Relationship between Safety Climate Factors and Safety Performance in Chemical Industries

Shalini Tayaparan, Jafri Mohd Rohani, Khidzir Zakaria, Fatin Amrina A Rashid, Mohd Izuddin M Ithnan
Department of Materials, Manufacturing & Industrial Engineering,
Faculty of Mechanical Engineering,
Universiti Teknologi Malaysia,
81310 Skudai, Johor Bahru, Malaysia
shalinitaya34@gmail.com, jafrimr@utm.my, khidzir@fkm.utm.my, famrina2@live.utm.my, mizuddin@utm.my

Abstract

Safety is an important issue in the rapid industrialization especially in chemical industries. The objective of this study is–to investigate relationship between safety climate factors and safety performance in chemical industries and proposes a new framework. This study uses safety management, work pressure, safety competence, safety procedures, safety communication and safety supervision as independent variables that explain the relationship towards safety performance in chemical industry at Pasir Gudang, Johor. A survey instrument was developed, and 220 responses were collected. Factor analysis and multiple linear regression was used to analyze the data collected using SPSS software. As a result, safety climate factors (safety management and work pressure, safety competence, safety communication and safety procedures) were able to explain 47.2% of variation safety performance. Nonetheless, it was found that reflections of safety climate factors on safety performance could not be similar with each industry, since findings would fluctuate due to geographical context and individual context. Despite the limitations, this study contributes to the literature by revealing table factor structures, where appropriate level of reliability and validity measures of safety climate factors and safety performance scales were developed.

Keywords
Safety Climate Factors; Safety Performance; Factor Analysis; Multiple Regression; SmartPLS; Chemical Industries

1. Introduction

Industrial accidents are considered as a major social challenge. According to International Labor Organization (ILO), it was reported that approximately 360 million fatal and 337 million non-fatal work-related accidents occur worldwide every year which holds the estimated cost of US $5 Billion worldwide (Hon, Chan, & Yam, 2014). The recent rapid industrialization, occupational safety is being a severe issue that shall be considered in all industrial and human activities. Unawareness and improper safety management could indirectly report the phenomenon of industrial accidents. Thus, a well-established method is required to evaluate the link between existing organizational characteristics and safety at work including risk for accidents.

Historically, in the industrial sector, the accident reduction approach has focused on examining “lagging” data or commonly known as past events, such as lost-time accident rates and incident rates (Rhona Flin, 2007). Based on lagging data, the injury or fatality needed to occur before the company took action to eliminate or reduce exposure to the hazard. Therefore, reporting was after an incident rather than a proactive attempt to prevent injury. However, these Traditional methods of improving safety within industry focused primarily on accident investigations to determine specific causes has been recommended for changes in the future by adopting an approach to prevent injuries and fatalities by focusing on predictive measures to monitor safety culture (R Flin, Mearns, O’Connor, & Bryden, 2000). Current safety management and injury prevention study suggests human behavior may have a greater role in preventing injuries or fatalities than was first suspected. Safety climate factors derive an approach to relate human behavior with accident preventions

1.1 Safety Climate Factors

Safety climate factor has been defined as sum of employee's shared perceptions of policies, procedures, and practices relating to safety in their working environment by Zohar, who first introduced safety climate as crucial construct for study of variables linked to accidents and injuries in the work place (Liu et al., 2015). Safety climate factors have been widely used for over 3 decades across diverse industries since they reflect characteristic of organizations since the attitudes of a specific group of people toward safety issues are important. Safety climate also provides a snapshot of organization state if safety at a discrete point in time (Vinodkumar & Bhasi, 2009). Safety climate factors will help to raise safety motivation, which then will increase safety knowledge of workers. Good safety knowledge among workers will make the workers be more confident in perceiving the safety and thus will leads to positive safety behaviour. Positive safety behaviour at the end will reduce the accidents and injuries which will reflect good safety performance (Rhona Flin, 2007).

Zohar in 1980 first developed safety climate using 40 items questionnaires in multiple industries in Israel. He concluded eight dimensions of safety climate through factor analysis which were safety training, management attitude towards safety, effects of safe conduct on promotion, states of safety officer, effects of state of conduct on social states and states of safety committee. However, further studies have been conducted by other researchers who have developed more factors such as employees' perception of management activities. Vinodkumar and Bhasi (2009) hhighlighted that, there were more studies had been conducted in the past three decades and many new factors were developed through the study on safety climate. Those factors include material factors (plant decision, production equipment, personal protective equipment), policies and practices (safety provokes, training, enforcement, daily routines, housekeeping), safety related conditions (work stress, social relations with coworkers), behavioral and attitude factors (personal motivation, safety knowledge, optimism, risk justification, fatalism, apathy) and level of concern and action by different people in work place (management, supervision, safety specialists, and safety committee).

Barbaranelli *et.al* (2015) explained that Zohar, founder of safety climate factors have highlighted some important safety climate dimensions to be considered when conceptualizing and measuring safety climate factors in industries (Barbaranelli et al., 2015). Those important climate factors include management values, safety communication, safety training, and safety system. Apart from this, Flin et al (2000) also have identified five most frequently occurring factors from 18 safety climate scales of different industries which were management or supervision, safety system, risk pressure, and competence (R Flin et al., 2000). Besides these, safety rules and procedures and worker's involvement in safety also being concerned as the most fundamental safety climate factors in industries (Zhou, Fang, & Wang, 2008).

1.2 Safety Performance

Safety performance is defined as evaluative 'actions or behaviors that individuals exhibit in almost all jobs to promote the health and safety of workers, clients, the public and the environment' (Burke, Sarpy, E.Tesluk, & Smith-Crowe, 2002). In other words, safety performance is defined as 'activities which a department head carries out to ensure safety (Wu, Chang, Shu, Chen, & Wang, 2011).

It was common to use self-report data of accidents or injuries to measure the safety performance of an organization in the past decades. However, continuous studies conducted had been found out that the accidents and injuries data are unreliable since the frequency of them are indefinable and unpredictable although the accuracy of self-reported injuries could be as high as 80% (M. Dominic Cooper & Phillips, 2004).

Thus, in light of the deficiency in using self-reported injuries and accidents as indicators of safety performance, (Hon et al., 2014) explained that safety behavior can be used as a measure of safety performance and this safety behavior has been adapted as safety performance indicators by researchers in their study until present which will be more discussed in the literature review section. Despites to safety behavior, the two fundamental safety performance indicators used by researchers are safety compliance and safety participation.

Safety compliance is defined as adherence to rules and procedures developed by companies and regulatory bodies by Zohar (2011). In other words, it also can be simplified as following rules in core safety activities which include obeying safety regulations, following correct procedures, and using appropriate equipment (Neal & Griffin, 2006). Meanwhile, safety participation is defined a behavior that indirectly contribute to an individual's personal safety.

1.3 The need of Safety Climate Survey in Chemical Industries

Chen, McCabe, and Hyatt (2017) reported that the risks in chemical industries have been increasing recently due to the increased complexity if the systems and thus accidents in chemical industries can be caused by new, unforeseen mechanisms. Therefore, well-managed safety engineering is dominant to predict these unexpected risks in chemical industries. Furthermore, it was explained that the concern on safety of chemical industries had been acknowledged only through Bhopal Gas Tragedy in India in 1984 which was caused by reliance of human life by company management, ignorance of complacency of workers, and total irresponsible attitude from regulatory agencies(Vinodkumar & Bhasi, 2009). Furthermore, the author explained that these negligence of any of the above factors possible to cause such catastrophic accidents in chemical industries worldwide. As a supportive tool for this Beale has reported that some major accidents in chemical industries such as Major explosion in Toulouse, France in 2001 which caused 29 fatalities, high pressure gas pipeline explosion in Belgium in 2004 which caused 24 fatalities, and major explosion at BP Texas in 2005 which caused 12 fatalities (WIEF, 2012). These major accidents share the common causes which are some of the dimensions of the safety climate factors as been developed by previous studies (Zohar, 2010).

In Malaysia, there are less accident statistics (lagging indicator) in chemical industries available and reliable to measure the safety performance. According to the accident statistical data in 2016 by Department of Environment (DOE, majority of the accidents occurs in constructions area and there are no any cases reported due to chemical industry hazards, injuries and accidents. Hence, this creates a space for using the leading indicator of safety climate to measure the safety performance, as safety climate is a strong predictor of safety performance. The finding have reported that safety climate factors cannot be exactly replicated in different cultural set ups and there is no universal set of safety climate factors which may be applicable to various industries, cultures and regions (Zohar, 2010). Hence, there is a need to develop safety climate questionnaire for the chemical industries in Johor, specifically in Pasir Gudang which have been proved as the largest chemical industrial area in Johor.

2. Methodology

The study methods to develop the relationship between safety climate factors and safety performance indicators are using quantitative method. The quantitative method includes survey instrument development, followed by exploratory analysis and lastly confirmatory studies (CFA). Survey instrument was developed through literature review which then proceeded with validation from industrial experts and academicians, followed by pilot study and then reliability analysis. Exploratory study was conducted through principal component analysis (PCA), since CFA is the most recommended tool in a multi-indicator measurement model where it could assess the non-dimensionality of the developed theoretical model (Shang & Lu, 2009). Meanwhile, confirmatory studies were conducted through SmartPLS

2.1 Sample and Population

Pasir Gudang is classified as one of the largest strategic industrial hub in Malaysia. Iskandar Malaysia metropolis 2025 master plan has decided to use Pasir Gudang as a key economic zone (Flagship D-Eastern Gate Development) for manufacturing industry.

Pasir Gudang consists of two major industrial areas which are Pasir Gudang Industrial Park and Tanjung Langsat Industrial Complex. These both areas are classified as the most highly invested industry location by World Islamic Economic Forum Foundation (MIDA, 2009; WIEF, 2012). Moreover, WIEF (2012) also have listed out petrochemical products and chemical and chemical products as two of the five core sectors of industry in Johor (WIEF, 2012). According to MIDA (2009), tank farms with a 1000 metre berth and hazardous cargo jetty, and three hazardous liquid bulk terminals to handle liquid petroleum gas, chemicals and petrochemicals have been developed in Tanjung Langsat (Carder & Ragan, 2003). The most common chemical products which are being produced in Pasir Gudang are ethylene, propylene, polyethylene, poly propylene, ethyl benzene, styrene monomer, expandable polystyrene, and ethylene vinyl acetate (MIDA, 2009). A total of 300 survey instruments were distributed and 220 responses were returned in 4 selected companies in Pasir Gudang.The response rate is 73%.

2.2 Survey Instrument Development

First level of survey instrument was developed through literature reviews which consisted of 6 scales for safety climate factors: Safety supervision, safety commitment, safety communication, work pressure, safety competence and safety procedures and safety performance indicator: safety behavior which constructs were related to safety compliance and safety participation. This drafted questionnaire contained 40 items which then submitted to industrial and educational experts to evaluate the rationality of the items. Upon validation and recommendation by experts, the survey instrument was re-amended to second level with 36 items of safety climate factors and safety performance indicators.

Upon validation by experts, a pilot test was conducted N=30 involving 8 supervisors and 22 first line managers. The questionnaire contained three parts, Part A: Demographic information, Part B: Safety Climate

Factors and Part C: Safety Performance Indicators. A 5-point Likert-type scale (1 = strongly disagree, 5 = strongly agree) was used to collect the workers' responses. The collected data were then preceded for quantitative validation by using Cronbach's Alpha to measure the internal consistency reliability of the scales.

Upon collecting the pilot data, the negative statements were recorded before running in SPSS. The safety climate factors and safety performance indicators scales with lower internal coefficient were removed to achieve the Cronbach's Alpha of 0.60 and above (Bhatnagar, Kim, & Many, 2014). However, some items were still remained unchanged although has the Cronbach's Alpha lower than 0.40 since this poorly correlated data could be due to the lower number of participants (Carder & Ragan, 2003).

Overall Cronbach's Alpha value of 0.756 in Table 1 shows that the 3rd level developed survey instrument is reliable to be used as finalized instrument in this study since the internal consistency is defined as good by researchers (Bhatnagar et al., 2014). From Table 2 and Table 3, it can be seen that individual Cronbach's Alpha for safety commitment factor was obtained at below 0.5 Although this value is at below the acceptable level of rule of thumb, these factors were still decided to be used in the questionnaire since it had been argued that statistics based on a single test administration do not convey much information about the accuracy of individuals' test performance(Shavelson & Webb, 1991).

Moreover, Field (2013) explains that smaller sample size would create bigger chance for the correlation coefficients between items differ which will lower the Cronbach's Alpha. Furthermore, Costello and Osborne (2005) proposed a common rule of thumb for researchers to collect at lease 10-15 participants per item (Costello & Osborne, 2005). Since, the number of samples was only 30; the lower Cronbach's value does not really determine the reliability of the factor in this study (Costello & Osborne, 2005)

Table 1 Overall Cronbach's Alpha value of survey instrument

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**No of Items**
0.752	0.756	33

Table 2 Individual Cronbach's Alpha, Mean and Standard Deviations for Safety Climate Factors

Factor	Items	Cronbach's Alpha	Mean	Standard Deviation
1	SC1, SC2, SC3, SC4	0.736	4.025	0.731
2	SCM1, SCM2, SCM3	0.439	4.378	0.763
3	SS1, SS2, SS3, SS4, SS5	0.628	4.007	0.628
4	WP1, WP2, WP3, WP4	0.638	3.558	0.797
5	SCP1, SCP2, SCP3, SCP4, SCP5, SCP6, SCP7	0.738	4.114	0.744
6	SV1, SV2, SV3	0.55	2.833	0.77

Table 3 Individual Cronbach's Alpha, Mean and Standard Deviations for Safety Performance Indicators

Performance Indicators (Safety Behavior)	Items	Cronbach's Alpha	Mean	Std.Dev
1	SB1, SB3, SB4 SB5, SB6, SB7, SB8	0.704	4.133	0.789

2.3 Exploratory Analysis

The finalised survey instrument was distributed to 4 selected chemical companies in Pasir Gudang. 300 questionnaires were distributed to the respondents in bi-languages: English and Malay and only 220 questionnaires were returned with response rate of 73.3%.

The factor analysis technique was used to identify the underlying cluster of factors which affect safety climate factors. A principal component analysis (PCA) factors with varimax rotation (converged in 9 iterations) on the 26 items for safety climate and varimax rotation (converged in 3 iterations) on the 7 items for Safety Performance was carried out through the SPSS 22.0.

2.4 Confirmatory Study

A regression model is defined as a mathematical model that can relate a number of independent variables to a dependent variable and can summarize data or the relationships among variables (Fornell & Larcker, 1981). Multiple linear regression analysis was used in this study to study the relationships between safety performance (dependent variable) and safety climate factors (independent variables). The reliability and validity of safety climate factors and performance construct was carried out through SmartPLS.

3.0 Results and Discussion

3.1 Demographic Analysis

Among N=220 respondents, there were only 3.6% of female respondents and 96.4% were male. Moreover, survey results also revealed that 47.7% of the respondents were supervisors, followed by 38.2% of operators and only 14.1% of technicians. Furthermore, most of the survey respondents are from the middle age (40 to 49) years old which represented 38.2%, followed by age range 50 to 59 years old with 33.6%, age range 31 to 39 years old with 20.9% and 7.3% respondents with below 30 years old. The respondents were also asked to share their working experience in the company in order to see whether they really understood and appreciated the importance of safety climate at their working environment (Shang & Lu, 2009). The survey revealed that most of the respondents were with working experience of 16 to 20 years which consumed 30.0%, followed by working experience of 11 to 15 years with 28.2%. There 26.8% of respondents who work less than 5 years and 15% of workers with less than 10 years working experience.

Table 4 KMO values of dependent and independent variables

Variable	KMO value
Safety Climate Factor	0.779
Safety Performance	0.676

Table 5 Individual factor loadings for Safety Behaviour

Items	Factor Loading
SB1	0.572
SB4	0.683
SB5	0.766
SB8	0.734

Table 6 Individual Factor loadings for Safety Climate Factors

Items	Factor Loading
SC1	0.796
SC2	0.741
SCM3	0.485
SS1	0.657
SS2	0.865
SS3	0.648
SS4	0.851
SS5	0.725
WP1	0.845
WP2	0.642
WP3	0.734
WP4	0.67
SV2	0.696
SV3	0.861
SCP1	0.592
SCP2	0.481
SCP3	0.457
SCP4	0.734
SCP5	0.878

3.2 Factor Analysis

The factor analysis technique was used to identify the underlying cluster of factors which affect safety climate factors. A principal component analysis (PCA) with varimax rotation (converged in 9 iterations) on the 26 items for safety climate and varimax rotation (converged in 3 iterations) on the 7 items for Safety Performance (N= 220) was carried out through the SPSS 22.0. According to George and Mallery (2006), the KMO value (Kaiser-Meyer-Olkin

Measure of Sampling Adequacy) should be greater than the acceptable threshold of 0.5 and a value greater than 0.6 is classified as mediocre, greater than 0.7 is defined as middling, value of greater than 0.8 is meritorious and value of KMO more than 0.9 is marvellous in order for a factor analysis to be proceeded (Shang & Lu, 2009). In this study, the KMO value for safety climate factors were obtained as 0.779 and KMO for safety performance was obtained as 0.676 (Table 4). KMO value of 0.676 and 0.779 which is above the threshold value indicates that the data is appropriate for factor analysis. Initially there were seven individual factors proposed for safety behaviour to measure safety performance, however only four safety behaviour items were remained after factor analysis. All the individual factor loadings were more than 0.4 which is the minimum criteria for accepting individual factors in factor analysis (Pallant, 2011) which could be referred in Table 5 for safety behaviour and Table 6 for safety climate factors.

Meanwhile for safety climate factors, 7 of 26 factors were excluded during factor analysis for subsequent analysis. Those six items (SV1, SC4, SC3, SCM1, SCM2, SCP6 and SCP7) were excluded since these factors act as only 2 items per latent variable.

Table 7 Extracted Safety Climate Factors

Item	Safety Climate Factors			
	Safety Management and Work Pressure	**Safety Competence**	**Safety Communication**	**Safety Procedures**
	Factor Scores (overall KMO=0.789)			
SCM3	0.521			
SS1	0.598			
SS3	0.669			
WP1	0.87			
WP2	0.667			
WP3	0.799			
SV2	0.648			
SCP1		0.6430		
SCP2		0.659		
SCP3		0.569		
SCP4		0.693		
SCP5		0.869		
SC1			0.848	
SC2			0.785	
SV3			0.796	
WP4			0.711	
SS2				0.83
SS4				0.8170
SS5				0.585

3.3 Multiple Linear Regression

Total 26 safety climate factors and 4 safety behaviour factors extracted through factor analysis were preceded with factor score analysis in order to develop the relationship through multiple regressions. There were 4 components of safety climate factors were extracted. All individual variables have factor loadings of value more than 0.5. These extracted 4 components were renamed as safety management and work pressure, safety competence, safety communication and safety procedures. Component safety management consist of supervision, commitment and safety procedures variables which were found to be more accurately related to management based on the previous researchers Shang ans Lu (2009) and Vinodkumar and Bhasi (2009). The extracted components of safety climate factors are shown in Table 7.

From Table 8, it also could be seen that some of the items of safety procedures (SS1 and SS3) are grouped under safety management because the constraints SS1: *Company emergency response plan give sufficient guidelines on how to deal with emergencies and it is tested* and SS3: *An effective documentation management system ensures the availability of procedures* more explains the role of management. Meanwhile, for safety behaviour indicators, all individual factors were found to be more than 0.4 as shown in Table 8.

Table 8 Extracted Safety Behaviour Items

Items	Factor Score
SB1	0.416
SB4	0.466
SB5	0.813
SB8	0.852

3.4 Modelling of Safety Climate Factors and Safety Performance Factors

Multiple linear regression analysis was used in this study to study the relationships between safety performance (dependent variable) and safety climate factors (independent variables). A stepwise variable selection was adopted as it is the most frequently used method for model building (Pallant, 2011). The stepping method criteria selected the p value = 0.05 for a variable to enter the regression equation and p value = 0.10 to remove an entered variable. The model gives an equation which contains a constant (intercept) and partial regression coefficients for each of the critical success factors. The four extracted component of safety climate factors were used as independent variables, meanwhile safety behaviour component was retained as dependent variable. The regression analysis computed adjusted R^2 value which is interpreted as the percentage of variance in the outcome variable that is explained by the set of predictor variables. Significance of the variables also maintained ($p<0.05$) (Hoaglin, 2013). The summarized regression analysis is tabulated in Table 9.

Table 9 Summary of Multiple Linear Regression Analysis

Item	Adjusted R Square	Significance
Constant		
Safety Management and Work Pressure	0.323	0.000
Safety Competence	0.444	0.000
Safety Communication	0.462	0.025
Safety Procedures	0.472	0.004

From Table 9, it can be seen that all those 4 factors are significant ($p<0.05$) and each of the safety climate factors contribute the relationship with safety performance, meanwhile R square adjusted value explains the percentage of variance each safety climate factors influence on safety performance. Overall R square value obtained as 0.472, which indicates that only 47.2% of variance of safety performance is explained by these 4 safety climate factors.

3.5 Validation Model

Based on the extracted safety climate factors and safety performance indicators through multiple regressions, a final model explaining the relationship between safety climate factors and safety performance indicators was validated using SmartPLS which could be seen in Figure 1.

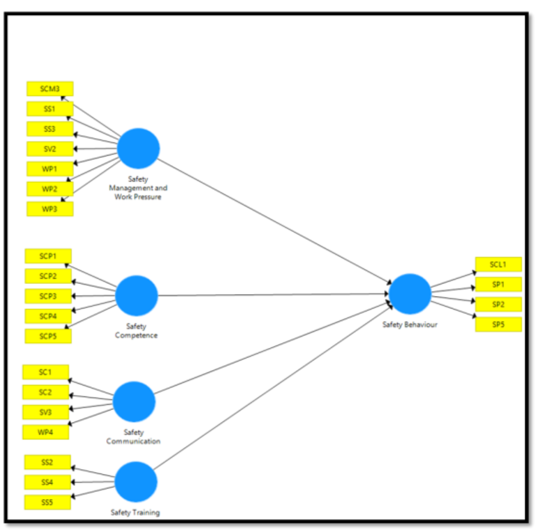

Figure 1 Validation Model

3.6 Model Evaluation

Measurement model evaluation is aimed to evaluate the consistency and validity of the observed variables. Consistency of the observed variables is explained through construct reliability tests and validity of the observed variables is explained through convergent validity (Joseph F. Hair, Black, Babin, & Anderson, 2010).

3.7 Consistency of Observed Variables

Cronbach's alpha and Composite Reliability (CR). Cronbach's alpha and CR indicate how well a set of manifest variables appraises a single latent construct. However, compared to Cronbach alpha, composite reliability is considered a better measure of internal consistency because it employs the standardized loadings of the observed variables (Fornell & Larcker, 1981). Litwin (1995) suggested that value of for composite reliability should be more than 0.70; however, for analysis through Partial Least Square Structural Equation Modelling, the suggested value of composite reliability is within 0.60 to 0.90 (Litwin, 1995). In this study, the composite reliability for each construct were obtained to be within the suggested range of 0.60 to 0.90 which proves that the observed variables are consistent with each other (Table 10)

Table 10 Composite Reliability and AVE values of Safety Climate Factors

	Composite Reliability (0.60~0.90)	**Average Variance Extracted (AVE) (>0.5)**
Safety Behaviour	0.799	0.599
Safety Competence	0.879	0.593
Safety Communication	0.703	0.578
Safety Management and Work Pressure	0.905	0.579
Safety Procedures	0.917	0.787

3.8 Convergent Validity

Convergent validity of the constructs is often determined through outer loadings which measures individual reliability of the variables, and Average Variance Extracted (AVE) test on variables which determines the amount of variance captured by latent variable from its relative observed variables due to measurement errors (Fornell & Larcker, 1981). According to Ringle, Sinkovics, and Hensele ,(2009), observed variables with outer loading 0.7 or higher are considered highly satisfactory, however loading value of 0.5 is still regarded as acceptable criteria (Liu et al., 2015). Joseph F. Hair et al. (2010) argued that a minimum 50% of the variance from observed variable should be captured by latent variables which implies that AVE value of the construct should be greater than 0.5 (Ringle et al., 2009). In this study, the outer loadings obtained for each individual variable are more than 0.6 (Table 11 and Table 12), meanwhile AVE values obtained as more than 0.5 which indicates that the construct of the finalised model is valid (Table 10).

3.9 Discussion

A positive significant relationship was found between safety management and work pressure, safety procedures, safety competence and safety communication and safety performance. Jazayeri and Dadi (2017) explained that International Civil Aviation Organization (ICAO) has defined safety management systems as "*systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures*" meanwhile International Labour Organization (ILO) has defined safety management systems as "*A set of interrelated or interacting elements to establish occupational safety and health policy and objectives, and to achieve those objective* (Jazayeri & Dadi, 2017). Safety management is considered to be a crucial factor in explaining the safety performance of a firm where Choudhry, Fang, and Mohamed (2007) explains the role of safety management in construction industry. Implication of safety management could be able to reduce the number of injuries to personnel and operatives in the workplace and also minimize the risk of major accidents. Moreover, systematic safety management is believed to minimize production interruptions and reduce material and equipment damage which indirectly minimize legal cost of accident litigation, fines, and also reduce expenditures of emergency supplies. Although those implications are focussed only in construction industry, it strongly believed that chemical industries also could have the same positive implications if proper safety management is take place.

Moreover, the finding of safety management approach is similar to some of the previous studies by Liu et al (2015) who concluded that management has a key role in safety and accountable for safety performance of a company. Liu et al. (2015) furthermore explains that when the top management is committed to safety, they may set goals for safe production, establish occupational safety management organization, increases communication and feedback, provide enough support and resources to safety activities which later will increase safety behaviour. Leaders have been found to affect safety compliance positively by standing out as positive and safe behaving role models for their staff by challenging workers to develop improved practices and by inspiring their staffs to achieve exceptional safety standards, thus safety supervision is crucial in explaining the safety performance of a firm. Furthermore, they also concluded that leadership will be more positive if supervisors involve in daily work operations (Kvalheim & Dahl, 2016).

Although there were fewer studies investigated the role of work pressure on safety performance, the finding of this study has similarities to previous studies. Brown, Willis, and Prussia, (2000) defined work pressure as conceptualize pressure for production as an employee's perception that the organization encourages him or her to work around safety procedures in order to meet production quotas, keep up with the flow of incoming work, or meet important deadlines. Work pressure has been found to have a small effect in predicting safety performance, accident and injuries relative to other safety climate dimensions in a meta-analytic study by (Brown et al., 2000). However, this finding against the findings of Masood and Choudhry (2011), whereas they found that work pressure is negatively impact safety performance in construction industry of Pakistan. Other than these, previous researchers had found that there are strong correlations between safety procedures and safety performance in industries.

Table 11 Outer Loading of Individual Items of Safety Climate Factors

Items	**Outer Loadings (>0.5)**
SC1	0.737
SC2	0.613
SCM3	0.755
SCP1	0.761
SCP2	0.834
SCP3	0.689
SCP4	0.727
SCP5	0.828
SS1	0.746
SS2	0.922
SS3	0.807
SS4	0.854
SS5	0.885
SV2	0.635
SV3	0.647
WP1	0.859
WP2	0.661
WP3	0.835
WP4	0.688

Table 12 Outer Loading of Individual Items of Safety Behaviour

Items	**Outer Loadings (>0.5)**
SB1	0.702
SB4	0.747
SB5	0.649
SP8	0.723

Kvalheim and Dahl (2016) indicated that negligence of perceived procedure in offshore service vessel industry to be negatively related to safety compliance. Furthermore, Antonsen (2009) also have suggested that simplicity of procedures are significant success criteria for high compliance. Furthermore, the finding of safety communication also were found to be similar with some of the previous studies by Sampson, Dearmond, and Chen (2008) where they highlighted that improved communication between line workers and supervisors will results in decreasing minor accidents and increasing in personal protective equipment (PPE) use.

3.10 Impact on Industry

It is strongly believed that reliable safety climate scale could provide proactive information about safety problems before they develop into accidents and injuries (Seo, Torabi, Blair, & Ellis, 2004). Although the finding that safety climate perceptions will not necessarily match actual levels of safety performance, M D Cooper and Phillips (2004) recommends that industry should focus its primary safety improvement effort on changing unsafe situations and conditions as well as people's safety behaviour at all organizational levels, rather than concentrating on improving people's attitudes, beliefs, and perceptions about safety. Even though previous studies in various industries found that worker's perceptions play major role in highlighting effectiveness of safety system in a firm, but there are always a need of physical changes within an organization (M D Cooper & Phillips, 2004).

4. Conclusion and Future Work

4.1 Conclusion

The main purpose of this study was to identify safety climate factors and safety performance in chemical industries in Johor and has been established. The finding of this study which derived the safety climate factors of safety communication, safety procedures, safety competence, safety management and work pressure are found to be similar to previous studies in various industries. Safety management was renamed to explain the safety commitment and safety supervision factors. A newly reliable developed relationship was able to explain 47.2% of relationship between safety climate factors and safety performance which full fill the second objective of this study. Although, only 47.2% of safety climate factors were found to impact safety performance of chemical industries in Johor, which common findings in a social investigation, then reflections of safety climate factors on safety performance could not be similar with each industry as compared with other researchers finding. In addition, the findings would fluctuate due to geographical context and individual context. Furthermore, even though the only 47.2 % of derived safety climate factors explain the relationship with safety performance, it is found that all 26 individual constructs are found to be valid and consistent thorough model evaluation. Although, the findings of the study were able to achieve the objectives, there are plenty of gaps and limitations which need be considered for future work.

4.2 Study Limitations

The findings of this study must be interpreted based on the following limitations. The results of this study were dependent upon sincere and honest responses from participants and there are no complimentary actions. Moreover, demographic factors also play an important role in manipulating the relationship between safety climate factors and safety performance (Vinodkumar & Bhasi, 2009). Thus, in future, effects of demographic factors on safety performance also should analyse co-currently, and the respondent's perceptions shall be analysed by demographic factors such as age, working experience, education and position in the particular firm.

Despite these limitations, this study actually contributes to the literature revealing factor structures of safety climate, where appropriate level of reliability and validity measures of safety climate scale was developed. However, it is strongly recommended to do more exploration on the safety climate factors by increasing the number of independent variables and number of samples and also compare the findings with previous studies by revalidating the previous established safety survey instrument.

4.3 Future Work

There are few items and issues to be considered in order to improve and increase the final results. Since in this study, the area of study was just focused on chemical industries in Pasir Gudang. In future, it should be expanded to more chemical industries around Johor and also around Malaysia. Furthermore, a longitudinal study should be carried out for the collected survey data since in this study was only in cross sectional. Furthermore, safety performance based on the perceptions will need to be supported by collecting more objectives and quantitative data measuring actual safety performance such as accident rates, injury cases, fatal cases and near missed cases. Other than these, this study also can be expanded by developing a model to explain the relationship between safety climate factors and safety performance by using Structural Equation Modelling (SEM) respectively.

References

Antonsen, S. (2009). Safety culture and the issue of power. *Safety Science*, *47*(2), 183–191.

Barbaranelli, C., Petitta, L., & Probst, T. M. (2015). Does safety climate predict safety performance in Italy and the USA ? Cross-cultural validation of a theoretical model of safety climate. *Accident Analysis and Prevention*, *77*, 35–44. https://doi.org/10.1016/j.aap.2015.01.012

Bhatnagar, R., Kim, J., & Many, J. E. (2014). Candidate Surveys on Program Evaluation: Examining Instrument Reliability, Validity and Program Effectiveness. *American Journal of Educational Research*, *2*(8), 683–690. https://doi.org/10.12691/education-2-8-18

Brown, K. A., Willis, P. G., & Prussia, G. E. (2000). Predicting safe employee behavior in the steel industry: Development and test of a sociotechnical model. *Journal of Operations Management*, *18*(4), 445–465. https://doi.org/https://doi.org/10.1016/S0272-6963(00)00033-4

Burke, M. J., Sarpy, S. A., E.Tesluk, P., & Smith-Crowe, K. (2002). GENERAL SAFETY PERFORMANCE: A TEST OF A GROUNDED THEORETICAL MODEL. *Personnel Psychology*, *55*(2), 429–457. https://doi.org/10.1111/j.1744-6570.2002.tb00116.x

Carder, B., & Ragan, P. W. (2003). A survey-based system for safety measurement and improvement. *Journal of Safety Research*, *34*(2), 157—165. https://doi.org/10.1016/s0022-4375(03)00007-0

Chen, Y., McCabe, B., & Hyatt, D. (2017). Impact of individual resilience and safety climate on safety performance and psychological stress of construction workers: A case study of the Ontario construction industry. *Journal of Safety Research*, *61*(Supplement C), 167–176. https://doi.org/https://doi.org/10.1016/j.jsr.2017.02.014

Choudhry, R. M., Fang, D., & Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. *Safety Science*, *45*(10), 993–1012. https://doi.org/10.1016/j.ssci.2006.09.003

Cooper, M. D., & Phillips, R. A. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, *35*(5), 497–512. https://doi.org/10.1016/j.jsr.2004.08.004

Cooper, M. D., & Phillips, R. A. (2004). Exploratory analysis of the safety climate and safety behavior relationship, *35*, 497–512. https://doi.org/10.1016/j.jsr.2004.08.004

Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9. https://doi.org/10.1.1.110.9154

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

Flin, R. (2007). Measuring safety culture in healthcare: A case for accurate diagnosis. *Safety Science*, *45*(6), 653–667. https://doi.org/10.1016/j.ssci.2007.04.003

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: identifying the common features. *Safety Science*, *34*(1), 177–192. https://doi.org/https://doi.org/10.1016/S0925-7535(00)00012-6

Fornell, C., & Larcker, V. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(3), 39–50.

George, D., & Mallery, P. (2006). *SPSS for Windows Step by Step: A Simple Guide and Reference, 13.0 Update*. Pearson A and B. Retrieved from https://books.google.com.my/books?id=eLYbAQAAMAAJ

Hoaglin, D. C. (2013). Making Sense of Coefficients in Multiple Regression, (January), 1–19.

Hon, C. K. H., Chan, A. P. C., & Yam, M. C. H. (2014). Relationships between safety climate and safety performance of building repair, maintenance, minor alteration, and addition (RMAA) works. *Safety Science*, *65*, 10–19. https://doi.org/10.1016/j.ssci.2013.12.012

Jazayeri, E., & Dadi, G. B. (2017). Construction Safety Management Systems and Methods of Safety Performance Measurement : A Review, *6*(2), 15–28. https://doi.org/10.5923/j.safety.20170602.01

Joseph F. Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th ed.). Englewood Cliffs: Prentice Hall.

Kvalheim, S. A., & Dahl, Ø. (2016). Safety compliance and safety climate : A repeated cross-sectional study in the oil and gas industry. *Journal of Safety Research*, *59*, 33–41. https://doi.org/10.1016/j.jsr.2016.10.006

Litwin, M. (1995). How to Measure Survey Reliability and Validity. Thousand Oaks, California. https://doi.org/10.4135/9781483348957

Liu, X., Huang, G., Huang, H., Wang, S., Xiao, Y., & Chen, W. (2015). Safety climate , safety behavior , and worker injuries in the Chinese manufacturing industry. *Safety Science*, *78*, 173–178. https://doi.org/10.1016/j.ssci.2015.04.023

Masood, R., & Choudhry, R. M. (2011). Measuring Safety Climate to Enhance Safety Culture in the Construction

Industry of Pakistan. *CIB W99 International Conference on Prevention: Means to the End of Injuries, Illnesses, and Fatalities, August 24-26*, *54*(2002), 1243–1249. Retrieved from http://www.irbnet.de/daten/iconda/CIB_DC24434.pdf

MIDA. (2009). *Profit from Malaysia's Petrochemical Industry*.

Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*. Neal, Andrew: ARC Key Centre for Human Factors and Applied Cognitive Psychology, School of Psychology, University of Queensland, Brisbane, QLD, Australia, 4072, andrew@psy.uq.edu.au: American Psychological Association. https://doi.org/10.1037/0021-9010.91.4.946

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using the SPSS program* (4th Editio). Berkshire: Allen & Unwin.

Ringle, C. M., Sinkovics, R. R., & Henseler, J. (2009). The use of partial least squares path modeling in international marketing. In *New Challenges to International Marketing* (Vol. 20, pp. 277–319). Emerald Group Publishing Limited. https://doi.org/doi:10.1108/S1474-7979(2009)0000020014

Sampson, J. M., Dearmond, S., & Chen, P. Y. (2008). Interactive Effects of Safety Constraints, Safety Uncertainty, and verbal Exchange. In *23rd Annual Conference of the Society for Industrial and Organizational Psychology*. San Francisco, CA.

Seo, D.-C., Torabi, M. R., Blair, E. H., & Ellis, N. T. (2004). A cross-validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research*. Seo, Dong-Chul: Department of Applied Health Science, Indiana University, HPER 116, 1025 E. 7th Street, Bloomington, IN, US, 47405-7109, sdongchu@indiana.edu: Elsevier Science. https://doi.org/10.1016/j.jsr.2004.04.006

Shang, K., & Lu, C. (2009). Effects of Safety Climate on Perceptions of Safety Performance in Container Terminal Operations. *Transport Reviews*, *29*(1), 1–19. https://doi.org/10.1080/01441640802264943

Shavelson, R. J., & Webb, N. M. (1991). *Generalizability theory: A primer*. Sage.

Vinodkumar, M. N., & Bhasi, M. (2009). Safety climate factors and its relationship with accidents and personal attributes in the chemical industry. *Safety Science*, *47*(5), 659–667. https://doi.org/10.1016/j.ssci.2008.09.004

WIEF. (2012). *The WIEF Johor Bahru Malaysia*. *Development*. Johor Bahru. Retrieved from https://wief.org/wp-content/downloads/2016/05/8th-wief-brochure.pdf

Wu, T.-C., Chang, S.-H., Shu, C.-M., Chen, C.-T., & Wang, C.-P. (2011). Safety leadership and safety performance in petrochemical industries: The mediating role of safety climate. *Journal of Loss Prevention in the Process Industries*, *24*(6), 716–721. https://doi.org/https://doi.org/10.1016/j.jlp.2011.04.007

Zhou, Q., Fang, D., & Wang, X. (2008). A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience. *Safety Science*, *46*(10), 1406–1419. https://doi.org/https://doi.org/10.1016/j.ssci.2007.10.005

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, *42*(5), 1517–1522. https://doi.org/https://doi.org/10.1016/j.aap.2009.12.019

Zohar, D. (2011). Safety climate: Conceptual and measurement issues. *Handbook of Occupational Health Psychology, 2nd Ed.* Washington, DC, US: American Psychological Association.

Biographies

Shalini Tayapara is a Master's degree student in Master of Science (Industrial Engineering) at Universiti Teknologi Malaysia. She has completed research projects that involve safety management in chemical industry.

Dr Jafri Mohd Rohani is currently a fulltime senior lecturer at Univerisiti Teknologi Malaysia specialized in Quality and Statistical Engineering area of study; and also, Coordinator of Industrial Engineering, in Department of Materials, Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Univerisiti Teknologi Malaysia.