Development of Safety Culture Assessment: A Case Study of Thai Truck Drivers

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Abstract

Safety culture assessment is the instrument that can be used to capture employees' perception about organizational safety culture in various dimensions. The main objective of this research was to investigate the constructs of multidimensional safety culture and consequently to develop a reliable and valid instrument to measure Thai truck driver's perception on safety culture level in the workplace. Safety culture assessment in this study was structured in four dimensions based on accident causation model as (1) organizational support to safety, (2) social support to safety, (3) preconditions for employee safety behavior, and (4) employee safety behavior. Item development was conducted through extensive literature reviews and interviews with subject matter experts using purposive sampling (e.g. 6 truck drivers, 3 logistics personnel, 2 safe-driving trainers, and 1 top management). Exploratory factor analysis (EFA) was performed to identify sub-factors of each dimension. Eight sub-factors with total of 30 items were emerged as a result of EFA including management commitment to safety, safety rules and training, supervisor support, co-worker support, work conditions, personal conditions, attentive action to safety, and supportive action to safety. Consequently, Confirmatory factor analysis (CFA) was performed to validate all the measurement constructs. The results suggested that the four-dimension safety culture model (30 items) had an acceptable fit with the data (RMSEA = 0.044, RMR = 0.020, CFI = 0.997, GFI = 0.989 and composite reliability = 0.8987). Therefore, the result supported the good reliability and validity of newly developed safety culture assessment. The paper also discussed possible future research as well as implications for utilizing safety culture assessment.

Keywords: Safety Culture, Thai Truck Drivers, Accident Causation Model, Four-Dimension Safety Culture, Factor Analysis

Introduction

The importance of safety cannot be disregarded in any industry including the land logistics and transportation. Road safety is a critical concern for logistics and transportation personnel, especially truck drivers. The Report on Road Safety 2015 (World Health Organization (WHO), n.d.) indicated that the estimated road traffic fatality rate in developed countries (i.e. Australia, Germany, France, Canada, the United States) was remarkably low. Apart from western countries' records, the estimated road traffic fatality rate in Japan and Singapore was also extremely low compared to the rest of the countries within the region. On the other hand, Thailand's performance on road safety was the worst, accounting for 36.2 deaths rate per 100,000 people. The figures from this report indicate an urgent need to improve road safety management in Thailand.

Due to the massive size of commercial trucks, accidents usually produce high impacts and can be more destructive than normal car accidents which result in undesirable outcomes (e.g. deaths, severe injuries, disabilities), not only for the driver but also for other road users and the organizations that they work for (Chen, Fang, Guo, & Hanowski, 2016; Huang, Zohar, Robertson, Garabet, Lee, & Murphy, 2013). Such changes and challenges create a need for establishing a positive safety culture (Arboleda, Morrow, Crum, & Shelley, 2003), especially in terms of logistics and transportation organizations.

Previous research has investigated the constructs of a safety culture; however, common agreement on the dimensions of what a safe culture has not been achieved yet. A number of safety culture measures have been developed in the past few decades (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2007; Flin, 2007; Glendon & Stanton, 2000). However, amongst the various existing safety culture instruments, the research found inconsistency in safety culture structures (Cox & Cheyne, 2000; Coyle, Sleeman, & Adams, 1995). The lack of a consensus regarding what a safety culture structure has been derived from adopting different frameworks underpinning its structure. Apparently, many studies have attempted to develop a safety culture framework based on various organizational support theories as well as behavioral theories without any linkage to safety science concepts.

The concept of a safety culture emerged in order to solve safety issues within the organization which involves the desired behaviors that need to be carried out as a way to prevent harm or to reduce possible risks. Therefore, it is important to carefully study how the risks and harm occur as well as how to mitigate them prior to making any preventive decision. These preventive actions will be carried out and will gradually become a part of the organizational culture. Thus, this research attempts to apply safety science, particularly the accident causation model (i.e. Swiss Cheese Model), to determine the components of the studied safety culture. As a consequent, this study shall propose the key dimensions and sub-factors of safety culture, and to establish the reliability and validity of safety culture assessment accordingly.

Literature Review

Swiss Cheese Accident Causation Model (SCM)

Previously, safety science research suggested that accidents were purely caused by human error (Reason, 2000; Wiegmann & Shappel, 2003). Later on, Reason proposed that human error was merely seen as a symptom of system failures, not a direct cause of the accident. According to Reason, accidents are possibly derived from specific failure domains: organizational factors, supervision factors, preconditions, and specific unsafe acts. Reason used Swiss cheese as a metaphor to explain his idea, where the holes in each layer of Swiss cheese represent the failures in the particular domain. Risks and hazards would pass through these holes resulting in undesirable incidents. In order to prevent harm from possible hazards, defensive shields or domain layers should ideally have no holes or at least a fewer number of holes. With an attempt to understand the creation of the holes in each defensive layer, Reason (1997) introduced two important terms that are essential for explaining the holes creation phenomenon, that is: "active failures and latent conditions" (Reason, 2000, p. 769). Active failures are referred to as those errors and violations committed by humans that in turn provide immediate negative consequences in particular regarding the work situation. The concept of active failures of Reason (2000) is consistent with the notion of "human error" (p. 768) in many accident causation theories and models. Unlike active failures, Reason (2000) pointed out that there are also certain external factors that drive human error toward accidents, for example, the management's values, organizational policies and procedures, professional standards, poor communication, and so forth. These forces were termed "latent conditions" or "latent failures" (p. 769) as they might or might not immediately cause an accident but create a long-lasting accumulative weakness in the layers. These latent conditions are seen as hidden factors, and if they are undiscovered or uncorrected, could contribute to a great number of accidents (Reason, 1997).

Like many industries, Swiss cheese model was used in several transportation studies to identify possible risk factors that may lead to truck driver's accidents. Short, Boyle, Shackelford, Inderbitzen, & Bergoffen (2007) conducted cause of accidents analysis using SCM. As a result, various safety barriers were detected, such as insufficient driver training, non-quality of truck maintenance and leaderships with no safety mindset.

The concept of latent conditions in the SCM addressed the hidden failures in the organization. Such latent conditions also represent the key stakeholders and areas to focus on when solving safety problems. Establishing a strong and positive safety culture is beneficial in terms of the reduction of accidents and injuries and to enhance the safety level in the workplace. Thus, creating a safety culture is centered around the assumptions that can minimize the opportunity for risks exposure, and accident occurrence. In order to achieve this aim, the organization should pay a great deal of attention to the specific latent conditions or failures in the SCM as they indicate the areas of weakness in regard to safety and its management.

Safety Culture

The concept of safety culture was strongly addressed and rapidly gained attention within several industries for over three decades (Glendon & Stanton, 2000). During the first stage, the term safety culture was not developed from organizational culture theories but was merely used to explain the phenomena where employees and management show dedication and accountability to any activity that concerns safety in a nuclear power plant (Choudhry, Fang, & Mohamed, 2007). In an organization where safety is addressed as a priority, employees are encouraged to perform their duties with a strong safety mindset (Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004). In addition, creating an atmosphere that encourages employees to be aware of occupational risks and to avoid unsafe acts in the workplace is a key objective of positive safety culture implementation (Fernández-Muñiz et al., 2007).

Several research revealed that the lack of a safety culture was the major cause of the accidents. Accidents and incidents are less frequent and less severe when the safety culture is strong, thus establishing and maintaining strong safety culture was suggested as a top priority across transportation industry in the United States (Morrow and Coplen, 2017). Numbers of research in regard with truck drivers' perception on safety climate were found (Huang et al., 2016), however still limited in the area of safety culture. Glendon and Stanton (2000) pointed that low-level safety management and a weak safety culture were the critical problems leading to undesirable safety outcomes, and organizations need to pay attention to these in order to securely manage their workplaces. Hence, appropriate assumptions that can solve safety problems are essential for establishing a safety culture. Based on this scenario, certain assumptions underpin the way in which a safety culture should be defined. Therefore, safety culture in this study will be defined as "a pattern of shared basic assumptions that the group learns as it solved its safety problems which has worked well enough to be considered valid and therefore, to be taught to new members as the correct way to perceive, think, feel and act in relation to those problems" (Strycker, 2011, p. 4).

Many safety culture measures have been developed based on various psychological and organizational theories, such as the social exchange theory (Huang et al., 2016; Neal & Griffin, 2006), the leader-member exchange theory (Hofmann, Morgeson, & Gerras, 2003; Zhou & Jiang, 2015), the organizational support theory (Gyekye & Salminen, 2007; Michael, Evans, Jansen, & Haight, 2005), and the theory of planned behavior (Hall, Blair, Smith, & Gorski, 2013). As a consequence, there is a lack of a consensus about safety culture components as well as a lack of the provision of a linkage to safety-related theory. Therefore, this study attempts to integrate knowledge from the accident causation model from safety science in order to identify the key components of a safety culture using the Swiss Cheese Model developed by Reason (1997).

The Key Domains of a Safety Culture are:

Organizational Support for Safety: the first domain in the SCM is known as organizational factors, which can be explained in terms of top management's point of view, and decision and support regarding safety issues. Reason elaborated that organizational failures are latent errors found in the organization which at a certain point and time can influence people to commit unsafe acts. These characteristics of safety culture constructs are congruent with the characteristics of organizational support. Several studies of safety culture and safety climate have extensively discussed the importance of management commitment, management support, and concern for safety-related issues (Huang et al., 2013; Zohar, 1980). Ostrom, Wilhelmsen, and Kaplan (1993) pointed that good safety culture is a mechanism for solving safety problems in which safety is a result of certain behavior modeled by top management. Therefore, developing a good safety culture requires strong support from management at the organizational level. Thus, the organizational factors in the SCM were identified as "organizational support for safety" in the present study.

Social Support for Safety: the second domain in the SCM was addressed by departmental support from line management. For example, inadequate supervision, inappropriate operation planning by the supervisor, as well as other characteristics of the supervisor such as failure to correct safety-related problems may bring about individual unsafe acts (Reason, 2000). This departmental factor is not only influenced by the supervisor but also includes co-workers. The concept of receiving support from people in the work community is congruent with the concept of social support in social science study. Therefore, the phrase "social support for safety" will be used in this study to represent the departmental level of support, which is one of the characteristics in the SCM.

Preconditions for Employees' Safety Behavior: the third component in the SCM focused on the preconditions that may impact an individual employee's safety, known as "preconditions for unsafe acts" in the model. A variety of preconditions have emerged, both psychological (i.e. stress, attitudes toward safety) and physical (i.e. work conditions and work environments). Reason (2000) explained preconditions as "latent states" of the individual employee (p. 205), as these precursors can contribute to a great variety of unsafe acts. Reason viewed the characteristics of preconditions that can cause unsafe acts as mental and physical conditions of individual workers, for example, the capability of being stressed, exhaustion, failure to recognize hazards, as well as personal readiness prior to commence the work. In the study of safety climate, the perceived level of risk in the workplace is one of the key constructs in several studies (Cooper & Phillips, 2004; Zohar, 1980). Preconditions may be developed by the individual and/or influenced by others (i.e. top-management, supervisor, and co-workers), and these variables appear to be another important factor driving the safe or unsafe behavior of particular employees. In order to develop an organizational safety culture, the positive safety behaviors of employees are expected. Therefore, the term "preconditions for employee safety behavior" was used in this study to align with the safety culture concept.

Employee Safety Behavior: the last component in the SCM refers to unsafe acts of individual workers. Unsafe acts mean a course of action committed by an individual worker that results in an accident or undesirable incident (Reason, 2000; Wiegmann & Shappel, 2003). In order to establish a safe workplace, it is essential to mitigate the frequency of employees' unsafe acts by encouraging more safety behaviors (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004). Many studies have concluded that the majority of accidents are caused by unsafe acts or the unsafe behavior of people (Wills, Watson, & Biggs, 2006; Wu, Liu, Zhang, Skibniewski, & Wang, 2015). Changing unsafe acts to behaving in a safe manner is the key to promoting safety behavior within the organization. Therefore, the phrase "employee safety behavior" was used in this present study to align with the safety culture concept. Employees' safety behavior in this study follows the work of Neal, Griffin, & Hart (2000) as they have identified safety behavior as safety compliance and safety participation (Neal et al., 2000). While unsafe acts in the SCM framework means to violating on something that leads to undesirable outcomes (Reason, 2000), compliance refers to the degree to which employee act in accordance with safety rules, commands, and instructions. These two variables provide the same sense of meaning but are presented in different directions.

Research Methods

This section explains the research methods as follows.

Population

The population in this present research was truck drivers operating heavy trucks from private logistics and trucking companies in Thailand. These truck drivers had to have Thai citizenship with at least three years of work experience as a truck driver. They also had to have the Transport Personnel License (i.e. class II, class III, or class IV), which is the required license to operate heavy trucks in Thailand. Due to the difficulty getting the actual number of current truck drivers in the labor market, this study used the number of registered Transport Personnel Licenses issued by the Department of Land Transport during the past three years, from December 2013 to December 2016. The cumulative number of registered Transport Personnel Licenses for commercial truck drivers from 2013-2016 was 142,494 units (Department of Land Transport, 2017), which was used as the representative population in this study. The truck drivers were chosen because the nature of their work is risky in terms of road accidents, which was found to be one of the biggest problems in the land logistics industry.

Data Sampling and Data Collection

Primarily, this research was conducted using case study research methods. The sample frame of this study was designed from Thai truck drivers' perspective. The purposive sampling technique was adopted to select the unit of study in both qualitative (for informant selection) and quantitative methods (for organization selection). In qualitative study, the interview was conducted with subject matter experts that is 6 truck drivers, 3 logistics personnel, 2 safe-driving trainers, and 1 safety director represents the top management. The informants were selected from various group of people in the transportation industry to generate variety of information and to avoid bias information receiving from truck drivers alone. Next in quantitative part, the participants were also purposively selected from logistics and transportation organizations in Thailand where safety practices have been implemented. The developed questionnaires were distributed to Thai truck drivers from several truck fleet companies that partnering with one of the largest logistics organization (Company S) that had safety management in place. Another set of questionnaires was sent to another logistics company (Company Y) where the organization had adopted ISO18000 implementation, which is an international standard for occupational health and safety management systems. These two large organizations were chosen because they exhibited good attention to safety management. A total of 1,010 questionnaires were distributed, and 413 with completed data (40.89%) questionnaires were kept for further analysis.

Kline (2011) suggested that the rule of thumb for number of responses to item should be around 10-20 responses for 1 item in order to conduct factor analysis. Additionally, the minimum number of sample size, according to Yang (2005), to perform confirmatory factor analysis should be at least 200. Thus, the usable of 413 questionnaires in this study were sufficient for such analysis.

Item Generation

In order to achieve the research objective, the conceptual model of safety culture was hypothesized based on the four domains in SCM, as previously discussed. While the SCM was used as the framework underlying this study, empirical studies and interviews with subject matter experts were also carried out in order to develop item pools underneath four constructs in the context of Thai truck drivers. Back-translation from English to Thai and vice versa was performed. The Thai version questionnaire was sent to truck driver, checking if the items were readable and understandable. Adjustments were made according to the received feedbacks. As a consequence, the first draft of the safety culture assessment questionnaire was comprised of 61 items covering four components. The 61-item survey was sent to the pilot group for item analysis. The rule of thumb for number of responses in pilot test as suggested by Browne (1995) should be 30 subjects or greater, whereas Teare, Dimairo, Shephard, Hayman, Whitehead, & Walters (2014) recommended for 70 subjects or greater. The draft questionnaires were sent to 120 participants and 75 completed questionnaires were returned. Therefore, the useable 75 subjects were acceptable for pilot trail.

(1) ***Organizational Support for Safety:*** Some example of the items for this construct included "Top management in this company reacts quickly to solve the problem when told about safety hazards" (Zohar & Luria, 2005), "All the safety rules and procedures in my workplace really work" (Williamson, Feyer, Cairns, & Biancotti, 1997), "I can work confidently and safely after I receive safe driving training."

(2) ***Social Support for Safety:*** Some example of the items for this construct included "my supervisor listens to my recommendation," and "my supervisor praises me for my safe behavior" (Williamson, Feyer, Cairns, & Biancotti, 1997), "My co-workers here advise me to work more safely." A 5-point Likert-type scale (1 = strongly disagree, 5 = strongly agree) was used to collect the truck driver's responses.

(3) ***Preconditions for Employee Safety Behavior:*** Some examples of the items for this construct included "My recent driving schedule is too tight, which gives me less time to rest" (Mearns, Whitaker, & Flin, 2003), "I put accidents down to bad luck which cannot be avoided or prevented" (Williamson et al., 1997).

(4) ***Employee Safety Behavior***: The employee safety behavior was identified as safety compliance and safety participation according to the measure developed by Neal et al. (2000). Example items were "I use the correct safety procedures for carrying out my job", "I voluntarily carry out tasks or activities that help to improve workplace safety'' and "I help my coworkers when they are working under risky or hazardous conditions." Some items were revised to reflect the nature of the truck driver's occupation.

A 5-point Likert-type scale (1 = strongly disagree, 5 = strongly agree) was used to collect the truck driver's responses on dimension 1-3, and a 5-point Likert-type scale (1 = never, 5 = always) for the last dimension to rate the frequency of certain behaviors.

Item Analysis

In order to eliminate low quality items, item analysis was performed during the pilot test using item-total correlation and internal consistency reliability approach (Hinkin, 2005). The item-total correlation provides correlation between individual item and the total score without that item. A coefficient value (r) less than 0.3 or above 0.8 indicates that the corresponding items do not correlate well or correlate too well (Everitt, 2002). The internal consistency was measured by the value of Cronbach's Alpha coefficient. Internal consistency is acceptable when Cronbach's Alpha is greater than 0.70. As a consequent, 41 items were maintained because the criteria were achieved. The overall Cronbach's Alpha of 41-item safety culture survey was 0.88.

Factor Analysis

Two types of factor analysis were used in this study. First, the Exploratory Factor Analysis (EFA) was conducted to identify those items that most clearly represent the content domain of the underlying construct and also used to refine the measurement scale (Hinkin, 2005). Next, the Confirmatory Factor Analysis (CFA) was conducted to validate the construct of Safety Culture Assessment measure. The criteria was represented by the value of goodness of fit indices such as χ^2, p-value (> .05), χ^2/df (< 2.00), RMSEA (< .05), RMR (< .05), SRMR (< .05), CFI (> .90), NFI (> .90), NNFI (> .90), GFI (> .90), AGFI (> .90), the internal consistency, composite reliability (ρ_C) and average variance extracted (ρ_V) (Diamantopoulos & Siguaw, 2000).

Prior to perform factor analysis, the measure of sampling adequacy was performed using Kaiser-Meyer-Olkin Test (KMO) and Bartlett's Test of Sphericity. KMO is the test that indicate the proportion of variance in variables that might be caused by underlying factors. The reference value of KMO should greater than 0.50 or as close as 1.00 to indicate the suitability of data. Bartlett's Test of Sphericity indicate the strong relationship among the variables. Small value of significant level (less than 0.05) indicate that factor analysis may be useful with the data.

Data Analysis and Results

This section presents the information on different level of data analysis as well as the results of each analysis.

(1) Preliminary Factor Analysis

The measure of sampling adequacy was performed using Kaiser-Meyer-Olkin Test (KMO) and Bartlett's Test of Sphericity. The result showed that KMO were greater than 0.50, and the Bartlett's Test of Sphericity showed significant value at 0.00. This indicated that the set of data was suitable enough for further factor analysis process.

EFA was conducted to extract the factor using principal component analysis the varimax rotation method. The aim of these method was to reduce groups of variables to conceptually important latent variables. The study indicated 3 sub-factors emerged for each safety culture dimension, total in 12 sub-factors for the overall scale. Apparently, 4 out of 12 sub-factors were grouped by the negative items. These unexpected constructs did not clearly represent the content domain. Schmitt and Stuits (1985) pointed that there is possibility that wholly negative items might form into one singular dimension in factor analysis process. As suggested by DeVellis (2016), negative items should be excluded from the scale as it might distort the factor structure. Therefore, 4 sub-factors emerged by negative items (11 items in total) were removed from the measurement scale in this study. As a result, the organizational support for safety dimension was comprised with 12 items, measured by 2 factors termed as 'management commitment to safety' and 'safety rules & training'. The social support for safety dimension was comprised with 7 items, measured by 2 factors termed as 'supervisor support' and 'co-worker support'. The pre-conditions for employee safety behavior was comprised with 5 items, measured by 2 factors termed as 'work conditions' and 'personal conditions. The last dimension, employee safety behavior was comprised with 6 items, measured by 2 factors termed as 'attentive action to safety' and 'supportive action to safety'. The 30-item safety culture assessment scale were remained for further scale validation and construct confirmation process.

(2) First-Order Factor Analysis

In this part, a series of confirmatory factor analysis (CFA) were performed to verify whether the factor structure match with the results derived from previous EFA study.

Organizational Support for Safety (Factor 1): the 2 sub-factors with a total of 12 items were run. The results of the CFA for the organizational support for safety (FAC1) showed the following statistics: χ^2= 43.428, df = 31, p = 0.068, χ^2/df = 1.401, RMSEA = 0.03, N1FI = 0.993, NNFI = 0.995, CFI = 0.998, RMR = 0.024, SRMR = 0.024, GFI = 0.983, AGFI = 0.957 and PGFI = 0.503. The results revealed that the goodness of fit was acceptable, indicated that the CFA has confirmed the studied factor structure.

Social Support for Safety (Factor 2): the 2 sub-factors with a total of 7 items were run. The results of the CFA for the social support for safety (FAC2) measurement model showed the following statistics: χ^2= 5.990, df = 5, p = 0.307, χ^2/df = 1.198, RMSEA = 0.022, NFI = 0.996, NNFI = 0.997, CFI = 0.999, RMR = 0.015, SRMR = 0.015, GFI = 0.996, and AGFI = 0.977. The results revealed that the goodness of fit was acceptable, indicated that the CFA has confirmed the studied factor structure.

Preconditions for Employee Safety Behavior (Factor 3): the 2 sub-constructs with total of 5 items were run. The results of the CFA for the preconditions for employee safety behavior (FAC3) measurement model showed the following statistics: χ^2= 1.131, df = 2, p = 0.000, χ^2/df = 0.566, RMSEA = 0.000, NFI = 0.998, NNFI = 1.007, CFI = 1.000, RMR = 0.010, SRMR = 0.010, GFI = 0.999, and AGFI = 0.992. The results revealed that the goodness of fit was acceptable, indicated that the CFA has confirmed the studied factor structure.

Employee Safety Behavior (Factor 4): the results of the CFA for the employee safety behavior (FAC4) measurement model showed the following statistics: χ^2= 6.573, df = 5, p = 0.254, χ^2/df = 1.315, RMSEA = 0.028, NFI = 0.991, NNFI = 0.993, CFI = 0.998, RMR = 0.023, SRMR = 0.023, GFI = 0.995, and AGFI = 0.978. The results revealed that the goodness of fit was acceptable, indicated that the CFA has confirmed the studied factor structure.

Table 1 Summary of the Results of the Finalized 30-item Safety Culture Assessment Scale

Dimension	N of Items	CR	AVE	Factor Loading	Cronbach's Alpha
1. Organizational Support to Safety	12	0.94	0.57	0.65 - 0.84	0.91
2. Social Support to Safety	7	0.86	0.48	0.53 - 0.91	0.82
3. Preconditions for Employee Safety Behavior	5	0.83	0.51	0.59 - 0.92	0.72
4. Employee Safety Behavior	6	0.78	0.39	0.24 - 0.77	0.72
Total Items = 30 (α = 0.93)					

In addition, the composite reliabilities (CR) of the constructs, the average variance extracted (AVE), and Cronbach's alpha were analyzed to check the reliability and validity of each component. The results in Table 1 showed that the composite reliability (ρ_c) of all dimensions was greater than 0.78, which was higher than the suggested criteria of 0.60 (Hair, Black, Babin, & Anderson, 2010, p. 680), which might be concluded that the convergent validity of the instrument was adequate.

(3) Second-Order Factor Analysis

In order to measure the construct validity of newly developed safety culture scale, the second-order confirmatory factor analysis was performed. Moreover, this safety culture assessment model was priori structured based on theoretical framework (i.e. SCM), thus CFA was adopted to test whether all sub-factors were under one main factor and to measure if the hypothesis model fit with the empirical data. The important goodness of fit indices and acceptable values to assess the model were χ^2, p-value (> .05), χ^2/df (< 2.00), RMSEA (< .05), RMR (< .05), SRMR (< .05), CFI (> .90), NFI (> .90), NNFI (> .90), GFI (> .90), AGFI (> .90), the internal consistency: Composite reliability (ρ_C) and Average variance extracted (ρ_V) (Diamantopoulos & Siguaw, 2000).

The results of the second-order CFA for the safety culture construct model validation indicated a good fit between the conceptual model and the observed data with the following goodness of fit statistics: χ^2 = 17.816, df = 10, p = 0.058, χ^2/df = 1.782, RMSEA = 0.044, NFI = 0.992, NNFI = 0.991, CFI = 0.997, RMR = 0.020, SRMR = 0.020, GFI = 0.989, and AGFI = 0.961.

The values of the average variance extracted (AVE) and composite reliability (CR) of the safety culture scale were .53 and .90, which were higher than the recommended level of .50 and .70 (Fornell & Larcker, 1981; Hair, Anderson, Tatham, & Black, 1998), respectively, which might be concluded that the convergent validity of the instrument was adequate. The results are shown in figure 1.

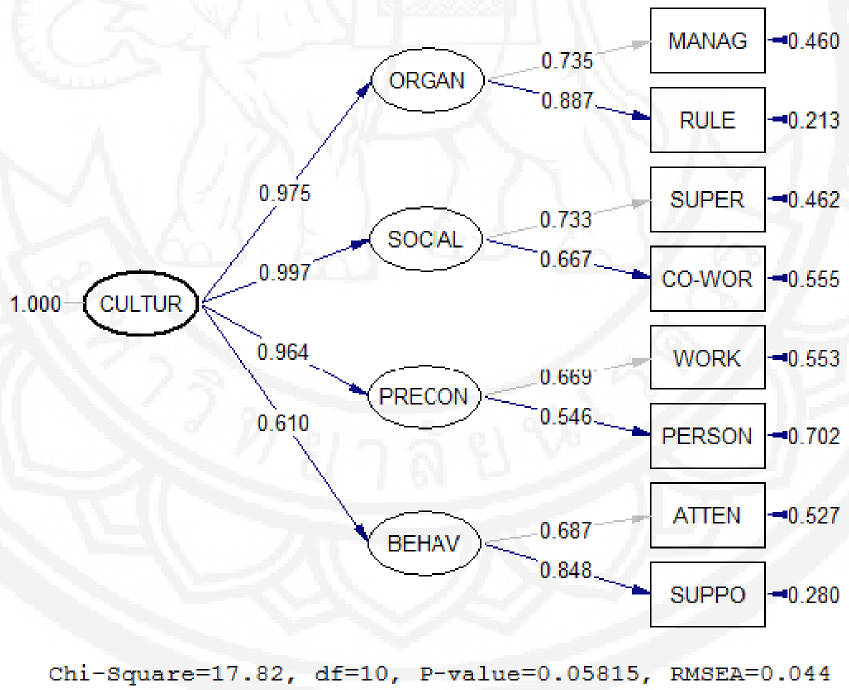

Figure 1 Safety Culture Construct Model

Conclusion

The research findings provided clear answer to the main purposes of this study which were-identifying the meaningful constructs of the four-dimension safety culture as well as to establish a reliable and valid instrument to measure Thai truck drivers' perception on the level of safety culture in the workplace. The four-dimension safety culture scale was comprised with 8 sub-factors (2 sub-factors under each dimension) including management commitment to safety, safety rules and training, supervisor support, co-worker support, work conditions, personal conditions, attentive action to safety, and supportive action to safety. The results from this study initially provided evidence of the validity and reliability of the newly developed safety culture assessment scale. Hereafter, the implication of the study, the limitations and recommendations for future research also addressed.

Discussion

This research is among the first to establish multidimensional measure of safety culture perceived by Thai truck drivers. The four-dimension safety culture assessment in this study was constructed using the accident causation model initiated by Reason (1997), known as Swiss Cheese Model (SCM), as an underlying framework. The SCM has been widely used in several industries as a way to help identifying series of errors that might cause workplace accidents and incidents (Guo, Yiu, & Gonzalez, 2016). Reason (1990) summarized that errors in the workplace derived from four major domains, that is, the organizational influences, unsafe supervision, pre-conditions for unsafe acts, and unsafe acts. Several studies attempted to develop the instrument to measure safety climate and safety cultures in various context including the transportation and logistics industries (Huang et al., 2013). However, few research addressed the possibility to conceptualize the research framework after SCM, especially in the area of safety culture. One of the previous research aiming to develop a multi-level safety climate measure for air freight handling. They applied the concept of SCM to exhibit two different levels of safety climate as organizational-level and group-level safety climate (Roberts, Douglas, Overstreet, Ogden, & Kabban, 2018). Similar to Roberts et al. (2018) study, this current research also addressed the knowledge of organizational influences and supervisor influences from SCM as one of the important domains when developing workplace safety culture constructs. While the previous study of Roberts et al. (2018) did not emphasize on the other two domains in SCM (i.e. preconditions for unsafe acts and unsafe acts), this research, on the other hand, included the knowledge of the two subjects in the conceptual framework to cover the broad perspective of culture concept.

Notably, most of the safety culture and climate studies did not include the domain of safety behavior in its scope (Fernández-Muñiz et al., 2007). The safety behavior was usually discussed as a separate parameter that may be impacted by safety culture or climate (Huang et al., 2013). Apparently, this research included safety behavior construct in the developed instrument based on two possible reasons. First, the behavior part was one of the key concepts composed in SCM addressed by unsafe acts which referred to unsafe behaviors that caused the occurrence of accidents. Second, the safety culture definition used in this study referred to "a pattern of shared basic assumptions that the group learns as it solved its safety problems which has worked well enough to be considered valid and therefore, to be taught to new members as the correct way to perceive, think, feel and act in relation to those problems" (Strycker, 2011, p. 4) which also addressed the way ones should act to solve the problems. Therefore, it is reasonable to add the safety behavior parameter in the studied scale.

Initially, the items appeared in employee safety behavior dimension was adapted from the work of Neal et al. (2000). They identified safety behavior into two separate variables as safety compliance and safety participant. Interestingly, the EFA result did not replicate the previous work but produced two new constructs. The two constructs were named after the characteristic of loaded factors that grouped together. That is, (1) attentive action to safety which refers to the way one acts attentively or paying close attention toward workplace safety, and (2) supportive action to safety which refers to the way one showing support or being helpful in regard with workplace safety. While the safety compliance indicates the degree to which employee should act in accordance with safety rules, command and instructions. Attentive action to safety, on the other hand, provides essential meaning to the extent beyond compliance as employee shows willingness to follow safety practices by their own sake rather than being forced to do so.

The concept of attentive action was the assumption to the knowledge of intrinsic motivation which aimed to explain how one would dedicate to do something for his/her own sake (Deci and Ryan, 1985). In contrast, further discussion with managers and truck fleet owners suggested that safety compliance was usually driven by punishments & rewards mechanism which central to the concept of extrinsic motivation or controlled motivation (Gagné & Forest, 2008). Thus, employee decides to follow safety rules and procedures to either avoid sanctions or seeking for incentive rewards. Such safety behavior is somehow good and acceptable but it produces no support for sustainability because employee may stop this behavior whenever the compliance is loosening. As a support to this extent, Hofeditz, Nienaber, Dysvik, & Schewe (2017) revealed that intrinsic motivators are not just important but more effective than extrinsic motivators in various behavioral studies. Therefore, this new emerged factor provided meaningful discovery to the current research.

Research Implications

The developed safety culture assessment in the present study may be used as a diagnostic tool to measure employees' perceptions and behavior toward the organizational safety atmosphere, as well as to detect areas of safety that require improvement (Cooper & Phillips, 2004). The survey results could be used to investigate which sub-constructs plays the largest role in influencing employee safety behavior (Roberts et al., 2018) and whether how each safety culture dimension impact to safety outcomes. Therefore, the results derived from safety culture assessment may also be fruitful for training and development planning as they indicate the areas where safety-related issues can be improved. This instrument can also be used to identify trends in an organization's safety performance and to establish benchmarks for the safety levels of different organizations (Glendon & Litherland, 2001). Moreover, further discussion with Thai truck drivers detailed that they would think about quiting the job if the company focus too much on the punishment for violating safety rules and procedures. It might be better idea to switch from focusing on safety compliance behavior to building up attentive action to safety behavior. Such attentive action to safety could be set as an ultimate behavior goal the organization might look for when recruiting the truck driver.

Limitations and Recommendation for Future Research

Several limitations of this research were found during the study. First of all, this research only centered around the study of Thai truck drivers which may impact the generalizability of the findings. Previously state, this measure was designed to be used with Thai truck drivers who appear to have a low level of education, and some of them cannot read well. Moreover, the back-translation of some items made no sense to the driver, so although a back-translation was performed it was found to be ineffective in this research. Thus, the items in this study were developed and discussed with the truck drivers. Even though the language was adjusted, the reverse items were addressed as another limitation. During the data collection, many of the truck drivers were observed to struggle to complete the questionnaire with the reverse items. Without proper explanation, many of them tended to misunderstand the meaning of the reverse items. As a consequence, those negative items were loaded into one single factor after EFA process which provided no clear meaning to the underlying construct and had to be removed from the questionnaire. Therefore, the final version of 30-item safety culture assessment measure contains none of negative items. This could be another weakness of the study as the negative items, suggested by several studies, are important as it help reducing the "acquiescence bias" (Solís-Salazar, 2015, p. 192) that happens when respondents tend to agree with all statements without carefully read or due to the laziness to complete the survey. The suggestion for the future research is to carefully consider adding the reverse items in the survey, either using fewer negative items or simplifying the sentences. Another option would be conducting a survey with a big group where one person reads and explains the questionnaire item by item, which may help increasing the reliability of the measurement scale.

Future research may also need to expand the scope of safety culture into other industries in order to continue examining the construct validity as well the predictive validity of the four-dimension scale. While many researches have aimed to examine the relationship between safety culture and safety outcomes, the investigation of the relationship between safety culture and non-safety outcomes may be take into consideration, for example: the intention to stay in the organization, job satisfaction, quality of work life, and so forth. It might also be interesting to examine the causal relationships among each dimension of safety culture, for example, how organizational support to safety influences employee safety behavior.

In conclusion, the research findings and the present newly-developed instrument provides meaningful discovery which may greatly contribute to the study of safety culture from both theoretical and practical perspectives. Hopefully, this assessment can be widely used in organizations to evaluate the level of safety culture that will create a safe workplace for employees.

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