics were used to present the data. Thereafter, factor analysis was performed to clarify the components of the T-NOSACQ-50 questionnaire. Finally, an exploratory factor analysis (EFA) was performed using the following criteria: principal components analysis (PCA), which is the default method of extracting the variables; varimax rotation; and eigenvalues greater than 1.0. Factor loadings higher than 0.40 were reported.[12] Confirmatory factor analysis was performed using Structural Equation Modelling (SEM) to determine the final factor structure model.

Correlation coefficients were reported to describe the correlation between each item and subscale (dimension) and the total scale. Multiple regression analysis was performed to determine the factors related to the safety climate score. P-values ($p < 0.05$) were used to present the significant differences.

RESULTS

The total dataset comprised 1191 records but after eliminating the missing values, there were 1,108 records of gender, 1,084 records of age, and 1,103 records of position. Of the participants, 65.7% were female and 34.3% were male. 38.8% were ≤ 35 years, 34.3% were 36-46 years, and 26.8% were over 46 years of age (Table 1).

The validity and reliability analysis of the T-NOSACQ-50 questionnaire was performed by three industrial hygienists. The mean of the content validity index (CVI) was calculated, and a score over 97% was considered acceptable for each question.

The EFA was performed with 1,141 records. The initial EFA of 50 items was used to conduct the factor analysis using the principal components factor analysis. Varimax rotation was employed for better interpretation of the factor loadings with eigenvalues greater than 1. The Kaiser-Mayer-Olkin measure-sampling adequacy (KMO) was 0.93, which was considered excellent. Bartlett's test of sphericity was performed to identify the matrix of variables (chi-square =15608.42, df = 861, and p-value < 0.001).

A principal components analysis (PCA) was performed, which is the default method of extracting the variables, with varimax rotation, and eigenvalues greater than 1.0. If the loading factor of an item was less than 0.4, it was dropped. For one problem question (No. 18 in the Thai version and No. 22 in the English version) that was loaded on the two expected factors, the dimension was assigned using the higher loading score. Then, the sequence and the total number of items on each dimension were revised (Table 2).

Table 2 shows that the correlated items' total score of items 32–35 and 37–38 was quite low while that of the other items was higher than 0.4. However, these items were retained, and item 18, 'Management treats employees involved in an accident fairly', was ultimately retained in the dimension with a higher loading factor. The EFA was performed again, revealing the 5 dimensions of the safety climate with 42 items, and a 45% variance (Table 3). Finally, Structural Equation Modelling (SEM) was performed to determine the relationship between the 5 dimensions. Figure 1 showed that all 5 dimensions were independent and all questions were strongly associated in each dimension.

The internal consistency of all dimensions in the final version of the T-NOSACQ was higher than 0.7. However, the dimension 'Employees' risk acceptance' showed the lowest correlation coefficients with each subscale, total scale score, and mean score of safety climate (Table 4).

Table 5 reports the factors that influence the safety climate score. Employee position and workplace were significantly associated with the safety climate score. The ratings of the leader group were significantly higher than those of the workers, and Factories E and F had significantly higher safety climate scores than the hospital. According to the beta value of interception, the interpretation of the safety climate score was divided into 3 levels: [14] low level (the workplace should improve their OSHE) of safety climate was ≤2.98, medium level (the workplace continuously maintains their OSHE) was 2.99-3.21, and high level (the workplace has excellent OSHE) was ≥ 3.22. Thai workers' risk acceptance was low (2.8±0.5) while 'employees' engagement to safety' was high (3.3±0.4).

The third dimension, 'Employees' engagement to safety' showed the highest safety climate score in all workplaces. Dimension 4, 'Employees' risk acceptance' showed the lowest safety climate score of all workplaces, and results revealed a desire to improve OSHE in some workplaces. In Factory B, there was no significant difference between safety climate scores of all dimensions, whereas the safety climate scores within each dimension were significantly different in all workplaces (Table 6).

Significant differences were observed in the worker and leader ratings in each dimension. The safety climate scores of all dimensions in the leader group were significantly higher than those in the worker group (Table 7). The safety climate scores of dimension 4 were the lowest amongst the worker group, who felt the workplace should improve its OSHE. The safety climate score of dimension 3 was high for both worker and leader groups, reflecting that both groups felt their OSHE was excellent.

Table 1: Demographic characteristics of participants

Characteristic	Factory A (n=120)	Factory B (n=19)	Factory C (n=29)	Factory D (n=78)	Factory E (n=119)	Factory F (n=362)	Hospital (n=464)	Total (n=1191)
Gender								
Male	23 (51.1)	7 (38.9)	9 (31.0)	44 (57.9)	96 (84.2)	51 (14.1)	151 (32.5)	381 (34.4)
Female	22 (48.9)	11 (61.1)	20 (69.0)	32 (42.1)	18 (15.8)	311 (85.9)	313 (67.5)	727 (65.6)
Age								
≤35	38 (84.4)	14 (77.8)	11 (39.3)	50 (72.5)	38 (36.5)	132 (36.5)	142 (31.0)	421 (38.8)
36-45	6 (13.1)	13 (16.7)	14 (50.0)	15 (21.7)	58 (38.4)	139 (38.4)	139 (30.3)	373 (34.4)
≥46	1 (2.2)	1 (5.6)	3 (10.7)	4 (5.8)	14 (25.1)	91 (25.1)	177 (38.6)	290 (26.8)
Position								
Worker	24 (54.5)	9 (52.9)	15 (60.0)	40 (45.5)	71 (62.8)	358 (98.9)	464 (100)	981 (88.9)
Leader	20 (45.5)	8 (47.1)	10 (40.0)	48 (54.5)	42 (37.2)	4 (1.1)	-	122 (11.1)

Table 2: Factor loadings of safety climate by exploratory factor analysis and correlation coefficients of each item to the total scale

Items/Version		Question	Correlated items to total scale	Dimension				
Thai	Eng			1	2	3	4	5
1	1	Management encourages employees here with by safety rules - even when the work schedule is tight	.44	.56	-.04	.12	.06	.24
2	2	Management ensures that everyone receives the necessary information on safety	.47	.60	.00	.16	.01	.20
3	4	Management places safety before production	.43	.53	.02	.15	.06	.01
4	6	We who work here have confidence in the management's ability to handle safety	.52	.60	.12	.25	.03	.02
5	7	Management ensures that safety problems discovered during safety rounds/evaluations are corrected immediately	.44	.53	.25	.15	.02	-.13
6	10	Management strives to design safety routines that are meaningful and work	.54	.63	.12	.21	.02	.13
7	12	Management encourages employees here to participate in decisions that affect their safety	.45	.49	.23	.25	-.05	-.11
8	14	Management strives for everybody at the worksite to have high competence concerning safety and risks	.46	.59	.05	.22	.00	-.01
9	16	Management involves employees in decisions regarding safety	.49	.44	.28	.27	-.06	.04
10	17	Management collects accurate information in accident investigations	.53	.56	.25	.20	.06	-.01
11	19	Management listens carefully to all who have been involved in an accident event	.56	.55	.35	.24	.-.04	.02
12	20	Management looks for causes, not guilty persons when an accident occurs	.51	.44	.35	.23	.17	-.19
13	3	Management looks the other way when someone is careless with safety	.45	.19	.48	.03	.18	.19
14	8	When a risk is detected, management ignores it without action	.52	.25	.48	.04	.32	.18
15	13	Management never considers employees' suggestions regarding safety	.47	.12	.68	-.02	.22	.16
16	15	Management never asks employees for their opinions before making decisions regarding safety	.48	.15	.68	-.02	.22	.14
17	21	Management always blames employees for accidents	.47	.11	.61	.13	.16	.03
18	22	Management treats employees involved in an accident fairly	.54	.41	.48	.26	.03	-.01

19	23	We who work here try hard together to achieve a high level of safety	.53	.22	.04	.66	.03	.06
20	24	We who work here take joint responsibility to ensure that the workplace is always kept tidy	.51	.27	-.04	.61	.08	.05
21	27	We who work here help each other to work safely	.51	.20	.03	.61	.09	.07
22	36	We who work here try to find a solution if someone points out a safety problem	.48	.15	.06	.60	.06	.09
23	37	We who work here feel safe when working together	.51	.16	.18	.61	-.03	.07
24	38	We who work here have great trust in each other's ability to ensure safety	.48	.14	.19	.64	-.15	.04
25	39	We who work here learn from our experiences to prevent accidents	.49	.19	.04	.65	-.06	.10
26	40	We who work here take each other's opinions and suggestions concerning safety seriously	.51	.20	.20	.66	.04	.11
27	42	We who work here always discuss safety issues when such issues come up	.50	.16	.16	.58	.10	.09
28	43	We who work here can talk freely and openly about safety	.50	.11	.11	.68	.05	-.02
29	44	We who work here consider that a good safety representative plays an important role in preventing accidents	.52	.20	.02	.61	.04	.18
30	46	We who work here consider that safety training is good for preventing accidents	.51	.29	-.07	.49	.06	.32
31	50	We who work here consider that it is important that there are clear-cut goals for safety	.48	.29	-.09	.47	.03	.31
32	26	We who work here avoid tackling risks that are discovered	.33	.13	.15	-.12	.46	.28
33	29	We who work here regard risks as unavoidable	.32	.05	.10	-.03	.63	.07
34	30	We who work here consider minor accidents as a normal part of our daily work	.36	-.04	.21	.07	.65	-.01
35	31	We who work here accept dangerous behaviour as long as there are no accidents	.33	-.03	.02	.13	.61	.11
36	32	We who work here break safety rule to complete work on time	.47	-.01	.26	.22	.55	.13
37	34	We who work here consider that our work is unsuitable for cowards	.28	-.02	.12	.04	.50	.04
38	35	We who work here accept risk-taking at work	.27	.08	.04	-.09	.69	-.03
39	41	We who work here seldom talk about safety	.48	-.05	.27	.36	.14	.47
40	45	We who work here consider that safety rounds/ evaluations do not affect safety	.52	.14	.28	.25	.07	.56
41	47	We who work here consider early planning for safety as meaningless	.41	.02	.11	.16	.12	.76
42	49	We who work here consider that safety training is meaningless	.48	.08	.08	.22	.20	.71

Table 3: Eigenvalues and percentage of variance

Dimensions	Number of items	Eigenvalues	%variance
Management's engagement and empowerment	12	2.90	7
Management safety priority and justice	6	4.51	11
Employee engagement in safety	13	5.78	14
Employees' risk acceptance	7	2.35	6
Safety activity	4	2.97	7
% cumulative of variance			45

Table 4: Internal consistency and correlation coefficients of each subscale with a total scale score

Dimension	Number of items	Alpha	Correlation coefficients	Mean±S.D.	Min - Max
Management's engagement and empowerment	12	0.85	0.80	3.1±0.4	
Management safety priority and justice	6	0.75	072	3.0±0.5	
Employees' engagement in safety	13	0.89	0.77	3.3±0.4	
Employees' risk acceptance	7	0.73	0.54	2.8±0.5	
Safety activity	4	0.74	0.63	3.2±0.5	

Table 5: Factors related to safety climate score (the worker and hospital were the reference group)

Parameters	Beta error	Std. Error	P-value
Intercept	3.02	0.01	<0.01
Position (leader)	0.19	0.04	<0.01
Factory A	-0.02	0.05	>0.05
Factory B	0.03	0.09	>0.05
Factory C	0.01	0.07	>0.05
Factory D	0.03	0.04	>0.05
Factory E	0.08	0.03	<0.05
Factory F	0.16	0.02	<0.01

Adjusted R^2 = 0.07, Residual standard error = 0.31, F = 12.46, df =1055

Table 6: Mean±S.D. of safety climate score of all employees in each factory and hospital

Dimensions	Dim1	Dim2	Dim3	Dim4	Dim5	P-value
Factory A (n =114)	3.10±0.31	2.85±0.51	3.47±0.33	2.37±0.60	3.41±0.51	<0.01
Factory B (n = 14)	3.02±0.34	3.13±0.31	3.27±0.27	3.03±0.39	3.23±0.57	>0.05
Factory C (n = 28)	3.09±0.29	3.11±0.48	3.21±0.40	2.82±0.45	3.34±0.49	<0.01
Factory D (n = 75)	3.10±0.39	3.04±0.58	3.32±0.36	2.98±0.50	3.17±0.48	<0.01
Factory E (n = 108)	3.10±0.40	3.11±0.56	3.32±0.41	3.06±0.53	3.24±0.59	<0.01
Factory F (n = 362)	3.20±0.34	2.99±0.52	3.30±0.33	2.99±0.40	3.35±0.47	<0.01
Hospital (n = 464)	3.00±0.44	2.95±0.50	3.22±0.41	2.74±0.47	3.02±0.51	<0.01

Table 7: Mean±S.D. of safety climate score of workers and leaders in each factory and hospital

Site	Dim1		Dim2		Dim3		Dim4		Dim5	
	Worker	Leader	Worker	Leader	Worker	Leader	Worker	Leader	Worker	Leader
Factory A (n =114)	2.98±0.32	3.04±0.39	3.00±0.30	3.18±0.45	3.29±0.29	3.27±0.23	2.67±0.45	2.92±0.45	3.34±0.50	3.13±0.63
Factory B (n = 14)	2.83±0.29	3.25±0.29	2.95±0.13	3.36±0.36	3.11±0.20	3.44±0.27	2.82±0.38	3.26±0.31	2.96±0.55	3.58±0.47
Factory C (n = 28)	3.01±0.24	3.15±0.35	2.98±0.39	3.23±0.57	3.17±0.36	3.20±0.47	2.81±0.46	2.99±0.41	3.48±0.45	3.18±0.55
Factory D (n = 75)	3.02±0.37	3.19±0.40	2.79±0.56	3.29±0.48	3.25±0.36	3.38±0.37	2.89±0.46	3.08±0.52	3.04±0.51	3.30±0.43
Factory E (n = 108)	3.03±0.39	3.19±0.38	3.03±0.59	3.29±0.44	3.26±0.42	3.38±0.36	2.97±0.57	3.25±0.39	3.15±0.67	3.40±0.39
Factory F (n = 362)	3.18±0.34	3.56±0.34	2.98±0.51	3.46±0.67	3.29±0.33	3.46±0.42	2.98±0.40	3.39±0.43	3.35±0.47	3.81±0.24
Hospital (n = 464)	3.00±0.44	-	2.95±0.50	-	3.22±0.41	-	2.74±0.47	-	3.02±0.51	-

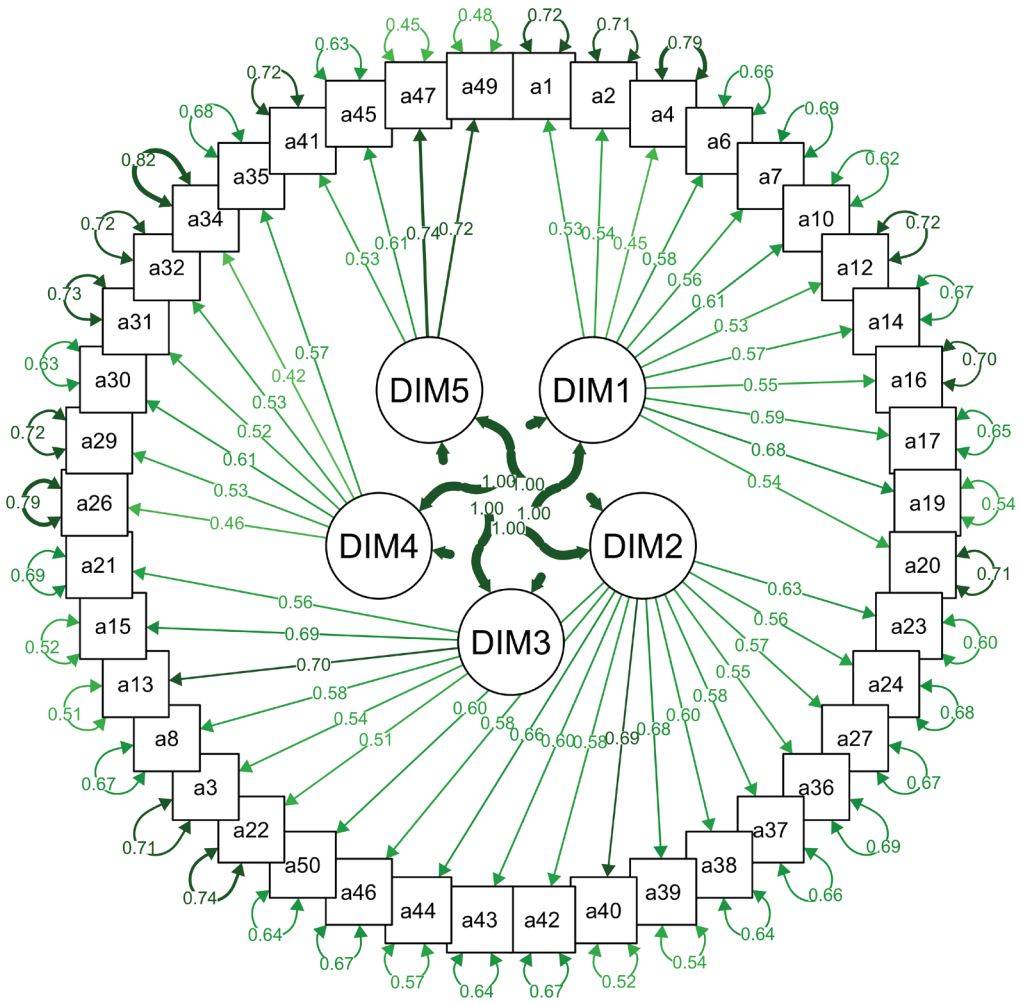

Figure 1: The structural equation modelling (SEM) of all variables and primary components.
Notes: the observed variables a1 to a50 refer to the original English version of the NOSACQ-50.

DISCUSSION

The T-NOSACQ was validated using EFA and SEM, and content validity was assessed after translation from English to Thai. During our pilot study, which used the full version of the T-NOSACQ-50, the validity of the translation was taken into consideration. The purpose of this study was explained to the participants before data collection. All participants' doubts and questions regarding the questionnaire were addressed and noted for further EFA analysis.[16] Most participants' questions concerned English item No 33. Additionally, the first paragraph in the general section of the questionnaire contained information such as the study purpose and the total number of items in each part. This format follows the guidelines of the Human Research Ethics Committee board of Prince of Songkla University, Songkhla, Thailand. Therefore, the participants could determine the reason each question was asked.[17]

The final version of the T-NOSACQ was different from the original NOSACQ-50. [14] In this study, the items with a loading factor higher than 0.4 were considered.[12] Therefore, items 5, 9, 11, 18, 25, 28, 33, and 48 were dropped. However, the internal consistency of each subscale was acceptable.[18,19] The version of the NOSACQ-50 that was translated into the T-NOSACQ contained 5 dimensions, whereas the Persian version included 6 dimensions.[15] According to the EFA analysis, the items related to the management dimension in the master version were combined into the 'Management's engagement and empowerment and 'Management safety priority and justice' dimensions in the T-NOSACQ version. The 'Employees' risk acceptance' dimension was similar to the master version dimension of 'Workers' safety priority and risk non-acceptance. The 'Workers' safety commitment' and 'Safety communication, learning, and trust in co-worker safety competence' (8 items) dimensions of the master version

were combined into the 'Employees' engagement to safety' dimension of the T-NOSACQ version. Finally, some items were dropped from the 'Workers' trust in the efficacy of safety systems' (7 items) dimension and the new dimension was labeled 'Safety activity' (4 items). This may have happened as a result of cultural differences and language translation.[20]

Only the complete data set was used to determine the safety climate score. Therefore, the total number of participants in Tables 6 and 7 was less than in Table 1. Position and workplace were influential factors in the perception of safety climate. The mean safety climate score in many studies showed that leaders consistently rated higher scores than workers, and each department in the same organization rated a different score.[7,21,22] Our results showed that Factories E (beverage manufacturing) and F (canned food manufacturing) had a significantly higher safety climate score than the hospital, and the leaders rated the safety score higher than the workers did. These results imply that an occupational health and safety department should be established in the hospital.

In this study, 'employees' risk acceptance' was low, while 'employees' engagement to safety' had the highest score. These results were consistent with Yousefi et al., who found that steelworkers rated the highest scores on 'workers' attitude toward safety' and the lowest on 'workers' safety priority'.[15] Therefore, workers' safety awareness and risk acceptance should be considered in all enterprises.

CONCLUSION

The safety climate in both leaders' and workers' groups can be predicted by the T-NOSACQ. Thai employees exhibited a positive perception regarding safety engagement. However, the OSHE management system in Thailand, especially employees' risk acceptance, should be improved.

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