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Factors affecting safety behavior in front-line workers of construction company

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Abstract

The study of factors affecting safety behavior in front-line workers of construction company aimed to investigate a relationship within safety climate, safety knowledge, safety motivation and safety behaviour like safety compliance and safety participation. This research used a 2-step structural equation modelling approach that was based on an extensive review of related literature. The samples were derived from front-line workers in several construction companies. Research tools were questionnaire with scales and using simple random sampling method. Firstly, the measurement model reliability and validity were analysed by confirmatory factor analysis technique. Then a causal relationship among safety-related latent variables was developed by structural regressions and path analysis. The results yielded a moderate fitness with empirical data with suitable reliability and validity. There were several significant direct effect, indirect effect, total effect and contrast effect on the relationship but safety motivation did not have indirect effect on safety climate to safety participation. As per results, management should still emphasize organizational-wide safety climate to promote workers' safety behaviour. Future research should mitigate common method bias by using multi-level approach and qualitative research should be studied deeply for a richer result.

Introduction

A safety workplace philosophy has long been the main issue that companies should consider and cultivate in organizational culture seeing that the result of accident and incident have a direct negative effect on company cost and expense both quantitatively and qualitatively (Zohar, 1980). To generalize, safety means an act that actually prevents individuals from exposure in any form to hazardous events and activities (Barling, Kelloway, & Iverson, 2003).

For the construction company, due to the nature of business which can easily cause accident and incident to employee, a safety workplace is a crucial concept and should be considered as the first priority especially for front-line workers. If they are not aware of safety at work, there is a high potential of facing a safety issue, which can lead to work-related accident that causes loss of

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assets, property or life. This impact not only affects the company but also a third party connected to the company.

There are several studies that emphasize factors affecting safety behaviour. Yet, there are few studies that focus on safety behavior on front-line construction workers. In accordance with the situation mentioned above, the question of the study was drawn. How does safety climate, which is mediated by safety knowledge and safety motivation, affect safety behavior? Therefore, the main objective of the study was to develop a structural model that can possibly investigate a causal relationship among those safety-related latent factors as front-line construction workers are at high risk of exposure to fatal accident or serious incident. The casual relationship among those safety-related factors is expected to clarify the reason behind those safety-related activity features and outcomes.

Contribution of the research could be expected. In practice, any civil works construction company could use the result from the research to gain more understanding regarding safety behavior among employees to implement a company-wide policy mitigating safety risk at work.

Literature Review

Social Learning Theory and Social Exchange Theory

In accordance with previous research, there is a positive relationship within environment and behavior, which is, in this case, considered as a climate. Positive safety climate at work would lead to positive work behavior (Zohar, 2000; Zohar & Luria, 2010). This phenomenon was explained by the social learning theory (Bandura & Walters, 1977). The theory stated that human behavior stems from 3-way interaction of behavioral, cognitive and environmental factors and the learning process is a result from an interaction between learners and environment that learners are in. Later on, another research found that supervisor behavior towards subordinates stemmed from the environment that came from higher management policy and this finally led to subordinates behavior (Latham & Saari, 1979). Furthermore, social exchange theory plays an important role in behavior (Cropanzano & Mitchell, 2005). One of the most important elements of this theory is reciprocity rules or repayment. While the company treated employees well with a safety-related climate at work, the safety-related working behavior from employees could be expected as a reciprocity activity.

Generally, the social exchange theory and the social learning theory were typically cited as background theories regarding any behavioral science or social science field of research. For this study, the rationale, backed up by social learning and social exchange theory, was to attest whether all safety-related factors especially the organization-wide climate still play a significant role, even in front-line civil construction worker, seeing that safety-related factors should own an ability to generalize in some broader contexts, especially in front-line employees, as these types of workers are likely to be exposed to work-related accident.

Safety Climate on Safety Compliance

Safety climate is an environmental level of safety and can be divided into management level and team level. This is considered as the most essential factor according to social learning theory because this can possibly lead to favorable safety behavior. In this study, safety behavior was separated into 2 components, which were safety compliance and safety participation. Safety compliance is a behavior where individuals willingly comply with safety rules and regulations at work (Griffin & Neal, 2000). For this reason, the first hypothesis is developed as follows:

Hypothesis 1: Management safety climate has a direct effect on safety compliance.

Safety Knowledge

Safety knowledge is self-explanatory, a knowledge regarding safety. According to past research, safety knowledge significantly played a mediation role between safety climate and safety behavior (Neal & Griffin, 2002). And, once again, this study aimed to confirm the mediation role of safety knowledge but in a context of front-line construction workers. The second hypothesis is developed as follows:

Hypothesis 2: Safety knowledge has an indirect effect between safety climate, safety compliance and safety participation.

Safety Motivation

In accordance with the classic theory of needs from Maslow, motivation can be a driver for individuals to do or act accordingly. Safety behavior was driven by positive safety motivation (Neal, Griffin & Hart, 2000). This study also aimed to affirm the mediation role of safety motivation in the context of construction business. The third hypothesis is stated as follows:

Hypothesis 3: Safety motivation has an indirect effect between safety climate, safety compliance and safety participation.

Safety Climate on Safety Participation

Owing to a safety climate, this can probably affect employee participation. Safety participation is positive participating activities among employee about safety-related issues at work and a willingness to join a safety-related promotional program (Kines, Andersen, Andersen, Nielsen, & Pedersen, 2013). For this relationship stated previously, the fourth hypothesis is formed as follows:

Hypothesis 4: Management safety climate has a direct effect on safety participation.

According to a review of related literature mentioned above, a distilled overview of conceptual model and hypotheses are portrayed in Figure 1.

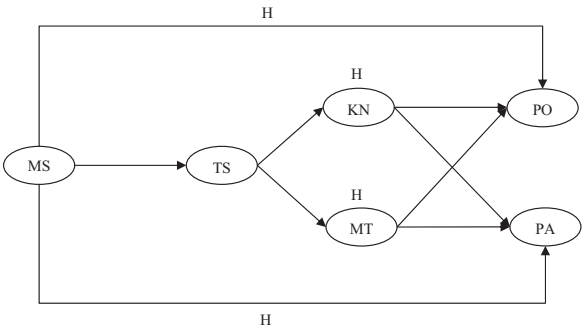

Figure 1 Conceptual model with hypotheses
Note: MS = Management Safety Climate, TS = Team Safety Climate, KN = Safety Knowledge, MT = Safety Motivation, CO = Safety Compliance, PA = Safety Participation.

Methodology

The research is quantitative. Population was construction workers working on construction site. A simple random sampling was applied. All questionnaires were hard copies and were distributed by researchers. The targeted construction companies were mid-size company operating mostly in civil works such as dam, road or bridge construction. Time period to collect data was 2 months from October to November 2019. A set of self-done 250 survey questionnaire with rating scale was sent out and this was discriminated into 7 sections, demographic data, management safety climate, team safety climate, safety knowledge, safety motivation, safety compliance and safety participation. 218 clean survey questionnaires were returned and put into a data analysis. Questionnaires were administrated according to current working situation, tradition and context. Hence, all measurements were translated and back-translated from original language to Thai.

Measures

All six measurements were based on the scale from past study (Neal & Griffin, 2006) and research (Vinodkumar & Bhasi, 2010). Management safety climate, team safety climate, safety knowledge, safety motivation, safety compliance and safety participation were all 3 items Likert rating scale to measure a level of safety aspects.

Data Analysis

The clean data of 218 samples were put into a data analysis process by utilizing 2-step structural equation modeling technique to test research hypotheses and answer research question. The major objective behind the using of this technique was that this allows multiple testing of latent variables and describes a relationship among them. As per objective of the study, confirmatory factor analysis would be first analyzed to assert reliability and validity in the model then a structural equation model with path analysis would be developed to hypothesize and answer research question. The analysis process from start to finish was entirely processed by R, a potent, reliable yet free statistical computer language (R Core Team, 2019).

Results and Discussion

Regarding a data analysis process, the results were provided with 2 sections consisting of descriptive part for a snap-shot of samples and inferential part for hypothesis testing.

218 clean samples were analyzed. For descriptive statistics, half of the samples were single (50.00%) with age range 16–30 years (51.38%) and salary per month range from THB 9,001 to 15,000 (50.00%). Most of the samples were male (68%), having education less than bachelor degree (64.2%) with current tenure less than 5 years (75.69%) and being a laborer (40.6%).

In accordance with Table 1, descriptive analysis for variables (V) is shown including means (M) and standard deviation (SD). Normality of the variables was checked by skewness and kurtosis and this showed both skewness and kurtosis were less than plus or minus 2 ensuring adequate normality. Furthermore, correlation among variables were all significant with medium level of correlation.

So as to test the fitness with the empirical data, the confirmatory factor analysis was calculated. The process consisted of a structural validation of the model on each construct to analyse the relationship among observed variables by correlation. Several assumptions of both relative and absolute fit indices criteria are portrayed in Table 2.

Table 1 Descriptive Statistics for Scale, Skewness, Kurtosis and Correlation Matrix

V	*M*	*SD*	Skew	Kur	MS	TS	KN	MT	CO	PA
MS	4.031	0.637	-0.142	-0.381	1	.59**	.54**	.65**	.61**	.62**
TS	3.865	0.667	-0.271	-0.218	.59**	1	.64**	.58**	.69**	.58**
KN	3.717	0.685	-0.104	-0.042	.54**	.64**	1	.54**	.73**	.68**
MT	4.138	0.686	-0.631	0.538	.65**	.58**	.54**	1	.63**	.50**
CO	3.884	0.644	-0.112	-0.041	.61**	.69**	.73**	.63**	1	.63**
PA	3.252	0.904	0.177	-0.325	.62**	.58**	.68**	.50**	.63**	1

Note: MS = Management Safety Climate, TS = Team Safety Climate, KN = Safety Knowledge, MT = Safety Motivation, CO = Safety Compliance, PA = Safety Participation.
**$p < .01$.

Table 2 Fit Indices Criterion

Fit Indices	Criterion	References
Chi-square	Not significant	Hair, Black, Babin, & Anderson (2013), Bagozzi and Yi (1988), Browne and Cudeck (1993)
Relative Chi-square	Less than 3	
Comparative Fit Index (CFI)	More than .90	
Tucker-Lewis Index (TLI)	More than .90	
Root Mean Square Error of Approximation (RMSEA)	Less than .08	
Standardized Root Mean Square Residual (SRMR)	Less than .08	

As per Table 3 and Table 4, confirmatory factor analysis model fit statistics and latent variables correlation are shown. All confirmatory factor analysis coefficients both estimated and standard values were statistically significant. According to measurement model fit indices, the model was fit with empirical data. However, Chi-square test was significant as the test was super sensitive to sample size. Thereby, no modification was done for the measurement model.

According to Table 5, composite reliability, reliability of internal consistency in rating scales, convergent validity and discriminant validity were presented. Cronbach's Alpha was utilized to evaluate the reliability of the internal consistency, and it showed that all parts of the rating scales were reliable. Composite reliability (CR) for measurement of reliability was calculated. Both minima cut off value for Cronbach's Alpha and composite reliability were 0.7 or higher to suffice reliable measures.

Convergent validity stands for the extent of which indicators of any construct converged (Hair et al., 2013). This could be measured by average variance extracted (AVE). A minimum cut off value for AVE was 0.5 or higher to display sufficient convergence validity.

Table 3 measurement model fit indices

Confirmatory Factor Analysis Fit Indices	Model Fit Statistics
Chi-square	251.705***
Degree of Freedom	120
Relative Chi-square	2.097
Comparative Fit Index (CFI)	.943
Tucker-Lewis Index (TLI)	.928
Root Mean Square Error of Approximation (RMSEA)	.071
Standardized Root Mean Square Residual (SRMR)	.048

Note: RMSEA 90% Confident Interval (0.060, 0.082).
*** $p < .000$.

Table 4 Confirmatory factor analysis latent variables correlation

Construct	Estimate	Standard	*SE*	z-value	*p*
Management Safety Climate (MS) on					
Team Safety Climate (TS)	.247	.717	.036	6.815	.000***
Safety Knowledge (KN)	.225	.581	.036	6.176	.000***
Safety Motivation (MT)	.313	.790	.039	8.018	.000***
Safety Compliance (CO)	.226	.715	.029	7.763	.000***
Safety Participation (PA)	.271	.635	.049	5.519	.000***
Team Safety Climate (TS) on					
Safety Knowledge (KN)	.279	.714	.040	7.070	.000***
Safety Motivation (MT)	.266	.662	.041	6.441	.000***
Safety Compliance (CO)	.260	.812	.035	7.330	.000***
Safety Participation (PA)	.311	.722	.067	4.617	.000***
Safety Knowledge (KN) on					
Safety Motivation (MT)	.257	.571	.043	6.002	.000***
Safety Compliance (CO)	.298	.830	.038	7.809	.000***
Safety Participation (PA)	.384	.794	.071	5.377	.000***
Safety Motivation (MT) on					
Safety Compliance (CO)	.271	.735	.036	7.628	.000***
Safety Participation (PA)	.303	.609	.063	4.830	.000***
Safety Compliance (CO) on					
Safety Participation (PA)	.321	.808	.062	5.206	.000***

Note: *** $p < .000$.

As per Table 6, discriminant validity or divergence validity means that indicators of a construct were truly diverging from other constructs. The criteria were that the AVE showed in diagonal of the Table 6 should be greater than squared multiple correlation of each construct. However, in this study, safety compliance and safety participation constructs seemed to lack discriminant validity as originally, these two constructs were considered in the same one big construct called safety behaviour (Neal & Griffin, 2002). Therefore, it was normal that these two constructs were not discriminated among each other when separated into two constructs.

After confirmatory factor analysis process, structural equation model was fitted and visualized. According to Table 7 and Figure 2, the results of the analysis and model fit indices portrayed that the structural regressions were moderately fitted with the empirical data.

In accordance with Table 8, all estimated and standard coefficient of structural regressions were statistically significant.

Finally, according to Table 9, the path analysis was analysed to determine the result of direct effect, indirect effect, total effect and contrast effect. Almost all coefficients of direct effect, indirect effect, total effect and contrast effect between two main paths were significant, however, indirect effect path 4 from management safety climate, team safety climate, safety motivation and safety participation were not. This indicated that safety motivation had no mediating role in the relationship between safety climate and safety participation. Hence, most hypotheses were supported, but hypothesis 3 was partially supported. Significant direct effects indicated that management safety climate attained a positive ability to affect positive effect on safety behavior. Significant indirect effects disclosed that, team safety climate, safety knowledge and safety motivation played a mediation role between management safety climate and safety behavior. Significant total effects implied that this causal relationship had an ability to explain cause-and-effect relation significantly. Lastly, significant contrast effects portrayed that these two relationship paths affected each other differently.

Table 5 Confirmatory factor analysis for reliability and convergent validity

Construct	Estimate	Standard	*SE*	z-value	Alpha	CR	AVE
MS							
MS1	1.000	.858					
MS2	1.055	.872	.078	13.457			
MS3	0.991	.862	.066	15.124	.898	.898	.747
TS							
TS1	1.000	.814					
TS2	1.111	.839	.079	13.984			
TS3	1.144	.810	.099	11.567	.859	.860	.674
KN							
KN1	1.000	.881					
KN2	1.040	.872	.060	17.411			
KN3	0.872	.759	.102	8.539	.869	.877	.705
MT							
MT1	1.000	.886					
MT2	1.075	.943	.051	21.260			
MT3	0.800	.746	.070	11.386	.888	.899	.750
CO							
CO1	1.000	.788					
CO2	1.025	.744	.084	12.259			
CO3	1.200	.804	.102	11.747	.820	.822	.608
PA							
PA1	1.000	.812					
PA2	1.159	.880	.160	7.241	.798	.800	.573
PA3	1.155	.650	.240	4.804	.798	.800	.573

Table 6 Confirmatory factor analysis for discriminant validity

Squared Multiple Correlation	MS	TS	KN	MT	CO	PA
Management Safety Climate (MS)	(.747)	-	-	-	-	-
Team Safety Climate (TS)	.514	(.674)	-	-	-	-
Safety Knowledge (KN)	.337	.509	(.705)	-	-	-
Safety Motivation (MT)	.621	.438	.326	(.750)	-	-
Safety Compliance (CO)	.511	.659	.689	.540	(.608)	-
Safety Participation (PA)	.403	.521	.521	.370	.652	(.573)

Table 7 Structural model fit indices

Confirmatory Factor Analysis Fit Indices	Model Fit Statistics
Chi-square	309.159***
Degree of Freedom	127
Relative Chi-square	2.434
Comparative Fit Index (CFI)	.922
Tucker-Lewis Index (TLI)	.906
Root Mean Square Error of Approximation (RMSEA)	.080
Standardized Root Mean Square Residual (SRMR)	.066

Note: RMSEA 90% Confident Interval (0.071, 0.092).
*** $p < .000$.

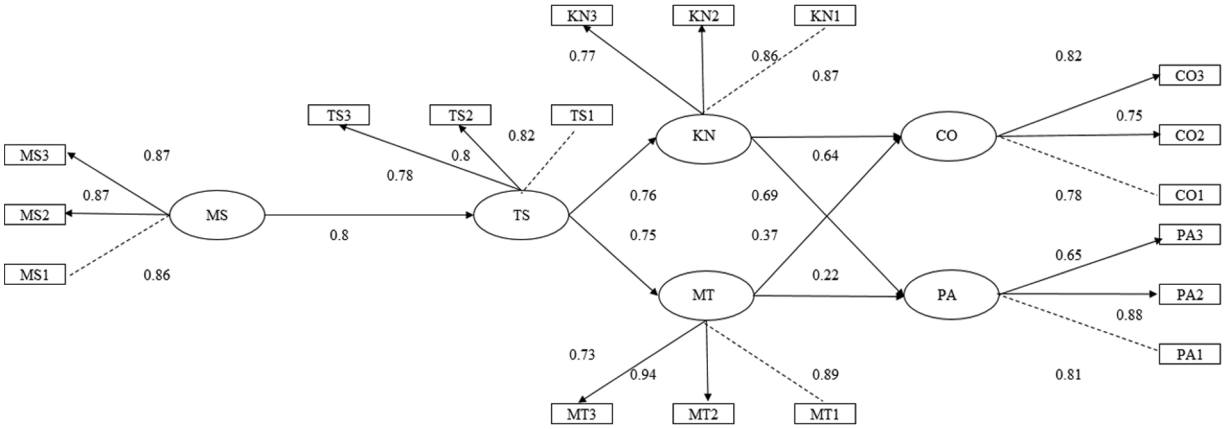

Figure 2 Structural Regression Model

Table 8 Structural equation model

Construct	R^2	Estimate	Standard	*SE*	z-value	*p*
CO	.824					
KN		.527	.641	.109	4.819	.000***
MT		.295	.374	.075	3.956	.000***
PA	.691					
KN		.764	.686	.159	4.817	.000***
MT		.234	.219	.092	2.549	.000***
KN	.585					
TS		.843	.765	.073	11.504	.000***
MT	.561					
TS		.861	.749	.102	8.427	.000***
TS	.633					
MS		.808	.795	.062	12.972	.000***

Note: *** $p < .000$.

Table 9 Model Paths Analysis, Direct Effect, Indirect Effect, Total Effect and Contrast Effect

Model Paths Analysis	Estimate	Standard	*SE*	z-value	*p*
Direct Effect					
MS CO (DIR1)	.171	.174	.046	3.728	.000***
MS PA (DIR2)	.492	.357	.071	6.973	.000***
Indirect Effect					
MS TS KN CO (IND1)	.148	.151	.027	5.388	.000***
MS TS KN PA (IND2)	.202	.147	.039	5.185	.000***
MS TS MT CO (IND3)	.088	.089	.021	4.190	.000***
MS TS MT PA (IND4)	.005	.004	.027	0.190	.849
Total Effect					
MS TS KN CO: MS CO (TOT1)	.319	.325	.050	6.344	.000***
MS TS KN PA: MS PA (TOT2)	.693	.504	.076	9.181	.000***
MS TS MT CO: MS CO (TOT3)	.259	.263	.047	5.450	.000***
MS TS MT PA: MS PA (TOT4)	.497	.361	.071	7.025	.000***
Grand total effect (Total)	1.257	1.006	.113	11.097	.000***
Contrast Effect					
IND1 – IND2	-.054	.004	.027	-2.007	.045*
IND3 – IND4	.082	.085	.032	2.609	.009**

Note: * $p < .05$; ** $p < .01$; *** $p < .000$.

To discuss the results mentioned above, the confirmatory factor analysis was analysed and structural equation model with path analysis was built and both were fitted with empirical data. The distinct contribution of this study was the context that derived from safety aspect. That is to say, all latent variables were safety-related within the context of front-line workers in construction industry. The study disclosed significant direct effect, indirect effect, total effect and contrast effect among those safety variables. This implied that safety climate that derived from both management-level and team-level led to safety compliance and safety participation and the research question had been answered. However, hypotheses 3 was partially supported as safety motivation had no indirect effect on the relationship among safety climate and safety participation. This might indicate that a worker with a full safety motivation in mind did not have an intention to participate in safety-related activities, but he or she, with safety motivation in mind, still conformed to the safety compliance. This result was found in congruence with previous research in professional drivers (Seibokaite & Endriulaitiene, 2012) and workers in China (Xia, Xie, Hu, Wang, & Meng , 2020). This study also confirmed the results from legacy seminal and scholars in safety (Neal, Griffin, & Hart, 2000) and behavioral sciences (Kath, Marks, & Ranney, 2010) that safety climate had a significant effect on safety behavior. This implied that safety-related climate, even today, still plays a quintessential role in workers' safety behavior, both in compliance and participation aspects.

Conclusion and recommendation

According to the proposed confirmatory factor analysis and structural regressions model mentioned earlier, it is clear that safety climate from both management and team are still the main components effecting safety behavior among workers. Safety climate is believed to be the organizational-wide philosophy regarding safety activities in companies. From this finding, a conclusion can be drawn for all management, that safety philosophy in organization is essential to promote safety workplace. In accordance with previous research (Vinodkumar & Bhasi, 2010), good safety behavior among employees is a good start to a safety workplace and a safety workplace is

more likely to be more profitable as there is minimal loss of assets, property, and this can promote employee quality of working life, bringing more productivity to the company in return. Besides, results of this study also imply that all safety-related factors, especially the climate, still play an important role even in front-line civil construction worker. Therefore, legacy researches regarding safety climate can still be generalized in different contexts even in the construction industry.

Ultimately, even though this research has confirmed the results from many previous manuscripts, there are several limitations and recommendations for future research. First, this research was self-administrated. This implies that common method variance and common method bias could be expected. Common method bias (CMB) occurs when variability in responses were normally caused by the instrument rather than the actual predispositions of the respondents that the instrument attempted to discover and the result might be contaminated by the noisy response stemming from the biased instruments. Accordingly, common method bias would lead to common method variance. Future research should be undertaken with a multi-level analysis with several confirmation accessories of intra-class correlation coefficients, means reliability and within group agreement to prevent common method bias. Second, this research was designed in a quantitative style. In order to dig deeper into samples' mind, qualitative research or mixed explanatory research method should be conducted because this might possibly gain a richer and deeper result about safety behavior.

Conflict of Interest

There is no conflict of interest

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