JRHS
Journal of Research in Health Sciences
journal homepage: www.umsha.ac.ir/jrhs

Original Article

Modeling the Factors Affecting Unsafe Behavior in the Construction Industry from Safety Supervisors' Perspective

Yahya Khosravi (MSc)[a], Hassan Asilian-Mahabadi (PhD)[a*], Ebrahim Hajizadeh (PhD)[b], Narmin Hassanzadeh-Rangi (MSc)[c], Hamid Bastani (MSc)[d], Ali Khavanin (PhD)[a], Sayed Bagher Mortazavi (PhD)[a]

[a] *Department of Occupational Health, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran*
[b] *Department of Biostatistics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran*
[c] *Occupational Health Research Center (OHRC), Iran University of Medical Sciences, Tehran, Iran*
[d] *Health, Safety and Environment Management, MAPNA Group Co., Tehran, Iran*

ARTICLE INFORMATION

Article history:
Received: *19 July 2013*
Revised: *18 August 2013*
Accepted: *24 August 2013*
Available online: *08 October 2013*

Keywords:
Unsafe behavior
Structural Equation Modeling
Construction industry

**** Correspondence***
Hassan Asilian Mahabadi (PhD)
Tel: *+98 21 82883590*
Fax: *+98 21 82883825*
E-mail: *asilia_h@modares.ac.ir*

ABSTRACT

Background: There can be little doubt that the construction is the most hazardous industry in the worldwide. This study was designed to modeling the factors affecting unsafe behavior from the perspective of safety supervisors.

Methods: The qualitative research was conducted to extract a conceptual model. A structural model was then developed based on a questionnaire survey (n=266) by two stage Structural Equation Model (SEM) approach.

Results: An excellent confirmed 12-factors structure explained about 62% of variances unsafe behavior in the construction industry. A good fit structural model indicated that safety climate factors were positively correlated with safety individual factors ($P<0.001$) and workplace safety condition ($P<0.001$). The workplace safety condition was found to play a strong mediating role in linking the safety climate and construction workers' engagement in safe or unsafe behavior.

Conclusions: In order to improve construction safety performance, more focus on the workplace condition is required.

Citation: Khosravi Y, Asilian-Mahabadi H, Hajizadeh E, Hassanzadeh-Rangi N, Bastani H, Khavanin A, Mortazavi SB. Modeling the Factors Affecting Unsafe Behavior in the Construction Industry from Safety Supervisors' Perspective. J Res Health Sci. 2014;14(1):29-35.

Introduction

The construction industry is the most hazardous sector in both developed and developing countries[1-4]. In developing countries, construction and mining cases were almost 2.5 times as fatal as the production sector[5]. Furthermore, occupational injuries and fatalities within the construction industry have also been associated with considerable financial costs. Occupational injuries within the construction industry cost nearly over $10 billion per year[6].

Safety at work is a complex phenomenon, and the subject of safety performance in the construction industry is even more so[7]. Although several studies have been conducted to investigate the causes of accident in the construction sites, but there is a fact that construction accident causation stop at a premature level to identify the root causes of accidents. For example, Toe et al. (2005) points out that previous studies did not provide a holistic framework that may help project managers handle the various policy, process, personnel and incentive aspects that may affect construction safety[8]. Therefore, construction safety is always a significant concern for both practitioners and researchers[9].

To improve safety performance in the construction industry, it is necessary to understand the contributing factors of the unsafe behavior[10,11]. By increasing the knowledge base and the known facts surrounding these contributing factors, the application of an effective safety model would contribute to improve the methods of how construction operations are planned and performed[10]. Therefore, the aim of this study was modeling the factors affecting unsafe behavior from the perspective of safety supervisors.

Methods

This study was a sequential mixed method study including a qualitative research followed by a questionnaire survey. The mixed methods research, where quantitative and qualitative methods are combined, is increasingly recognized as valuable, because it can potentially capitalize on the respective strengths of quantitative and qualitative approaches[12]. Gittleman et al. (2010) stated the current investigations of workplace safety have integrated qualitative and quantitative methods to gain additional information about safety issues[6]. This integration of qualitative and quantitative approaches allowed them to obtain a better understanding of employees' conceptualizations about risk, safety behaviors, and attitudes toward safety[6,13].

The qualitative research

The qualitative research was conducted to extracting a conceptual model and to generating a new questionnaire. Thirty six safety supervisors with a mean age of 43.4 years (SD=7.6) were interviewed. Semi- and unstructured individual interviews were conducted with participants. Thematic analysis provided a rich database allowing a grounded theory approach to emerging the factors affecting unsafe behaviors. The participants were a theoretical sample of supervisors from different tasks, work site, and projects in different geographical and cultural areas in Iran according to the procedure of Glaser and Strauss (1967)[14]. Three basic types of the triangulation were used in this study according to Denzin (2009): (a) Data triangulation; (b) Investigator triangulation; and (c) Methodological triangulation[15]. To achieving the data triangulation, data generation was conducted in different times (2012-2013), space (the south, center and north of Iran), and persons (from different work sites and projects). The investigator triangulation was met by involving multiple researchers. In order to achieving triangulation at the methodological level, the researchers used more than one method to generate or verify the data (interviews, field observations, and document reviews) and to analyze the data (holistic and detailed thematic analysis).

In addition, the measures recommended by previous studies[15,16], were met to achieve the trustworthiness criteria in this study. One of the important measures was testing the emerging themes against original data extracted from the interviews, documents and observations. In addition, the first author, who engaged part time for nine months in the various projects, reported back the findings to the representatives of participants.

The verification process was conducted through an external checker and two member checkers (second and last authors). Furthermore, having multiple researchers and then assessing inter-rater reliability helped to strengthen the trustworthiness of the findings via investigator triangulation[17]. To evaluate inter-rater reliability, the researchers rated how close the themes were between two raters. The following scale was used: 0 (no agreement); 1 (a little agreement); 2 (much agreement); and 3 (total agreement). Then, the researchers computed Kappa coefficient to calculate the overall agreement between the two raters for all of the themes[17].

The grounded theory was used to extracting the conceptual model. Corbin and Strauss (2008) stated that a researcher does not begin a grounded theory study with a preconceived theory in mind. Rather, the researcher begins with a study and allows the theory to emerge from the data[18]. Therefore, in the first stage, the researchers provided a rich database allowing the grounded theory to emerging the conceptual model. Then, the conceptual model was compared against the previous studies to achieve the more trustworthiness and to confirm the hypotheses.

The questionnaire survey

The questionnaire items were generated from the qualitative research according to detailed thematic analysis approach[19]. Key measurement properties (face validity, content validity, construct validity and reliability) were examined using qualitative and quantitative approaches. The face and content validity was obtained by comparing the questionnaire items against original data extracted from the qualitative research. The questionnaire items were analyzed on a five-point scale so that higher item score indicated a more unsafe statue. Due to paucity of space, the generated questionnaire has not been discussed here and can be obtained from the corresponding author upon request. A structural model was then developed based on a questionnaire survey by Structural Equation Model (SEM). The questionnaire survey was conducted by 266 safety supervisors from 75 different construction projects in the south, north and center of Iran. The mean age of participants was 39.1 yr (SD=10.2). The survey was implemented in two main clients with different construction types. The construction safety supervisors were chosen to achieve the proposed objectives because safety supervisors have the most information about the specific practices and procedures being carried out in the construction projects and have access to documentation related to safety. In addition, the safety supervisors occupy an intermediate position between the management and the workers[20].

The Exploratory Factor Analysis (EFA) was conducted on the original data (n=266) using the Principal Component Analysis (PCA), in an attempt to determine observed variables of the proposed structural model. For each observed variable, internal consistency was estimated on the original data (n=266) using the Cronbach's alpha. The SPSS v.19 software was utilized to conduct the EFA and the internal consistency. Two-stage SEM approach according to Anderson and Gerbing (1998) was followed in the data analysis to test the hypotheses[21]. First, the Confirmatory Factor Analysis (CFA) was conducted on the measurement model to test the validity of the observed variables of each latent variable. In the next stage, the proposed structural model was estimated in the SEM. To apply the SEM, the LISREL 8.8 software was used to conduct the analysis of both the measurement and structural models. In order to assess the fit of the models, the common goodness-of-fit indices were used: Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Parsimony Goodness of Fit Index (PGFI), Root Mean Square Residual (RMR), Root Mean Square Error of Approximation (RMSEA), Normalized Fit Index (NFI), Non-Normalized Fit Index (NNFI), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Relative Fit Index (RFI) and χ^2/df [22].

Results

Conceptual model and hypotheses

The thematic coding revealed three categories, 12 themes (factors) and several subthemes that can be related to the unsafe behavior (Table 1). The selected quotations presented to illustrate some emphasized subthemes.

These categories refer to: (1) Safety Climate Factors (SCFs); (2) Individual Factors (IFs); (3) and Workplace Condition Factors (WCFs). The triangulation results showed the completeness and confirmation of findings in the qualitative research. The external and member checkers confirmed the overall consistency of the data extracted in different time, space, and persons. Moreover, they certified that the field observations and document reviews confirmed the themes emerged from the interviews. In addition, they concluded that findings of detailed thematic analysis were in direction with holistic thematic analysis. The results of the inter-rater reliability indicated that there was a significant agreement (kappa=0.81) among two raters in the coding of the themes. The grounded theory and previous studies suggest the following hypotheses reflect the relations among the above factors:

There is an increasing amount of literature that shows the safety climate can be reflected in the individual employee's attitudes and beliefs[1,23-25]. Therefore, the SCFs and IFs were proposed as the exogenous and endogenous variables, respectively. As a result, the corresponding hypothesis was proposed:

H1. *The SCFs have a positive effect on the IFs.*

The previous studies[26,30] confirmed the workplace hazard can be predicted by the safety climate dimensions. Thus, the researchers proposed that the SCFs play the role of exogenous variables against the WCFs as endogenous variable. Accordingly, it is hypothesized that:

H2. *The SCFs have a positive effect on the WCFs*

Based on previous studies[23,27], the construction workplace has a direct impact on worker's psychological aspects. Therefore, it is proposed that the WCFs act as an endogenous variable (independent variable) against the IFs as another endogenous variable (dependent variable). In the SEM, a variable here the WCFs) can act as both independent and dependent variable[22]. Consequently, the following hypothesis was established:

H3. *The WCFs have a positive effect on the IFs.*

These hypotheses in the form the conceptual model represent relations between latent variables, as illustrated in Figure 1.

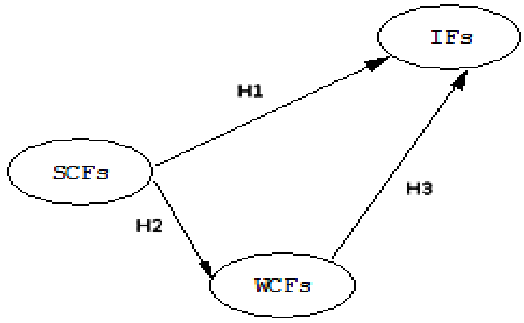

Figure 1: Conceptual model extracted from grounded theory

Table 1: Descriptions of the factors extracting from the exploratory factor analysis based on the qualitative research findings and verifying studies

Themes (factors)	Descriptions	Verifying studies
Individual Factors (IFs)		
Safety motivation and prohibition (IF1)	Refers to subthemes related the arousal and direction process to a safe or unsafe behavior. such as "*Risk taking to become a key person in a contractor*"	Aksorn and Hadikusumo, 2008[3]; Larsson et al., 2008[29]
Safety attitude and belief (IF2)	Refers to subthemes related to an internal feeling toward safety issues and is expressed through words and behavior. such as "*Accident as a chancy phenomena*"	Choudhry and Fang, 2008[11]; Gittleman et al., 2010 [6]
Safety behavior (IF3)	Refers to subthemes related to non- and intentional deviations from the safety regulations and procedures. Such as *" I leave my PPEs because these devices are annoying "*	Choudhry and Fang, 2008[11]; Gittleman et al., 2010 [6]
Safety values (IF4)	Refers to subthemes related to degree of the worth or importance a person attaches to safety issues. Such as "*Safety Last as a core value*"	Choudhry and Fang, 2008[11]; Gittleman et al., 2010 [6]
Workplace Condition Factors (WCFs)		
Psychological condition (WCF1)	Refers to subthemes related to stressful sit condition resulting from project management, which might lead to workers' exhausting, sleep deprivation, depressive symptoms, mental distraction or job dissatisfaction. Such as *" hurry to finish the work "*	Hon et al., 2010 [27]; Siu et al, 2004 [30]
Physical condition (WCF2)	Refers to subthemes related to unsafe site condition resulting from project management, which might lead to the more exposure of workers with hazards. Such as "*using old and defective machines"*	Gittleman et al., 2010 [6]; Choudhry and Fang, 2008[11]
Safety Climate Factors (SCFs)		
Client safety climate (SCF1)	Refers to subthemes related to perceived client management attitudes toward safety. Such as "*contractors are under client time pressure"*	Meliá et al, 2008 [1]; Gittleman et al., 2010 [6]; Törner and Pousette, 2009 [2]
Contractor competency (SCF2)	Refers to subthemes related to the combination of skills, experience and knowledge that contractors must be have to meet the contractual requirements. Such as "*contractors prefer to part-time recruitment*"	Petrovic-Lazarevic et al. 2007[28]
Safety supervision and management (SCF3)	Refers to subthemes related to the combination of regulation, procedures and practices to meet the safety goals and policies. Such as "*There is significant gaps between procedures and work practice"*	Törner and Pousette, 2009 [2]; Gittleman et al., 2010 [6]
Contract management (SCF4)	Refers to subthemes related to the process of systematically and efficiently managing contract creation, execution and analysis for maximizing operational and financial performance and minimizing risk. Such as "*There is no specific resource allocation for safety"*	Törner and Pousette, 2009 [2]; Petrovic-Lazarevic et al. 2007[28]
Social safety climate (SCF5)	Refers to subthemes related to perceived society attitudes toward safety such as *"an 'unsafe worker' is an 'unsafe driver' "*	Meliá et al, 2008 [1]; Choudhry and Fang, 2008 [11]
Contractor safety climate (SCF6)	Refers to subthemes related to perceived contractor management attitudes toward safety. Such as *"Take shortcut for achieving a higher profit"*	Törner and Pousette, 2009 [2]; Choudhry and Fang, 2008[11]

Structural model development

The EFA findings in Table 2 indicated that the PCA revealed an interpretable 12-factor structure, which explained 61.51% of the variance. These factors (or observed variables) according to the findings of the qualitative research and realistic meaning of rest items or the items with high factor loading were interpreted as follow: IF1 (safety motivation and prohibition), IF2 (safety attitude and belief), SCF1 (client safety climate), SCF2 (contractor competency), SCF3 (safety supervision and management), IF3 (safety behavior), SCF4 (contract management), SCF5 (social safety climate), WCF1 (psychological condition), WCF2 (physical condition), SCF6 (contractor safety climate), and IF4 (safety values). As shown in Table 2, the internal consistency of the all observed variables were good to excellent (Cronbach's alpha from 0.70 to 0.89). As Table 1 shows, the previous studies certified the factors extracted from this study.

Table 2: Internal consistency and exploratory factor analysis of measurement model

		Before rotation			After rotation		
Observed variables	**Cronbach's alpha**	**Eigen values**	**% of Variance**	**Cumulative %**	**Eigen values**	**% of Variance**	**Cumulative %**
Safety motivation and prohibition	0.89	14.99	26.76	26.76	6.14	10.96	10.96
Safety attitude and belief	0.81	3.99	7.12	33.88	3.44	6.14	17.10
Client safety climate	0.82	2.28	4.06	37.94	3.27	5.84	22.94
Contractor competency	0.72	2.06	3.68	41.62	3.12	5.57	28.51
Safety supervision and management	0.77	1.93	3.45	45.07	2.91	5.20	33.71
Safety behavior	0.76	1.67	2.97	48.04	2.81	5.02	38.73
Contract management	0.70	1.55	2.76	50.81	2.51	4.48	43.21
Social safety climate	0.71	1.40	2.51	53.32	2.32	4.15	47.35
Psychological condition	0.73	1.33	2.38	55.69	2.29	4.09	51.45
Physical condition	0.70	1.22	2.18	57.87	2.20	3.92	55.37
Contractor safety climate	0.84	1.17	2.10	59.97	1.87	3.35	58.71
Safety values	0.70	1.07	1.90	61.87	1.77	3.16	61.87

Note: Extraction method: principal component analysis. Rotation method: Varimax with Kaiser Normalization. Rotation converged in 25 iterations

In Table 3, the goodness-of-fit indices of the measurement and alternative models obtained from the SEM can be compared with recommended values suggested by previous studies[22]. The CFA results confirmed that the measurement model (Figure 2) provided an excellent goodness-of-fit to the data (GFI= 0.97, RMR=0.33, RMSEA=0.04; CFI =0.99; NFI=0.98; χ^2/df =1.49). However, the original structural model (Figure 3) did not indicate such an excellent fit (GFI=0.90, RMR=0.69, RMSEA=0.09; CFI=0.96; NFI=0.94; χ^2/df =3.26). Therefore, a six-stage model specification and refinement strategy was conducted on the original structural model to obtain a better goodness-of-fit. As seen in Table 3, all the indices of the modified model (Figure 4) indicated an excellent fit to the data (GFI=0.95, RMR=0.48, RMSEA=0.49; CFI =0.99; NFI=0.97; χ^2/df =1.76).

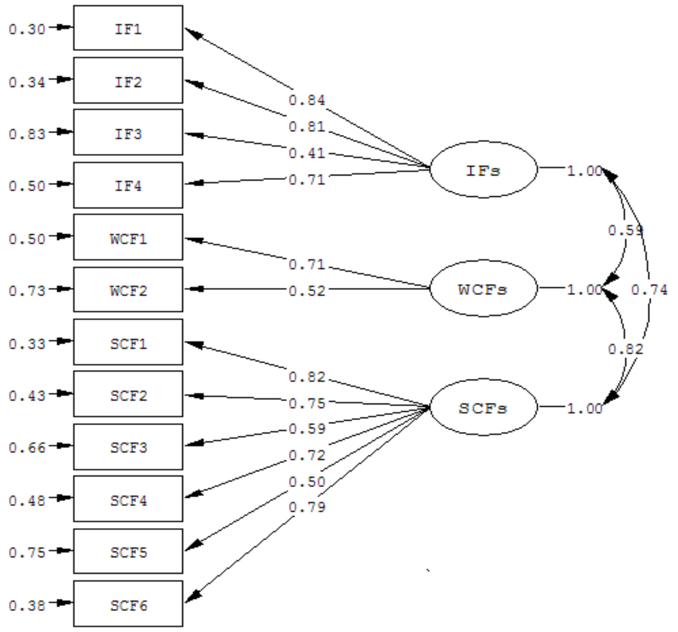

Figure 2: Confirmatory factor analysis of the model measurement

Table 3: Comparison goodness-of-fit indices of measurement and alternative structural models

Fit indices	Recommended values	Measurement model	Original structural model	Modified structural model
GFI	>0.90	0.97	0.90	0.95
AGFI	>0.90	0.94	0.85	0.92
PGFI	>0.50	0.44	0.60	0.59
RMR	<0.50	0.33	0.69	0.48
RMSEA	<0.10	0.04	0.09	0.49
CFI	>0.90	0.99	0.96	0.99
IFI	>0.90	0.99	0.96	0.99
RFI	>0.90	0.96	0.93	0.96
NFI	>0.90	0.98	0.94	0.97
NNFI	>0.90	0.99	0.95	0.98
PNFI	>0.50	0.54	0.74	0.71
χ^2/df	≤3	1.49	3.26	1.76

Hypothesis test, as illustrated in Figures 3 and 4, indicated that the SCFs were positively correlated with the IFs (standardized path coefficient=0.70, *t*-test=8.50, *P*<0.001) and the WCFs (standardized path coefficient=0.80, *t*-test=6.61, *P*<0.001), which the results supported both the hypothesis H1 and H2. However, the WCFs did not indicate a positive effect on the IFs (standardized path coefficient= -0.06, *t*-test= -0.36, *P*=0.36), which the hypothesis H3 was rejected. The modified model in Figure 4 suggested that the client safety climate (SCF1) has the highest correlation (standardized path coefficient=0.85) with the overall safety climate (SCFs). Among the main individual factors (IFs), the safety motivation and prohibition (IF1) had the greatest correlation (standardized path coefficient=0.88) with the overall individual safety factors (IFs). The psychological condition (WCF1) had the highest correlation (standardized path coefficient=0.71) with the overall workplace safety condition (WCFs). While, the safety behavior

(IF3) was found to have a moderate correlation (standardized path coefficient=0.41) with the overall individual factors (IFs) as depicted in Figure 3, the modified model in Figure 4 indicated that the safety behavior (IF3) has a high correlation (standardized path coefficient=0.66) with the workplace safety condition (WCFs). The workplace safety condition (WCFs) played a strong mediating role in linking overall safety climate (SCFs) and the safety behavior (IF3).

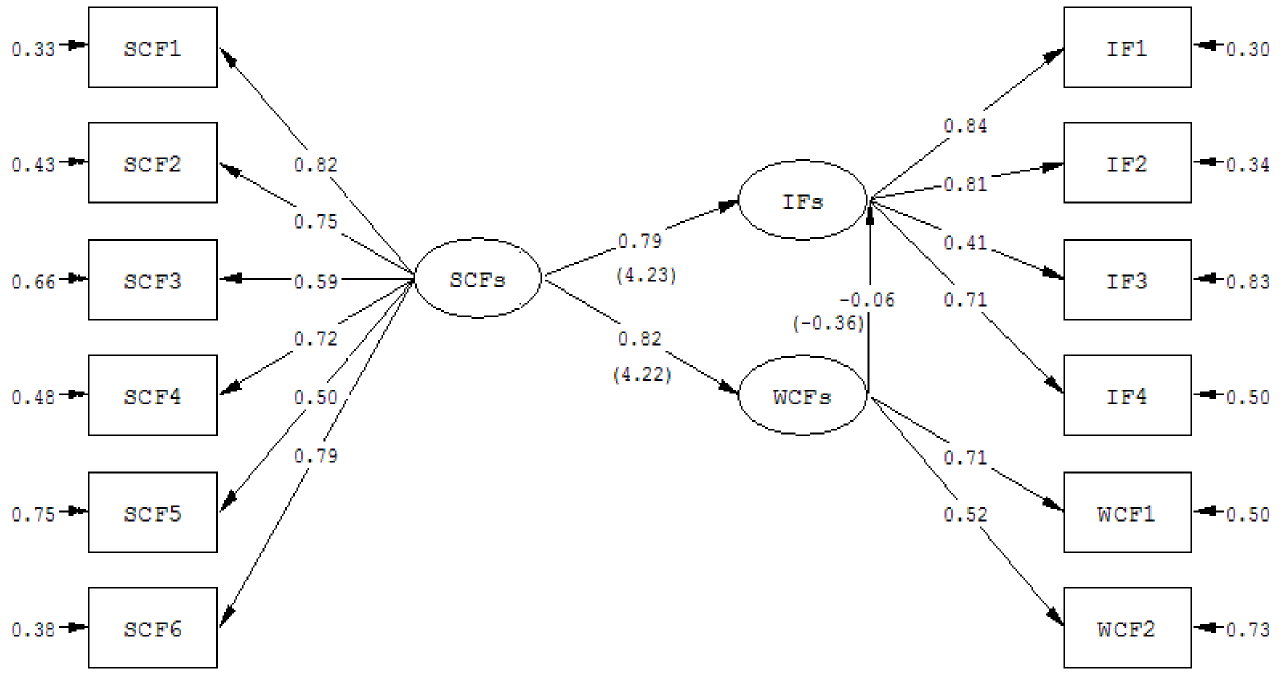

Figure 3: Original structural model with standardized path coefficients (t-Value in parentheses: t-Value above 1.96 shows significant at 95% confidence level)

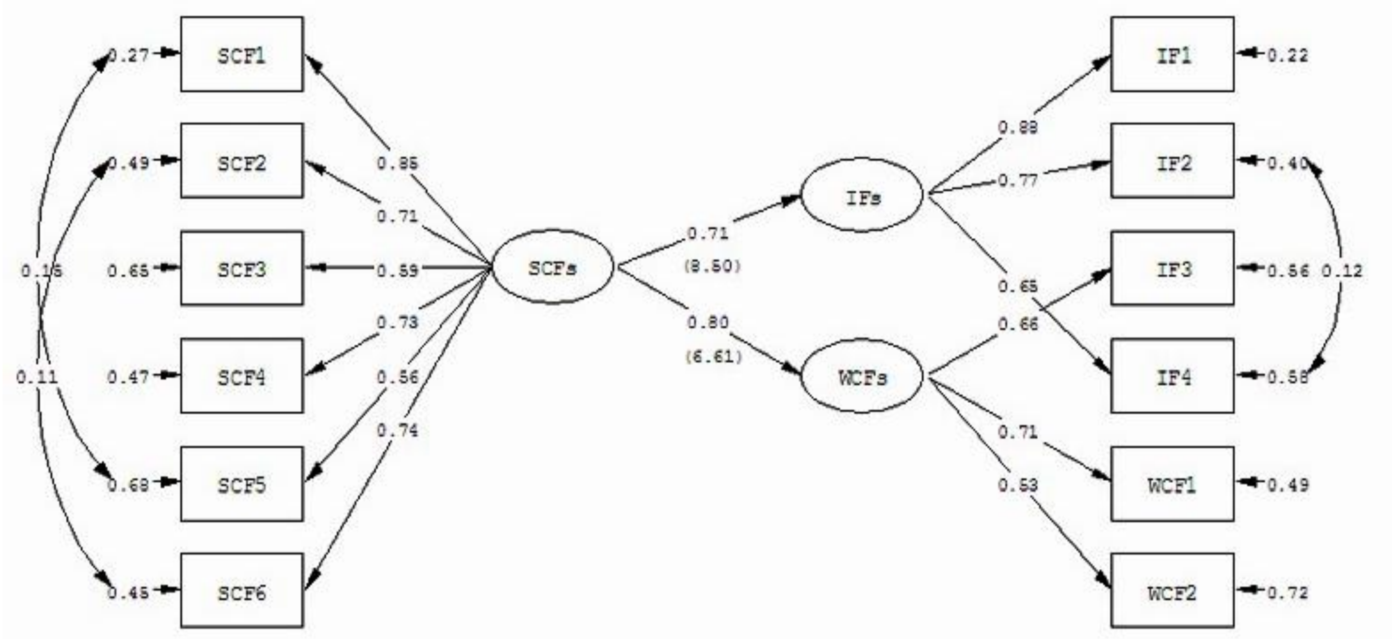

Figure 4: Modified structural model with standardized path coefficients (t-Value in parentheses: t-Value above 1.96 shows significant at 95% confidence level)

Discussion

Prior studies noted the importance of the distal factors on safety performance in the construction industry. Therefore, the current study set out with the aim of modeling the distal and proximal factors affecting unsafe behavior in the construction industry. This study provided a good-fit structural model suggests that safety climate factors, which include social safety climate, client safety climate, contract management, contractor safety climate, contractor competency, and safety supervision and management, were positively correlated with the safety individual factors and workplace safety condition. A theoretical implication of this finding is the integration of distal and proximal factor affecting unsafe behavior into a comprehensive model. Among the overall safety climate factors, client safety climate was found to be the key factor in the project safety management. This finding is partially in the line of the previous findings that safety climate is one of the most important factors affecting unsafe behavior and accident1[23-25]. While, the multidimensional nature of safety climate is no longer being debated, the exact nature of the dimensions is still being studied[23]. With a few exceptions, previous research lacks a clear distinction between safety climate and individual attitudes[24]. The results of this study provide interesting evidence that the different safety climate predictors in the contractor, client and social levels, were associated with the overall safety climate in the construction industry. A practical implication of this finding is that they help us to address the observed factors that should be encouraged to reduce unsafe condition and improve safe behavior in the construction organization. The results of this study indicated that the safety motivations and prohibitions are very important individual safety features among the main individual factors. This result corroborated the findings of the previous work in this field[3,4]. The current study found that the correlation among the workplace safety condition with the psychological condition tended to be higher than with the physical condition. This finding supports the insight that the psychological features such as comfortable feel with supervisors and living conditions of workers on site can be effective in the construction safety performance[25]. Contrary to expectations, the most interesting finding was that the safety behavior has a more correlation with safety workplace condition than individual safety factors. This finding alters the widely accepted view among the construction industry that individual characteristic is the key factor in the accident causation[2,3,8]. To implement the effective intervention in the construction sites, more focus on psychological and physical unsafe condition is therefore suggested. The physical unsafe condition on construction sites refers to unsafe sit condition which might lead to the more exposure of workers with hazards. This condition might result from the absence of appropriate safety equipments, using old and defective machines, lack of appropriate safety equipment, insufficient lighting, poor housekeeping and working in bad weather condition. In return, the psychological unsafe condition on construction sites refers to stressful sit which might lead to workers' exhausting, sleep deprivation, depressive symptoms, mental distraction and job dissatisfaction. The psychological unsafe condition might result from the lack of welfare facilities, work group interaction, bad relationships, workers 'distrust to management, work pressure and mental workload.

In order to improve workplace conditions on the construction sites where the inherent complexity of construction work complicates safety management[2], the distal contributing factors such as client safety climate would contribute to improve the methods of how construction operations can be planned and performed safely.

Conclusions

Over the current past years, several attempts have been made to develop new structures toward understanding of the complex nature of the safety performance in the construction industry. This study provided a new good-fit structural model suggests that the workplace safety condition play a strong mediating role in linking the safety climate and construction workers’ engagement in safe or unsafe behavior. The new structural model, which integrated the pervious constructs, can be used to better understand the factors affecting the safety performance in the construction industry.

Acknowledgments

The authors would like to thank Mr Fariborz Kakaei (MAPNA) and Dr Abdolrahman Keshvari (Gharargah Khatam) for their coordination and constructive comments.

Conflict of interest statement

The authors declare that have no conflict of interest.

Funding

The study was financially supported by MAPNA Group Company and Tarbiat Modares University.

References

1. Meliá JL, Mearns K, Silva SA, Lima ML. Safety climate responses and the perceived risk of accidents in the construction industry. *Saf Sci.* 2008;46(6):949-958.
2. Törner M, Pousette A. Safety in construction – a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers. *J Safety Res.* 2009;40(6):399-409.
3. Aksorn T, Hadikusumo BHW. Critical success factors influencing safety program performance in Thai construction projects. *Saf Sci.* 2008;46(4):709-727.
4. Lai DNC, Liu M, Ling FYY. A comparative study on adopting human resource practices for safety management on construction projects in the United States and Singapore. *Int J Proj Manag.* 2011;29(8):1018-1032.
5. ERGöR OA, Demiral Y, Piyal YB. A significant outcome of work life: occupational accidents in a developing country, Turkey. *J Occup Health.* 2003;45(1):74-80.
6. Gittleman JL, Gardner PC, Haile E, Sampson JM, Cigularov KP, Ermann ED, Stafford P, Chen PY. [Case Study] CityCenter and Cosmopolitan Construction Projects, Las Vegas, Nevada: Lessons learned from the use of multiple sources and mixed methods in a safety needs assessment. *J Safety Res.* 2010;41(3):263-281.
7. Sawacha E, Naoum S, Fong D. Factors affecting safety performance on construction sites. *Int J Proj Manag.* 1999;17(5):309-315.
8. Teo EAL, Ling FYY, Chong AFW. Framework for project managers to manage construction safety. *Int J Proj Manag.* 2005;23(4):329-341.
9. Cigularov KP, Chen PY, Rosecrance J. The effects of error management climate and safety communication on safety: A multi-level study. *Accid Anal Prev.* 2010;42(5):1498-1506.
10. Hinze JW, Teizer J. Visibility-related fatalities related to construction equipment. *Saf Sci.* 2011;49(5):709-718.
11. Choudhry RM, Fang D. Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Saf Sci.* 2008;46(4):566-584.
12. Östlund U, Kidd L, Wengström Y, Rowa-Dewar N. Combining qualitative and quantitative research within mixed method research designs: A methodological review. *Int J Nurs Stud.* 2011;48(3):369-383.
13. Pezzullo L, Filippo RD. Perceptions of industrial risk and emergency management procedures in Hazmat Logistics: A qualitative mental model approach. *Saf Sci.* 2009;47(4):537-541.
14. Glaser BG, Strauss AL. *The discovery of grounded theory: Strategies for qualitative research*. New Jersey: Aldine Transaction; 2009.
15. Denzin NK. *The research act: A theoretical introduction to sociological methods*. New Jersey: Aldine Transaction; 2009.
16. Guba EG, Lincoln YS. *Naturalistic inquiry.* California: Sage; 1985.
17. Leech NL, Onwuegbuzie AJ. An array of qualitative data analysis tools: A call for data analysis triangulation. *Sch Psychol Q.* 2007;22(4):557.

18. Corbin J, Strauss A. *Basics of qualitative research: Techniques and procedures for developing grounded theory*. California: Sage; 2008.

19. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* 2006;3(2):77-101.

20. Fernández-Muñiz B, Montes-Peón JM, Vázquez-Ordás CJ. Safety climate in OHSAS 18001-certified organisations: Antecedents and consequences of safety behaviour. *Accid Anal Prev.* 2012;45(0):745-758.

21. Anderson JC, Gerbing DW. Structural equation modeling in practice: A review and recommended two-step approach. *Psychol Bull.* 1988;103(3):411.

22. Jöreskog KG, Sörbom D. *Lisrel 8: Structured equation modeling with the Simplis command language*. Illinois: Scientific Software International; 1993.

23. Goldenhar LM, Williams LJ, Swanson NG. Modelling relationships between job stressors and injury and near-miss outcomes for construction labourers. *Work & Stress.* 2003;17(3):218-240.

24. Pousette A, Larsson S, Törner M. Safety climate cross-validation, strength and prediction of safety behaviour. *Saf Sci.* 2008;46(3):398-404.

25. Abbe OO, Harvey CM, Ikuma LH, Aghazadeh F. Modeling the relationship between occupational stressors, psychosocial/physical symptoms and injuries in the Construction Industry. *Int J Ind Ergon.* 2011;41(2):106-117.

26. DeJoy DM, Della LJ, Vandenberg RJ, Wilson MG. Making work safer: Testing a model of social exchange and safety management. *J Safety Res.* 2010;41(2):163-171.

27. Hon CKH, Chan APC, Wong FKW. An analysis for the causes of accidents of repair, maintenance, alteration and addition works in Hong Kong. *Saf Sci.* 2010;48(7):894-901.

28. Petrovic-Lazarevic S, Perry M, Ranjan R. Improving the occupational health and safety measures in the Australian construction industry. *Zagreb Int Econ Rev Bus.* 2007;10(2):17-34**.**

29. Larsson S, Pousette A, Törner M. Psychological climate and safety in the construction industry-mediated influence on safety behaviour. *Saf Sci.* 2008;46(3):405-412.

30. Siu O-l, Phillips DR, Leung T-w. Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. *Accid Anal Prev.* 2004;36(3):359-366.