THE DEVELOPMENT OF SAFETY CULTURE ASSESSMENT AND ITS VALIDATION: CASE STUDY OF THAI TRUCK DRIVERS

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A Dissertation Submitted in Partial
Fulfillment of the Requirements for the Degree of
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ABSTRACT

Title of Dissertation	The Development of Safety Culture Assessment and its Validation: Case Study of Thai Truck Drivers
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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.

This study employed the exploratory sequential mixed-method design (i.e. qualitative research followed by quantitative research) to achieve the research objectives. The qualitative research was conducted using the indept interview with 12 subject matter experts (e.g. 6 truck drivers, 3 logistics personnel, 2 safe-driving trainers, and 1 top management) in logistics industry using purposive sampling in order to determine the key constructs of safety culture in the context of Thai truck drivers. In accordance with the interview results, the existing accident causation model was applied to structure the key dimensions of safety culture. As a consequent, the key constructs were identified. Pool of items was generated adapting from existing instruments as well as newly developed based on the interview results. The first draft of safety culture assessment questionnaire was developed with 60 items altogether.

Next step, the quantitative study was performed in order to examine reliability and validity of the newly developed scale. Firstly, the pilot test was conducted with 75 samples for item analysis purpose. At this stage of analysis, total of 19 items were removed. As a result, 41 items were remained for next analysis.

The 41-item questionnaires were distributed to 1,010 truck drivers with 413 questionnaires returned, accounted for 40.89% . These questionniares were then proceeded in the next level of analysis. 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, 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 convergent validity (CR = 0.90 and AVE = 0.53) of newly developed safety culture assessment.

In order to examine the concurrent validity, two analyses were performed. First, partial correlation was used to examine the relationship between four safety dimensions and safety outcomes. The result revealed that employee safety behavior dimension had negative relationship with the likelihood of near-miss accident. In addition, the structural equation modeling (SEM) was later conducted to examine how safety culture influence safety outcomes. After adjusting the model, the results suggested that safety culture had a direct effect on both safety outcomes, as well as produced an indirect effect to the likelihood of accident transmitted through the likelihood of near-miss accident. As a consequent, the results showed evidence for good concurrent validity of the studied instrument. The paper also discussed the limitation of the study, the possible future research as well as implications for utilizing safety culture assessment.

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ABBREVIATIONS

Abbreviations	Equivalence
ACTU	Likelihood of Accident
AGFI	Adjusted Goodness of Fit Index
ATTEN	Attentive Action to Safety
CFA	Confirmation Factor Analysis
CFI	Comparative Fit Index
COMPL	Safety Compliance
COWOR	Co-worker Support
CULTUR	Safety Culture
DE	Direct Effects
EFA	Exploratory Factor Analysis
EMPLO	Employee Safety Behavior
GFI	Goodness of Fit Index
HRM	Human Resource Management
HROD	Human Resource and Organization Development
IE	Indirect Effects
INSAG	The International Nuclear Safety Advisory Group
MANAG	Management Commitement
NEAR	Likelihood of Near-miss Accident
NFI	Normed Fit Index
NNFI	Non-Normed Fit Index
OHS	Occupational Health and Safety
ORGAN	Organizational Support to Safety
OTP	The Office of Transport and Traffic Policy and Planning

PARTI	Safety Participation
PERFOR	Safety Performance
PERSON	Personal Conditions
PGFI	Parsimony Goodness of Fit Index
PRECON	Preconditions for Employee Safety Behavior
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
RULE	Safety Rules and Training
SCM	Swiss Cheese Model
SD	Standard deviation
SMC	Square Multiple Correlations
SOCIAL	Social Support to Safety
SRMR	Standardized Root Mean Square Residual
SSO	Social Security Office
SUPER	Supervisor Support
SUPPO	Supportive Action to Safety
TE	Total Effects
WHO	World Health Organization
WORK	Working Conditions

CHAPTER 1

INTRODUCTION

Occupational health and safety (OHS) is an area concerned with safety, health, and welfare of people engaged in work employment. Engaging in OHS intervention such as safety climate can protect employees who might be affected by undesirable work environments, risks, and potential hazards. Proper safety climate has extensive benefits to the organization, including cost saving (e.g. medical expenses and compensation) and improving workplace safety which affects the overall productivity, employees' satisfaction, and employees' retention. The concept of OHS and safety culture are not new, however they have always been left behind the productivity and profitability. This study shall point out the need for creating and determining safety culture assessment as a tool to evaluate organizational safety culture, especially in logistics and trucking industry where safety is a key concern for all truck drivers.

1.1 Research Background and Problem Statement

The remarkably high logistics costs in Thailand impact on industrial structure, regional distribution of the economy as well as the overall organizational management within its industry (Liu, 2016). Liu posits that logistics costs include transportation costs, inventory costs, administration costs and infrastructure costs. In Thailand, the transportation costs itself raised up to 49.4 % of Thai's total logistics costs in year 2009 (Liu, 2016). In order to remain the competitive advantage, many firms attempt to reduce the relevant transportation costs as a way to maximize profits (Hummels, 2007). Several practices are carried out to enhance the organizational productivity but may overlook the importance of safety.

The Office of Transport and Traffic Policy and Planning reveals that thousands of deaths and disabilities occur due to occupational accidents each year, especially for truck driver occupation (OTP, 2015). Road accidents caused by big vehicles constantly appear in the newspaper and social media channels on a daily basis.

Table 1.1 Road Traffic Death Report by Country as of 2016

Country	Reported number of road traffic deaths	Estimated road traffic death rate per 100,000 population
Australia	1,296	5.6
Canada	1,858	5.8
France	3,477	5.5
Germany	3,206	4.1
Indonesia	31,282	12.2
Japan	4,682	4.1
Malaysia	7,152	23.6
Myanmar	4,887	19.9
Singapore	141	2.8
South Korea	4,292	9.8
Thailand	21,745	32.7
United States	35,092	12.4

Source: Adapted from Global Status Report on Road Safety 2018, WHO, n.d.

Table 1.1 presents estimates of road traffic fatalities by country in year 2016. The selective countries in this table were extracted from the report in Global Status Report on Road Safety 2018 (WHO, n.d.). The estimated road traffic fatalities rate in developed countries (i.e. Australia, Germany, France, Canada, United States) were remarkably low. Apart from western countries' record, the estimated road traffic fatalities rate in Japan and Singapore were 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, not only when comparing with developed countries but even within South East Asian region, accounted for 32.7 death rate per 100,000 populations. The figure from this report indicates an urgent need to improve road safety management in Thailand.

Road safety is a critical concern for logistics and transportation personels, especially the truck drivers. The current record of Occupational Injury and Illness Statistics prepared by Workmen’s Compensation Fund (SSO, n.d.) reported that there were 86,278 workers involved in occupational accidents and injuries in 2017. As the highest overall injuries’ rate went for the workers in construction sector, but the top ranking of work-related fatalities’ rate was found among workers in logistics and transportation sector.

The analysis of the situation of road accident in Thailand by OTP (2015) reported the total number of 57,658 road accidents in year 2016. Motorcycles 20,550 cases (35.64%), cars 17,683 cases (30.67%), and pick-up trucks 9,780 cases (16.96%) ranking top three involving the road accidents respectively. As for the big trucks, the number of road accidents were only accounted for 1,936 cases or about 3.35% of total road accident (OTP, n.d.). Even though the number of traffic collisions from trucks are found in a very small number compare to other type of vehicles, but it generates intense impact to human lives and their properties. Because of the massive size of these commercial trucks, the accidents usually produce high impacts and can be more destructive than the car accident which result in undesirable outcomes (e.g. deaths, severe injuries, disabilities) not only to the driver but also other road users (Chen, Fang, Guo, & Hanowski, 2016; Cheunwattana & Chamnansook, 2010; Huang et al., 2013a; Islam & Hernandez, 2013)

Such changes and challenges create a need for establishing positive safety culture (Arboleda, Morrow, Crum, & Shelley, 2003), especially in logistics and transportation organizations. The concept of safety culture is becoming a focus of consideration in relation to workplace safety (Cooper, 1998), because safety culture is considered to represent a certain of shared basic assumptions that determined the way people think, feel, and act toward safety problems (Mearns, Whitaker, & Flin, 2003).

Safety culture has emerged and gained much attention after the Chernobyl explosion in 1986 (Chenhall, 2007). The concept of safety culture has been developed and implemented widely in high-risk industries such as nuclear power plant, petrochemical, oil and gas and medical industry in various countries for example, the

United States, United Kingdom, and China (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2007). Having an insightful understanding of the safety culture is a requirement for an organization which aims to design an effective safety development programs and interventions. It is important to start designing the safety culture program by examining safety culture constructs through extensive review on existing studies related to safety culture and safety literatures in order to gain a better understanding of its concept.

Numbers of safety culture measures have been developed in the past few decades (Fernández-Muñiz et al., 2007; Flin, 2007; Glendon & Stanton, 2000). However, among various existing safety culture instruments, research found inconsistent in the factors within its scale (Cox & Cheyne, 2000; Coyle, Sleeman, & Adams, 1995). The lack of consensus in safety culture structure is derived from adopting different frameworks underpinning the scale structure. Additionally, many safety culture scales have been developed based on various psychology and organizational theories such as social exchange theory (Huang et al., 2016; Neal & Griffin, 2006), leader-member exchange theory (Hofmann, Morgeson, & Gerras, 2003; Zhou & Jiang, 2015), organizational support theory (Gyekye & Salminen, 2007; Michael, Evans, Jansen, & Haight, 2005), and theory of planned behavior (Hall, Blair, Smith, & Gorski, 2013). Whereas the primary focus of safety relates with key objectives in limiting harms and dangers, and reducing the frequency of accidents and injuries (Liu, Huang, Guo, Zhou, & Chen, 2014). Hence, it is essential in this present research to adopt safety foundations and concepts as a guideline framework for the development of safety culture assessment.

As for Thailand, the concept of safety culture is also adopted from the west as a way to improve workplace safety. However, its studies are only limited to some sectors such as nursing and hospital (Sngounsiritham, 2011), petrochemical (Jitrada, 2015), aviation and construction industry (Muangsorot, 2014).

Additionally, existing research in Thailand mainly focus on the importance of safety culture on safety outcomes, but less research attempts to explore the constructs of safety culture assessment, especially in Thai context. There is also no evidence on the study of safety culture in logistics and transportation sectors in Thailand to date, especially for truck driver occupation. As the concept of safety culture developed in response to reduce major organizational accidents, yet it is being widely used to explain individuals' accident as well (Mearns et al., 2003). Apart from the lack of safety-related theories as support foundation in safety culture scales development, the specific contextual conditions, such as Thai national culture, occupational characteristics (i.e. truck driver), socio-cultural aspects, industry, and work conditions brings a lot attention to this present study as these elements may also influence the way the organization forms safety culture. Therefore, such contexts are essential for scale development in this research as they may have an impact on the constructs and item generation of this safety culture assessment.

1.2 Research Questions

In the present study, the research questions are;

1) What are the key constructs and sub-constructs underlying of truck fleets safety culture in Thai context?

2) What is the relationship between safety culture and safety outcomes?

1.3 Objectives of the Study

To answer the research question, the main objectives of this study are: (a) 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, and (b) to examine the influence of safety culture on two safety outcomes (i.e. the likelihood of near-miss and the likelihood of accident).

1.4 Significance of the Study

The area of occupational health and safety is one of a critical issue that need to be addressed under Human Resource and Organization Development (HROD), however the number of literatures about occupational safety and healthy, especially for truck driver occupation in Thailand, is quite limited. One possible reason for having small number of literature in truck drivers' safety and accidents area is due to the difficulty to contact the drivers as they always be on the road most of their working time (Jeong, Lee, & Park, 2016).

A great deal of existing safety culture research is often carried out by those authors involving in specific safety science area or relevant areas, for example engineering, science and technology. There is also a lack in empirical research about truck drivers and a systematic analysis for safety and work-related accidents in Thailand, most of the studies aim to focus how to reduce cost of operations, improving technology system, and widely emphasize on driving behaviors and health issues. This present study shall offer an integrative knowledge of safety science in the area that being beneficial to HROD and the logistics personnel.

Other than that, the newly developed safety culture assessment may be used as a diagnostic tool to measure employees' perceptions and behavior toward organizational safety atmosphere, as well as detecting areas of safety that require improvement (Cooper & Phillips, 2004). Therefore, the result derived from safety culture assessment may also be fruitful for training and development planning as it indicates the area where safety-related issues can be improved. This instrument can also be used to identify trends in an organization's safety performance and establishing benchmarks for safety levels of different organizations (Glendon & Litherland, 2001).

1.5 Research Design

This research was divided into two parts using the mixed methods. The first part was involved with qualitative research and the second part was involved with quantitative research. The extensive literature reviews about safety culture and the accident causation theories and models were used as a framework in order to develop the key dimension of safety culture instrument. The qualitative part was performed to get insightful information about the key factors of each safety culture dimension as perceived by Thai logistics personnel, including truck drivers. Together with the interview results, the study of several existing safety climate and safety culture instruments were reviewed as a mean to establish pool of items. The initial questionnaire was developed and sent to subject matter experts for examining initial validation (i.e. fact validation and content validation).

Next, different levels of quantitative part were conducted with an attempt to 1) conduct item analysis during the pilot test, 2) refine the measurement scale using EFA analysis, 3) examine reliability and validity of the measurement models using CFA analysis, and 4) validate the concurrent validity by examining the relationship between safety culture dimensions and safety outomes using correlation and SEM.

This study was consisted of 5 chapters. Chapter 1 provided overall background information as well as significant of study, research questions and objectives. Chapter 2 provided a review of relevant literatures on occupational safety & health situation, truck driver occupation and its contextual conditions, safety culture and its measurement, accident causation models, and safety outcomes. Due to small number of research studies about truck traffic accidents in Thailand, the general road traffic collision in Thailand together with truck-related collision from other countries were synthesized. The key objective of the literature review was to describe theoretical backgrounds in order to develop safety culture components for Thai truck drivers. Chapter 3 provided methods of this research which separated into two parts: qualitative research and quantitative research as previously stated. This chapter explained the population and sample used in present study, as well as the instruments and analytical methods used in both parts. Chapter 4 presented the empirical evidence related to each hypothesis and provided answer to each research questions. Finally, Chapter 5 summarized the results and discussed the findings. This part also addressed the implications of study, the limitations and recommendation for future research, as well as the conclusion.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter provides the relevant literature review that aim to explores the different aspects and facets of safety culture such as: the definitions of safety culture, the concept of safety culture, the safety culture measurements and constructs, and the use of accident causation model as a framework to develop safety culture assessment.

2.1 Occupational Safety and Health

Occupational Safety and Health (OSH) becomes an essential issue reflecting not only within the organization setting but nation wide. The area of OSH has been widely studied across the globe including Thailand. As OSH is one of the key foundations for human resource management (HRM) and human resource and organization development (HROD), unfortunately few studies of OSH are found under HRM and HROD research. This study emphasizes the importance of OSH aspect toward employees' safety during their service for the organization. The initial review of OSH explains the need to pay great attention on safety culture establishment in an attempt to create the safety workplace.

2.1.1 Definition and Concept

Work has a major impact on health and safety of people in community as the evidence shows that there are millions of people suffering from work-related injuries each year. The occupational safety and health issues have gained prominent attention globally (Bohle & Quinlan, 2000).

Alli (2008, p. viii) describes the definition of occupational health and safety in his book as " the science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment."

The word safety itself is not complicate in its meaning. This word is assumed to be known by everyone with immediate meaningful to us all. The origin of this word seems to derive from the old French word sauf, which in turn influenced by Latin word salvus, and the meaning of sauf refers to "uninjured or unharmed" (Hollnagel, 2014, p. 10). Hollnagel states that the modern meaning of safety is defined as "not being exposed to danger." Merriam-Webster provides the meaning of safety as "the state of being safe, freedom from harm or danger, and the state of not being in dangerous". While the Oxford dictionary defined safety as "the condition of being protected from or unlikely to cause danger, risk, or injury". Weick (1991, as cited in Reason, 1998, p. 294) defined safety as "a dynamic non-event. Non-events, by their nature, tend to be taken for granted, particularly in the face of continuous and compelling productive demands." The term safety also describes "a condition where adverse events and hazards are avoided, and barriers are erected to prevent future occurrences or interactions with such events or hazards" (Short, Boyle, Shackelford, Inderbitzen, & Bergoffen, 2007, p. 6).

As for Thailand, the Minister of Labor (n.d., p. 2) has developed The Occupational Safety, Health and Environment Act B.E. 2554 as the main OSH law of Thailand, in which occupational safety, health and environment (OSHE) means "actions or working conditions which are safe from any cause resulting in danger to life, physique, mentality or health arising out of or related to working".

In a broad sense, safety is a condition of being free from any kind of dangers, accidents, risks, hazards, or injuries. Thus, it is essential, when study about occupational safety, to address the components of such accidents, risks, or injuries to its context.

Alli (2008, p. 4) points that occupational and industrial accidents are a consequence from "preventable factors" and these factors could be eradicated through "preventive strategies". Therefore, protecting employees from work-related accidents and undesirable health conditions is not an extra role for management, but it should be addressed as one of the management's key responsibility along with other managerial tasks. The vision and mission statements should adhere the context for profitability, productivity, together with an attention to the value on employees' safety and health. When management shows the strong commitment and truly walk-the-talk on safety and health issues, then the employees will likely perform safely (Alli, 2008). Apart from management team, supervisors are another key individual in occupational safety and health program as they are the immediate person in contact with the front-line workers. Supervisor shall carry out the safety policy and procedures and communicate the safety issues with their staffs (Alli, 2008).

Friswell and Williamson (2010, p. 2068) revealed safety at work as it "depends upon hazard environment of the job". In order to effectively manage occupational health and safety in the organization, it is important to understand the specific hazard and risk profile of particular job and workplace (Friswell & Williamson, 2010; Makin & Winder, 2008). Organizational risk and safety analysis should address the potential hazards associated with key elements toward people, physical workplace and management. Makin and Winder (2008, p. 936) point out that a "hazard profile" arise from a systematic analysis of those three elements, and that different organizations may experience different hazards and/or having different hazard profile. Thus Friswell and Williamson (2010) suggest that safety management shall involve all kind of activities to eliminate potential hazards, reduce the possibility of accident exposures, and minimize the impact of such exposure. Hudson (2001, p. 8-1) on the other hand, proposes the creation of a safe environment "as allowing dangerous activities to take place successfully, which means without harm or damage". According to Hudson's perspective, safety has to be "actively managed to allow profit or advantage to be gained".

2.1.2 Occupational Safety and Health in Thailand

Work-related accidents are unexpected events that can happen to anyone in the workplace. Regardless of the reasons behind its occurrence, its impacts spread out once it happens. Employee who involves directly in the accident may be injured, become disability and in the worst case, death (SSO, n.d.).

As in Thailand, the outbreak of heavy manganese poisoning cases in 1964 provided severity levels of illness among workers in a battery manufacturing in Samutprakarn city, helped raising awareness on OSH in the country (Occupational

Safety and Health Bureau, 2015, p. 5). However, public health was the only concern issues in the early stage of OSH development until 1974 when the “Occupational Safety Section” was established as an agent responsible for occupational safety which operated under the Division of Labour Protection, Department of Labour. The first master plan on Occupational Safety, Health and Environment was developed in 2002, later on the government announced the policy on “Decent Safety and Health for Workers” as the national OSH agenda as a guideline for all relevant sectors. Finally, the new regulation on OSH has been developed under the name of Occupational Safety, Health and Environment Act, B.E. 2554 (A.D. 2011), which became effective since 2011 until present (Occupational Safety and Health Bureau, 2015, p. 4).

Number of occupational accident and injury rates among Thai workers across the nation degreased significantly from 2002 to 2014 (see figure 2.1). In the meantime, the occupational fatality rates have a tendency to gradually reduce after 2005, except for 2012 which the rate raised up a little.

Table 2.1 presents the number of workers’ occupational injury and illness by severity in Thailand during 2008 – 2017. Number of employees suffering for work-related accidents and injuries were 176,502 with 613 fatalities in 2008. The statistic in Table 2.1 indicates that number of total workers involved in occupational accidents and injuries has declined gradually year by year. The decrease of occupational accidents and injuries rate over the past decade indicates the achievement on occupational safety and health administration of the country.

Figure 2.1 Trend of Occupational Injury Rates by Severity and Workmen's Compensation

The current record of Occupational Injury and Illness Statistics by Workmen's Compensation Fund under Social Security Office, Thailand (SSO, n.d.) reports that there were 86,278 workers involved in occupational accidents and injuries in 2017. As the highest overall injuries' rate went for the workers in metal manufacturing, but the top ranking of work-related death's rate was found among workers in logistics and transportation sector which accounted for 18.15% of total occupational fatality. The report further identified the significant cause of occupational fatality, the data indicated that number of 278 out of 570 death workers (48.77%) were died by vehicle-related accidents, and 131 of the death workers were in the driver position which accounted for 22.98 % of total occupational fatality.

Table 2.1 Number of Workers' Occupational Injury and Illness by Severity

Year	No. of workers	Level of Severity					Total
		Death	Disability	Loss Organs	Leave > 3 Days	Leave < 3 Days	
2008	8,135,606	613	15	3,096	45,719	127,059	176,502
2009	7,939,923	597	8	2,383	39,850	106,598	149,436
2010	8,177,618	619	11	2,149	39,919	103,813	146,511
2011	8,222,960	590	4	1,630	35,709	91,699	129,632
2012	8,575,398	717	18	1,818	36,166	93,106	131,826
2013	8,901,624	635	28	3,036	31,419	76,776	111,894
2014	9,132,756	603	11	1,463	29,254	68,903	100,234
2015	9,336,317	575	6	1,324	27,845	65,924	95,674
2016	9,449,984	584	12	1,290	26,829	60,773	89,488
2017	9,777,751	570	17	1,200	25,820	58,671	86,278

Source: SSO Thailand, n.d.

2.2 Truck Driver Occupation

Truck driver occupation is selected as a population in this present study. The nature of this job is considered to be high-risk occupation. As the statistic shown in Table 2.2 emphasizes the high fatality's rate of Thai workforce falls in logistics and transportation business, this brings great attention to present study with an attempt to examine truck drivers' safety.

2.2.1 Truck Driver Occupation Characteristics

Truck driving is seen as a dangerous, tough and risky job (Trakarnvachirahut, Sirisoponsilp, & Pavakanun, 2014). Truck drivers often work long hours, they may spend days and nights or even weeks traveling on the road, sleep and sometimes eat on the truck prior to get to the destination (Cheunwattana & Chamnansook, 2010; Prescott, 2012). Prescott (2012) wrote on the book Career as a Truck Driver that truck drivers usually work outside the organization premise, regardless of weather conditions such as heavy rain and storms, they must also keep working to ensure the complete delivery and loading. They even view their vehicle as a second home, the mobile one. Those truck drivers who work for the companies, are usually required to work a pattern roster which, most of the time, results in having uncertainty day-off. As their working time is practically based on shift-schedule, they need to be flexible enough to handle both day-shift and night-shift. Driving the truck can be very challenging and also very stressful, especially at night time when they have to drive through the dark with limitation of vision and to risk sleepy driving (Kemp, Kopp, & Kemp, 2013).

Kemp et al. (2013) point that truck drivers' job requires an interaction with dispatchers and customers whom can sometimes tightly tie the loading schedule and give pressure on truck drivers to complete their delivery task under the pressure of time. Additionally, when something goes wrong with the delivery, truck driver will likely have to deal and respond with the customer or representative's complaints (Prescott, 2012).

Prescott (2012) describes truck driver's duties in his book in several aspects. He explains that truck drivers must have certain knowledge about the laws and regulations, especially the traffic laws. Also, truck drivers must comply with specific regulations that have been developed by the department of transportation such as physical and age requirements in order to apply for truck drivers' license. They need to be aware about the driving behavioral issues on how and why they may lose their commercial driver's license. In addition, the organizations where they work for will usually establish own rules, regulations, standards and policies that enforce truck drivers to follow strictly. For instance, according to safety policy, truck drivers shall not drive exceeding to the certain speed limit (e.g. not over 60 km/hour for chemical and hazardous-carried truck) at all-time otherwise they will be punished.

Truck drivers' income varies from the type of truck they operate, and the size of organization they work for. Trakarnvachirahut et al. (2014) interviewed one top management of Thai's logistics company and found that average income of the ten-wheel truck is range around 12,000 – 15,000 THB, the eighteen-wheel truck is range around 15,000 – 18,000 THB, and for trailer truck is range around 18,000 – 20,000

THB. While in big and well-known trucking companies, the total income per month could be 25,000 THB or more. Generally, the pay scheme of this occupation can be different from organization to organization. One of the payment scheme that widely used in many middle to large organizations is through a combination of basic salary together with mileage allowance per trip, and other available incentives (e.g. zero-accident incentive). Another payment scheme is purely based on number of trips the driver can handle, usually found in small company. According to this later type of payment scheme, the driver will not have a fixed salary but get paid by the cumulative amount of trips they can manage within particular period (Jeong et al., 2016). With both type of payment schemes, it indicates that total income of truck driver can be varied from month to month depends on number of trips they have been assigned to work each month (Cheunwattana & Chamnansook, 2010).

Table 2.2 Average Monthly Salary in Thai Organizations by Level of Education

Level of Education	**Monthly Salary (THB)**
Diploma/High School or lower	9,000 – 12,500
Bachelor’s degree holder	15,000 – 21,000
Master’s degree holder	18,600 – 31,400
Doctoral’s degree holder	27,200 – 51,200

Source: Matichon Online News, 2016.

Interestingly, the total income of truck driver occupation is rather high comparing to the same level of job with the same level of education. According to Trakarnvachirahut et al. (2014), the education level of Thai’s truck driver in their study is range from primary school grade 1 – bachelor degree, however the majority of them fall between primary school grade 1 – grade 6 or below (50.5 %). This information is clearly illustrated that to become a truck driver, educational background is not a critical criterion for recruitment. And to those with the same educational level (i.e. primary school grade 1 – grade 6), but working in different industry such as in manufacturing plant, may receive less than 10,000 THB a month (approximately 300 THB/day according to new labor laws), or up to about 15,000 THB if they are committed for an over-time work. Table 2.3 presents the average salary in Thai private organizations, especially those employees working in engineering, information technology, finance and accounting, logistics and supply chains, and business management sectors. The figure in this table indicates that average Thai workers who hold diploma or bachelor degree may receive less amount of total salary comparing to uneducated truck drivers.

Apart from good payment, flexibility is another key factor that attract people to work as a truck driver. While in manufacturing plants, for instance, workers are required to work a specific hour using clock in and out to measure their attendant. Truck driver, on the other hand, will receive their schedule from supervisor then they start to self-manage their own working time. Truck driver can stop for eating and sleeping whenever they want, without informing their supervisor. Basically, there is only one driver per truck for short route destination and two drivers per truck for long-haul. Truck driver spend most of their working time on the road, They have to work alone (in some case together with their partner) without close supervision from their boss (Huang et al., 2013a). Thus, its independency keeps the driver away from immediate support from supervisor and other workmates.

2.2.2 Truck Driver and Road Traffic Accidents

World Health Organization (WHO) (n.d.) reported that more than 1.25 million people were killed in traffic collision each year with more than 50 million people suffer from non-fatal injuries. Many of the survivals become disability as a result of the accidents.

Road traffic accident causes considerable economic losses and damages to victims, their families, the organization they work for, and to nations as a whole (Castillo-Manzano, Castro-Nuño, & Fageda, 2016; Girotto, Andrade, González, & Mesas, 2016; Jeong et al., 2016). These losses arise from various aspects, for example the cost of medical treatment, lost income during hospitalized, the cost of vehicle repairing as well as productivity losses for an organization (Chen et al., 2016). Surprisingly, more than 90% of fatality from road traffic collisions were found in low – middle income countries (WHO, n.d.).

Thailand is one of the country where death rate from traffic collision is extremely high, ranking number two after Libia, accounted for 32.7 death rate per 100,000 population reported in Road Traffic Accident Death Rate as of 2018 issued by WHO (WHO, n.d.). The Office of Transport and Traffic Policy and Planning (OTP) - one of the division under Thailand Ministry of Transport – state in Road Accident Analysis Annual Report 2012 that road traffic collision in Thailand is a major problem affecting Thai economic and social development, causing immeasurable loss of life and property (OTP, 2013). OTP's research (2013) on road accident found that every time there is a fatal-related accident occurred, it costs approximately 5,300,000 THB per accident. And for the accident that involved with disability cost around 6,200,000 THB in average. These estimate costs arise from direct and indirect costs such as loss income, loss productivity, medical expense, loss of quality of life, insurance payment, and other costs related to vehicles and properties.

In response to the 64th Session of the United Nations General Assembly in Moscow, Thailand determine to participate 'The Decade of Action for Road Safety' by setting up the goal of reducing number of road accident fatality less than 10 death rate per 100,000 populations. Additionally, determining eight guidelines for 'The Decade of Action for Road Safety' as a framework for 2011 – 2020 Action Plan, 1) promoting helmet wearing enforcement, 2) reducing the risk of drunk driving, 3) fixing vulnerable and dangerous spots/areas, 4) changing road users' behavior, especially motorcyclists, bus and truck drivers to drive within speed limit, 5) raising vehicle safety standard, especially for motorcycles, buses and trucks, 6) developing road users' driving competency, 7) developing service level of emergency medical and rescue includes quick treatment and rehabilitation, and (8) developing road safety management to be more efficient (OTP, 2013).

The analysis of the situation of road accident in Thailand by OTP reported the total number of 57,658 road accidents in year 2014. Motorcycles 20,550 cases (35.64%), cars 17,683 cases (30.67%), and pick-up trucks 9,780 cases (16.96%) ranking top three involving the road accidents respectively. As for the big trucks, the number of road accidents were only accounted for 1,936 cases or about 3.35% of total road accident (OTP, 2015).

Even though the number of traffic collisions from trucks are found in a very small number compare to other type of vehicles, but it generates intense impact to human lives and their properties. Because of the massive size of these commercial trucks, the accidents usually produce high impacts and can be more destructive than the car accident which result in undesirable outcomes (e.g. deaths, severe injuries, disabilities) not only to the driver but also other road users (Chen et al., 2016; Cheunwattana & Chamnansook, 2010; Huang et al., 2013; Islam & Hernandez, 2013). News about truck accident has been reported on a daily basis through various media. Apart from official media (e.g. newspaper, television, and official website), members of Thai truck driver group on Facebook constantly share at least two to three truck accidents a day in their group. These statistics suggest that the organization, especially the logistics and transportation sector, should place more concern on promoting safe driving for its drivers to prevent and control work-related road accidents (Amponsah-Tawiah & Mensah, 2016).

Reason (1990) found that roads are one of the place where errors and violations are abundant and easy to observe. The violations on the roads include drinking and driving, racing with other drivers, exceeding speed limits and the like. The erroneous behaviors include failing to see the signage, failing to check mirror before overtaking. Castillo-Manzano et al. (2016) points that truck accident may be affected by several factors, for example, from loading capacity, the size of the truck, together with working condition and surrounded environments. The causes of traffic accidents are primary derived from four key factors; human (Jeong et al., 2016; OTP, 2013), vehicles (Jeong et al., 2016; OTP, 2013), road conditions (OTP, 2013, 2015), and surrounded environments (Jeong et al., 2016; OTP, 2013). The human factor can be identified as a human error through their driving behavior, includes breaching the traffic laws, less awareness of passengers' safety, and lack of safety awareness toward themselves and society. Some examples of human factors are an exceeding speed limit, lacking an ability to control the vehicle in specific events, and fatigue due to long-hour driving. The vehicle factor, for example, the condition of the car that has been heavily used for a long time, the modified vehicles, over-weight carried truck, the broken engine and related parts (e.g. tire and brake system). Road factor refers to the condition of the road that might affect driving efficiency. For examples, rough and bumpy road surface, inappropriate U-turn spot, and intersections without the traffic lights. The last factor is the environment which provides minimal effect toward road accidents, however it is uncontrollable, thus the driver must pay a lot attention while driving under some condition such as raining, storming, hailstone, and unexpected incident from other road users (OTP, 2013). The structure of the vehicle, its strength of the body, and its massive size, for instance, are viewed as the factor that contributes to the severity of the road accident, as well as the other objects along the road side (e.g. big trees, electric poles, and pillars).

According to (Thonglim, 2012), the cause of the road accidents is truly caused by human, however it has been suggested that in order to reduce the road accidents caused by truck drivers, the need to create safety standard should be addressed and derived at the organization level.

Truck drivers' fatigue and drowsiness are appeared to be a critical major cause of traffic crashes among truck drivers. Inadequate sleep and rest time lead to physical fatigue of drivers, thus it is essential to ensure that drivers have sufficient sleep and rest opportunities prior to perform their duty on the road (Chen et al., 2016; Zhang, Yau, Zhang, & Li, 2016). Moreover, (Maldonado, Mitchell, Taylor, & Driver, 2002; Zhang et al., 2016) reveal that to increase the company's profits, the trucking company owners, especially in developing countries, usually force their drivers to work excessively in long hours, neglecting their fatigue. Then the drivers, in return with more income and job security, have agreed to drive regardless of their physical exhaust. The study of Seo and colleagues found the positive relationship between self-perceived fatigue and workers' safety behavior. Thus, the fatigue condition may gradually develop certain unsafe acts or undesirable behaviors as a result (Seo et al., 2015).

As suggested by Chen et al. (2016), the trucking owners and the management should address more concern on truck drivers' physical wellness as a preventive action programs to enhance occupational health and safety for commercial trucking operations.

Department of Highway (2007) intensively studied the costs of road accident in Thailand using the report of Road Crash Costs in Australia as a research framework. The research identifies damage costs into three groups; human-related damage costs, vehicle-related damage costs, and general damage costs. There are various costs in relation to human-related damage costs. The value of lost productivity is basically calculated on the basis of lost time at work due to the traffic accidents. Lost quality of life is another aspect that need to be considered when calculating the costs of accident. Medical treatment expense, long term rehabilitation costs, imprisonment costs and workplace expense due to lost productivity from injured employee are also categorized in this human-related damage costs.

Next group is vehicle-related costs which arise from the cost of vehicle repairing that is varied from factor to factor, such as the severity of crash and the type of damaged vehicle. The cost of towing and loss of time due to lacking the vehicle for transportation are also addressed in this category.

Last group is the general costs toward road accident. For example, the property damage cost (non-vehicle property) such as the damage on traffic light, the traffic signs, the electric pole and the like. Other expenses arise from police, insurance, rescue team, lawyer, and loss time on traffic congestion due to the accident.

Driving beyond the speed limit is found to be a critical risk factor for road accident and traffic injuries (WHO, n.d.) including Thailand. Girotto et al (2016) investigated the relationship between truck drivers' experience and involvement in traffic collision in Brazil, the result shows that the length of working experience is negatively related to the involvement in accidents. It can be explained that more experienced drivers are likely to have greater skills and ability to drive the truck.

Castillo-Manzano et al. (2016) argues in their research that differences in truck load capacity (light, medium, and heavy) seem to influence the road safety, however depends on the accident type. The research shows that the light-weight trucks are likely to associate more with traffic accidents, while the medium-weight trucks are found to relate with traffic fatalities the most, amongst these three types of trucks. The heavy trucks appear to be safer than light trucks according to this research. (Jeong et al., 2016) analyzed traffic accidents of heavy truck in South Korea and the result pointed that tight and tough working schedule appears to be one of the main reasons of the accidents.

Girotto et al. (2016) reveals that improving knowledge and skill of truck driver through effective training and appropriate practicing hours can possibly reduce number of accidents among drivers. Furthermore, in order to reduce number of truck accidents, drivers are required to follow company's rules and regulations strictly as it will help them to safely perform their duty at all-time. Apart from defensive driving skills, drivers should have sufficient mechanical knowledge, so that they can self-check the readiness of their trucks prior working. More importantly, truck drivers should take care of their health and ensure that they are physically and mentally fit before they drive (Tipinto, 2010). Samutharak (2013) investigated the preventive behavior of one ceramic factory workers toward occupational accident, the result shows that most of the workers have good accident prevention behavior as they have been coached and worked under close supervision by their supervisor. Coaching, training, and close monitoring by immediate supervisor influence workers' preventive behavior toward occupational accidents. Although this research aimed to study the behavior of factory workers not truck drivers, but the concept of successful accident prevention is in our interests.

Road accident is inevitably a potential hazard not to all road users (Li & Itoh, 2014) but for all commercial truck drivers, as their work will usually be on the road most of the working time. Apparently, none of them wants to associate with that incident, not to mention that they never want to risk themselves killing their own lives or even others. Every truck driver prefers to work as safe as they can, like other workers. Many researches pointed that the accident caused by truck drivers can be identified as a human error, thus emphasis mainly on individual driver's work behavior.

Many research explain that most of the road accidents are mainly caused by driving skills and driving behaviors which mostly emphasis on human factors (Cheunwattana & Chamnansook, 2010; Özkan, Lajunen, & Summala, 2006). Thonglim (2012) argues that the road accidents, especially in transportation industry in Thailand, are caused by human (i.e. truck drivers), mainly due to the unavailability of their physical and mental readiness. However, such condition of truck drivers' readiness is involved with employer's decision to go for profitability rather than to strict with the safety enforcement.

2.2.3 Contextual Conditions for Thai Truck Drivers

There are several contextual conditions to be considered when attempting to develop new safety culture assessment. This section provides essential conditions that may influence the framing of safety culture in particular occupation like truck driver in Thai organization.

2.2.3.1 Socio-cultural Background

Culture differences between countries affects individual personality and behavior and organizational culture. Chuenwattana (2008) conducted the research to study truck drivers' road traffic accident in Thailand in order to understand the construct mindset together with the contextual conditions that influence Thai truck drivers' awareness and behaviors toward road accident. The research results show that 1) socio-cultural influences the determination to become a truck driver, and 2) the working conditions influentially shape the truck driver's mindset toward traffic accidents and their risky driving behaviors. The author reveals, under the sociocultural context, that most of Thai truck drivers are from poor family background which attempting to find whatever best for them to raise themselves and the families. Because of the poverty, they tend to lack the opportunity for school and higher education, as a consequence, they are identified as a low educated workforce. In addition, it is not easy to get a good job while having low education with no other special abilities and skills. Becoming a labor workforce in farming, gas station, construction site, manufacturing factory, and trucking industry are seen as a possible career path for these people. In comparison with other labor-works, driving a truck is found to be the most attractive job for those poor and low educated people due to its higher income. However, it is not easy to become a truck driver because the trucking company usually require someone who has the appropriate driver license and truck driving experiences.

In reality, obtaining the specific driver license to operate heavy truck is not hard in Thailand, but gaining truck driving experience is somewhat difficult. Many of the truck drivers these days started their way from truck assistant job in which they can learn how to drive and operate the large truck later on. While some of them may apply for the driver license first and then leave it for a year or more in order to falsify their experience to the company/truck owner.

2.2.3.2 Work Conditions

Similarly, to other labour-works, truck driver job requires the workers to perform their duties according to the conditions set by employers or owners (Chuenwattana, 2008; Cheunwattana & Chamnansook, 2010). Drivers are likely to deal with various undesirable work conditions in return with money. For instant, they might have to drive improper vehicle (e.g. brake pad problem, old engine problem, and the like) to get the job done, even though they know how risky it is to keep driving such vehicle. Time pressure and tight schedule are another key working condition that gradually influence the unsafe driving behavior of truckers. As many employers determine the pay scheme for truck driver job based on number of trips they can achieve, the more they drive the more they earn. Thus, the truck drivers may attempt to exceed the speed limit, or refuse to decelerate in order to compete with time.

In return with higher income, on the other hand, truck drivers are usually required to work long hours a day on the road. The number of working hours together with tight schedule is seen as an important factor to create chronic fatigue (Khamnak, 2014). Unlike the developed countries (e.g. United States, United Kingdoms) where there are appropriate truck stops and resting areas along the road, Thai truck drivers have to risk themselves by parking the vehicle along the road side for sleeping, as well as experiencing the robber attack (Chuenwattana, 2008). The drivers' anxiety due to the fear of robber attack is found to be one of the factor interrupting their sleep during the night. Under this situation, drivers are likely to have insufficient sleep hours as such anxiety keeps them awake all night.

2.2.3.3 Bargaining Power and Interpersonal Relationships

Many of truck drivers in Thailand work for small enterprises and/or family business where the management system seems to be different from the large and well-established organization. In small trucking enterprise, the owners are found to be the one who take all the responsibilities to ensure the smooth operation in the business, including to pay the bribe for police officers in order to let go of their trucks, especially for the overloaded case (Chuenwattana, 2008). Overweight loading is one of the source of hazard to roadway structures as well as the traffic collisions. Trucks exceeding the legal load limits are more likely to increase road accidents with high severity consequences (Jacob & Beaumelle, 2010). According to the information provided on Office of Traffic Weight Control's website (2016), the harmful effect from oversize loads impact, not only to the truck drivers and other road users, but also the government as well as the trucking enterprises. All truck drivers are aware that driving overloaded vehicle is risky, however this is one of the working conditions they have to handle in order to keep their job secure (Chuenwattana, 2008). Thai truck drivers tend to have less bargaining power with their employers in term of safety and other welfares (Khamnak, 2014).

Moreover, prior to operate the trucking business, the truck owners are required to obligate in the insurance programs. The insurance offers protection from vehicle damage or injuries to truck drivers and other people. When the accident occurs, the insurance company together with the truck fleet owner will manage everything for drivers, including compensation to the victim’s family, and offering the bribe for police officers in the hope that details of the case could be rewritten (Chuenwattana, 2008).

Another influential cultural context of interpersonal relationships centered around the concept of “Boon Koon” (Pimpa, 2012, p. 14) which can be concluded as a form of moral or spiritual allegiance. This concept emphasizes the need for ones to be loyal to the person who does good deeds which prevent them from problematic consequences (Baczek, 2013; Pimpa, 2012; Punturaumporn, 2001). Thai truck drivers usually work closely to the owner in case of small truck fleet enterprise, and the drivers are always gained some helps from the owner for example, receiving an advance salary when needed, and being supported when dealing with the police officers (Chuenwattana, 2008). Thus, it is hard for the drivers to refuse when the owner begs them to do an extra delivering as taking the job is found to be one of the best way to repay the owner’s kindness.

2.2.3.4 High Power of Distance

Thailand has been classified, according to Hofstede, into a “high power distance culture” in which “the less powerful members of organizations and institutions accept and expect that power is distributed unequally” (Hofstede, 2011, p. 9). This high power distance influences the behavior of people in the society (Rhein, 2013). Hofstede identifies some interesting characteristics of high-power distance society as; the senior people and those with handful of power and authority are respected and feared, less power people expect to be told what to do, high frequency of corruption, bribe offering to cover up the scandals.

The tall hierarchical structures in most Thai organizations are also influenced by high power distance cultural aspect (Thanasankit, 2002). By looking at this contextual perspective in organizational setting, the person who holds much of the power; as known as boss, is likely to dictate their subordinates to follow their direction and command (Hofstede, 2001). The management hierarchy separates the level of leaders and workers tall apart, creating command-and-control management style, expecting the workers to obedience the leader (Pimpa, 2012). Biatas (2009, p. 107) also reveals that this cultural context creates “fear of punishment in case of disagreement with the management’s decision”. In addition, the internal communication in the organization is linked with the power distance context. In the society where, low power distance is dominant, the communication is found to be more open, and top management is more easily reachable for discussion and consultation. Whereas, in high power distance society, top management is praised for superior and unreachable (Biatas, 2009). Therefore, this high-power distance cultural dimension inhibits the drivers to refuse their boss from doing an extra hour driving, and/or to negotiate on work safety issues.

The combination of these contextual conditions creates certain mindsets toward truck driver’s road traffic accident. In Chuenwattana’s study (2008), Thai truck drivers perceive that driving the truck and road accident are concomitant. The traffic accidents are seen as a common incident for this type of occupation regarding to its nature of working conditions. Most of the driver view that road traffic accidents are derived from determined work constructs by the company or fleet owner, which is found to be the factor beyond their control.

Therefore, the most effective way to implement safety culture concept in particular industry is to tune safety process in accordance with organizational culture, its structure and practices, as well as other important contextual conditions (i.e. national culture, job characteristics, work conditions and so forth).

2.3 Safety Culture

The notion of safety culture is a key interest in this study. Safety culture has emerged three decades ago after Chernobyl accident in 1986. Many high-risk industries were alert to this concept and started to establish safety culture in an attempt to minimize the occurrence of accidents and injuries. The concept of safety culture, however, may be overlooked in logistics and transportation business especially in Thailand. Therefore, this study attempts to emphasize the need to have good safety culture in place for this particular industry.

2.3.1 Definition of Safety Culture

Before the Chernobyl's accident in 1986, the issues of organizational safety have already emerged. Zohar (1980, p. 101) was among the first scholars who studied the concept of organizational safety, and initiated the term of safety climate into safety literature as well as provided its definition as "a unified set of cognitions regarding the safety aspects of their organization". This climate reflects employees' perceptions about the relative importance of safe conduct in their occupational behavior (Zohar, 1980). Later on, the term of safety culture was first introduced by International Atomic Energy Agency (IAEA) in 1986 right after the Chernobyl's disaster (Chenhall, 2007). Many researches have shifted the focus to safety culture as it was claimed to be the contribution to Chernobyl's accident. Numerous researches provide definition of safety culture in several ways.

Number of definitions of safety culture have been proposed (Cooper, 2000; Edwards, Davey, & Armstrong, 2013; Flin, 2007), however these definitions of safety culture range from the very broad meaning for example the one derived from Confederation of British Industry (CBI), which provides very simple meaning on safety culture as the way how group of people do or behave around here. In most common definition, safety culture refers to "the safety-related values, attitudes, beliefs, risk perceptions and behaviors of all employees" (Lee & Harrison, 2000, p. 61). Cooper (1998, p. 17) defines safety culture as "the product of multiple goal-directed interactions between people (psychological), jobs (behavioral) and the organization (situational)". Safety culture is viewed as a component of corporate culture that affect and influence health and safety via individual, job and organizational characteristics (Cooper, 2000; Fernández-Muñiz et al., 2007). Generally, its broad term refers to those key components in the organizations that matter to safety, as well as the way employees perceive and behave toward safety (Pessemier, 2012).

Table 2.4 presents various definitions of safety culture adopted by Cooper (2000) and Wiegmann et al. (2004), in which some commonalities among these definitions are addressed.

Unlike safety climate which basically focuses on the perception, attitudes, and feeling of employees toward safety in the workplace (Zohar, 1980), the commonality of safety culture definition is rather covered the degree to which individuals and groups within the organization have shared same values, norms, beliefs, and behaviors toward safety which can maximize the level of safety in the workplace. It also includes the level of commitment to take personal responsibility for safety, act and behave in the safe manner as part of daily routine (Wiegmann et al., 2004).

Table 2.3 Definitions of Safety Culture

Source	Definition
ACSNI (1993)	"The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management"
Carroll (1998) (Nuclear Power, US)	" a high value (priority) placed on worker safety and public (nuclear) safety by everyone in every group and at every level of the plant. It also refers to expectations that people will act to preserve and enhance safety, take personal responsibility for safety, and be rewarded consistent with these values"

Table 2.3 (Continued)

Source	Definition
CBI (1991)	“ the ideas and beliefs that all members of the organizations share about risk, accidents and ill health”
Ciavarelli & Figlock (1996)	“as the shared values, beliefs, assumptions, and norms which may govern organizational decision making, as well as individual and group attitudes about safety”
Cox & Flin (1998)	“the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’ s health and safety management”
Fernández-Muñiz et al. (2007)	“a set of values, perceptions, attitudes and patterns of behavior with regard to safety shared by members of the organization; as well as a set of policies, practices and procedures relating to the reduction of employees' exposure to occupational risks, implemented at every level of the organization, and reflecting a high level of concern and commitment to the prevention of accidents and illnesses”
McDonald & Ryan (1992	“ the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers, and members of the public to conditions considered dangerous or injuries”

Table 2.3 (Continued)

Source	Definition
Mearns, Flin, Gordon, & Fleming (1998)	“ the attitudes, values, norms and beliefs which particular group or people share with respect to risk and safety”
Pidgeon (2001)	“ a set of assumptions, and their associated practices, which permit beliefs about danger and safety to be constructed”
Turner (1989)	“ the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered
UK Health and Safety Commission (1993)	“the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health & safety programs”

Source: Cooper, 2000, p. 113; Wiegmann et al., 2004, p. 122.

Since safety culture is considered as one of a sub-culture of several existing organizational cultures, many research attempts to define safety culture based on how general organizational culture is defined. One commonly referenced definitions of organizational culture found in most literature is “ shared values and beliefs that interact with a company’ s people, organizational structures and control systems to produce behavioral norms” (Uttal, 1983). The organizational culture of Uttal centered around the notion that existing shared values, beliefs and norms of members shall determine particular culture. However, Schein (1990, p. 111) viewed that culture is “a pattern of basic assumptions” that formed within particular place by particular group of people as a way to solve particular problems and once it works well enough, it will be taught to all members as the way to perceive, think, feel and act in relation to those problems. The term of safety culture was formed and acknowledged due to the disaster of Chernobyl eruption in 1986. The post Chernobyl's accident meeting addressed that the lack of safety culture was the major cause of such accident (IAEA, 1986). With the case of Chernobyl, low level of safety management and weak safety culture were the critical problems that many organizations need to pay attention in order to securely manage their workplaces. Hence, the appropriate assumptions that can solve the safety problems are essential influences for establishing safety culture. Based on this scenario, certain assumptions are underpinning the way safety culture should be defined. Therefore, safety culture in this study will be defined based on the notion of Schein (1990), that is: "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, 2010, p. 4).

2.3.2 The Concept of Safety Culture

After the disaster of Chernobyl nuclear power plant in 1986, the term of safety culture has been raised and rapidly gained attention within industrial management (Glendon & Stanton, 2000). At the first stage, the term of culture was not developed from organizational culture theories but merely used to explain the phenomenon in which employees and management show dedication and accountability of any activity that concern with safety in nuclear power plant (Choudhry, Fang, & Mohamed, 2007). An increased interest in safety culture is due to it helps reducing the number of accidents in several organizations. In an organization where safety is addressed as a priority, employees are encouraged to perform their duties with strong safety mindset (Wiegmann et al., 2004). In addition, creating an atmosphere that encourage employees to be aware of their occupational risks and avoid unsafe acts in the workplace is the key objective of positive safety culture implementation (Fernández-Muñiz et al., 2007).

In general, culture can be identified into three conceptualizations as the normative, anthropological and pragmatist (Edwards et al., 2013). The normative concept underlying the notion that "culture is the knowledge of the best that has been said and thought" (Arnold, 1993 as cited in Edwards et al., 2013, p. 72) assuming that culture consists of a set of norms. The anthropological concept refers to the overall way of life (i.e. beliefs and attitudes) that have been shared within its community. This conceptualization of culture is dominant in culture literature. The pragmatist conceptualization of culture, on the other hand, based on practice theory which an attempt to understand behavior. It refers to the routine or things that have been carried out repeatedly overtime (Edwards et al., 2013).

Safety culture is viewed as a component of organizational culture where its focus at the organization characteristics that affect individual's health and safety while working (Cooper, 2000; Fernández-Muñiz et al., 2007) and considered as a multidimensional concept, however there is still a lack of consensus in its structure and content (Fernández-Muñiz et al., 2007). However, many research attempts to explain safety climate as another form of safety culture, and both terms are used interchangeably (Berends, 1996). According to Sutherland, Makin, and Cox (2000, pp. 34-35) the term safety climate refers to "the sum of individual perceptions of the organization", while safety culture, on the one hand, is seen as "a group phenomenon, the expression of strongly held norms, consisting of shared beliefs and values". Cooper (2000, p. 120) establishes the model to analyze safety culture in the organization based on the previous work of Bandura's reciprocal determinism and named it "reciprocal safety culture model". There are three important dimensions in the mode identified as 1) person - measured by safety climate scale, 2) situation - measured by safety management system audit, and 3) behavior - measured by safety behavior scale. Therefore, according to Cooper (2000), the elements of organization's safety culture are the set of attitudes, perceptions and beliefs of employees, as well as, employees' behaviors and the safety management systems. Cooper's safety culture model, thus, obviously distinguish safety climate from safety culture and confirms its difference in concept but they are inter-related as the safety culture cannot be effectively implemented without existence of positive safety climate.

In congruent with Cooper (2000), Guldenmund (2000) differentiated safety culture and safety climate based on the work of Schein's organizational culture (1990). While there are three levels of organizational culture (i.e. basis assumptions, espoused values and artefacts), the author found that the level of espoused values composed of employees' attitudes which also aligned with the concept of safety climate. Thus, safety climate is seen as one part in the whole culture.

The International Nuclear Safety Advisory Group or INSAG revealed that safety culture is a top-down process as senior management is a key person that is very important to the development of safety culture in organization. Official policies and organizational objectives regarding safety are also found to be a critical indicator of organizational safety culture (INSAG, 1991 as cited in Short et al., 2007).

Establishing safety culture is an approach to improve safety management as it provides a great support on accident reduction within the organizations (Fernández-Muñiz et al., 2007). Fernández-Muñiz and colleagues have developed key dimensions of safety culture and use the instrument to identify the area where safety can be improved within the workplace. The result of their study also posits that management plays a great role in term of promoting employees' safe behaviors, thus these managers need to have strong commitment to, as well as, involved in safety programs.

An organization with a safety culture in place provides deep concern for employee well-being. In order to concrete the safety culture, the firms need to stand for safety as a corporate's core values and shall define set of safety policy and procedures accordingly. Appropriate trainings are required as a mean to maximize safest operations. Essential information regarding to occupational risks exposure as well as preventive and corrective actions should be well communicated to all employees. In addition, adequate incentives may be used to encourage employee to strongly involve in all safety activities in the workplace. At the very end, the workers are aware of the importance of safety which leading them to comply with safety regulations and participate in all safety activities (Fernández-Muñiz et al., 2007).

2.3.3 Measuring Safety Culture

Traditionally, organizational culture and other sub-culture are measured through the application of qualitative methods such as observations and interviews (Cooper, 2000). However, such qualitative methods consume both time and effort. These days, safety culture is usually measured by using survey questionnaire to assess the perceptions and attitudes of individual employees (Gordon et al., 2007), and the individual scores will be aggregated to generate the score of organization which in turn represent the safety climate and safety culture level (Sutherland et al., 2000, p. 497). The safety culture measurement is claimed to provide an "early warning" of safety system failure possibility (Cooper & Phillips, 2004). Hayes et al. (1998) developed the work safety scale to assess employees' perception toward work safety. The 50-item instrument consists of five constructs 1) job safety, 2) coworker safety, 3) supervisor safety, 4) management safety practices, and 5) satisfaction with the safety program. This instrument was used as a predictor of workplace accidents and compliance with safety behaviors, and the result reported that management safety practices and supervisor safety subscales were found to be the best predictors of accidents, job satisfaction, and compliance with safety behaviors.

Cooper (2000) reveals that the three main dimensions of organizational culture (i. e. psychological, situational and behavioral) can be measured through a combination of quantitative and qualitative methods. The situational dimension refers to policies, procedures, management system which are often measured by both internal and external auditing. The behavioral dimension refers to the way people act and reflect on safety issues which can be measured through observations and self-reporting. The psychological dimension refers to the employees' perceptions on particular issue, this dimension is equivalence to safety climate, thus often be assessed through the use of safety climate assessment questionnaires. Thus, according to Cooper, only one certain measurement cannot fully assess the safety culture, but it requires a combination method.

Cox and Cheyne (2000) carried out the research to develop generic safety culture assessment as a tool to improve safety performance in UK offshore organizations. The authors developed safety climate and culture questionnaires based on intensive focus groups and extensive literature reviews, resulted in nine constructs; 1) management commitment, 2) priority of safety, 3) communication, 4) safety rules, 5) supportive environment, 6) employees' involvement, 7) personal priorities and need for safety, 8) personal appreciation of risk, and 9) work environment. The questionnaire was distributed and tested with 350 employees of three offshores in UK with Cronbach's alpha around .70.

Grote and Künzler (2000, p. 136) argued that existing model of safety culture were not well integrated. The authors further developed measurement model based on sociotechnical approach to serve as part of safety management audits and used it to diagnosis organizational safety culture. Three key elements were drawn in this model; 1) proactiveness – refers to an integration of safety in organizational structures and processes, 2) sociotechnical integration – refer to joint optimization of technology and work organization aiming at the control of disturbances at their sources, and 3) value consciousness – refer to norms related to sociotechnical design principles like automation philosophy and beliefs concerning trust and control. The final questionnaire composed of three sets of items; 1) operational safety with total of 20 items include organizational, technical, person-related safety measures, together with actual safety performance, 2) safety and design strategies with sixteen pairs of forced-choice statements e.g. "employees are motivated for safety by information and interesting tasks vs. employees are bound to safety by strict control", 3) personal job needs with total of 21 items assessing employee's need for good job performance, training, and quality of job design. The questionnaire was tested in six global petrochemical organizations, five in the US and one in the UK.

On the other hand, Flin (2007) addressed that safety climate survey is a mean to assess underlying safety culture. The author proposed model of safety climate with the intervening mechanism of motivational component on unsafe behaviors. The assumption portrays the errors as a consequence of employees' unsafe actions.

Fernández-Muñiz et al. (2007) have identified the key indicators of safety culture as management commitment to safety, employees' involvement, and safety management system. Assessing organizational safety culture is not about have or not have a safety culture in place, but it goes deeper as whether safety norms and beliefs are shared within and between groups, as well as the determination of relationship between these safety norms and safety performance (Grote & Künzler, 2000).

Clarke (2006b) performed meta-analytic study to examine the criterion-related validity of the relationships between safety climate, safety performance, and occupational accidents. These safety climate measures serve the purpose of evaluating employee perceptions toward organizational safety, which also widely acknowledged as an important tool to assess safety culture as well (Flin et al., 2000).

Table 2.4 shows variety of safety climate studies and its association with safety performances using meta-analysis approach (Clarke, 2006b). It can be noticed from Table 2. 4 that manufacturing sector was the most popular area of studying among various sectors in previous research. Construction, nuclear powerplant and off-shore installations were also received great attention for researchers' investigation. Only few studies were conducted in the field of logistics and transportation business where drivers are perceived as high-risk occupation, and they are one of the key positions that really drives this type of business.

Table 2.4 Review of Safety Climate Study

Authors	Measures	Outcome Measure	Industrial Secotr	Sample
Barling et al. (2002)	Safety climate (Zohar, 1980)	Injuries (self-report frequency scale)	Service sector in Canada	Restaurant workers
Brown & Holmes (1986)	Safety climate (Zohar, 1980)	Accident over previous year	Manufacturing in US	Production workers
Clarke (2006)	Safety climate (based on OSQ)	Accident history at work	Manufacturing in UK	Assembly line workers
Cree & Kelloway (1997)	Percetions of safety attitudes (developed for this study)	Accident (self-report frequency scale)	Manufactoring in Canada	Prodiction workers in plastic plants
DeJoy et al. (2004)	Safety climate (DeJoy et al. 1995)	Safety participation	Retail sector in US	Employees in large retailers
Donald & Canter (1994)	Safety attitude questionnaire (Donald & Canter, 1993)	Accidents	Chemical processing in UK	Workers
Garavan & O'Brien (2001)	Safety climate (Zohar, 1980; Dedobbeleer & Beland, 1991)	Accident history	Manufacturing in Ireland	Manufacturing workers
Gillen et al. (2002)	Safety climate (Dedobbeleer & Beland, 1991)	Injuries (from record)	Construction in US	Construction workers

Table 2.4 (Continued)

Authors	Measures	Outcome Measure	Industrial Secotr	Sample
Goldenhar et al. (2003)	Safety climate (DeJoy et al., 1995)	Compliance Injuries (self-report frequency scale)	Construction in US	Construction workers
Griffin & Neal (2000)	Safety climate (developed for this study)	Compliance Participation	Manufacturing and mining in Australia	Front line workers
Hayes et al. (1998)	Work safety scale (developed for this study	Accident (self-report) Compliance	Various sectors in US	workers
Hofman et al. (2003)	Safety climate (Zohar, 1980)	Participation	Military in US	
Hofman and Stetzer (1996)	Safety climate (Zohar, 1980)	Accidents (injuries record in previous year)	Chemical processing in US	Manager, workers and administrators
Huang et al. (2006)	Safety climate (developed for this study)	Injuries (self-report)	Various sector in US	Employees
Huang et al. (2013)	Safety climate (developed for this study)	Injuries	Trucking	Truck drivers
Lee (1998)	Safety attitudes (developed for this study)	Accidents (self-report accident history)	Nuclear in UK	Station employees

Table 2.4 (Continued)

Authors	Measures	Outcome Measure	Industrial Secotr	Sample
Lee & Harrison (2000)	Safety attitudes (based on Lee, 1998)	Injuries (self-report accident history)	Nuclear in UK	Station employees
Mearns et al. (1998)	Offshore risk perception questionnaire (Mearns et al. (1996)	Accident (self-report in previous 2 years)	Offshore oil and gas in UK	Supervisor and workers
Mearns et al. (2003)	Offshore safety questionnaire (OSQ; Mearns et al., 2001)	Accident/injuries (record and self-report)	Offshore oil and gas in UK	Supervisor and workers
Michael et al. (2005)	Safety climate (Zohar, 1980)	Injuries (from record)	Manufacturing in US	Workers in wood products
Morrow & Crum (2004)	Safety climate (Zohar, 1980)	Accident (self-report over previous year)	Road haulage in US	Drivers from road haulage firms
Neal et al. (2000)	Safety climate (developed for this study)	Compliance Participation	Hospital in Australia	Employees
Neal & Griffin (2006)	Safety climate (Neal et al., 2000)	Participation & Compliance Accidents	Hospital in Australia	

Table 2.4 (Continued)

Authors	Measures	Outcome Measure	Industrial Secotr	Sample
Oliver et al. (2002)	Safety climate (based on Thomas & Oliver, 1995, and Cheyne et al., 1998)	Accidents	Various sectors in Spain	Workers in dangerous occupations
Probst (2004)	Perception of organizational safety climate (Neal et al., 2000)	Accident/injuries in past year	Manufacturing in US	Production workers
Prussia et al. (2003)	Safety climate (developed for this study)	Compliance	Manufacturing in US	Operators and managers
Siu et al. (2004)	Safety attitude questionnaire	Accident/injuries (self-report)	Construction in China	Workers
Williamson et al. (1997)	Safety climate (developed for this study)	Accident	Manufacturing in Australia	Workers in plant and outdoor workers
Zacharatos et al. (2005)	Safety climate (Neal et al., 2000)	Compliance Participation	Petroleum and Telecommunications	Employees

Table 2.4 (Continued)

Authors	Measures	Outcome Measure	Industrial Secotr	Sample
Zohar (1980)	Safety climate (developed for this study)	Injuries	Manufacturing in Israel	Workers
Zohar (2000)	Group safety climate (developed for this study)	Injuries	Manufacturing in Israel	Workers
Zohar (2002)	Group safety climate (Zohar, 2000)	Injuries	Manufacturing in Israel	Production workers
Zohar & Lauria (2004)	Group safety climate (Zohar, 2000)	Injuries	Military in Israel	Infantry soldiers

Source: Adapted from Clarke, 2006.

Table 2.4 also indicates the repeated safety climate measures that have been empirically used in the past studies. Among all these measures, safety climate developed by Zohar in 1980 was the most popular. Great deals of research used and adopted Zohar's measure in their own work. Safety climate has been considered to use for evaluating employees' perception toward safety issues in the organizations. These types of measure can assess both personal aspect and situational aspect as addressed in Cooper's safety culture model (2000). Therefore, Table 2.5 provides key safety climate measures that beneficial for safety culture assessment development in this study. In order to cover all of the three aspects addressed in Cooper's safety culture model (2000), this study will apply the existing work of safety climate measures in conjunction with safety performance measures which addressed the behavioral aspect in Cooper's model.

2.4 Theoretical Foundation of Safety Cultures: Swiss Cheese Model

Social culture research has been carried out through various disciplines (i.e. social and organizational psychology, organizational culture, business and management, and the like) resulting in differences in conceptualization of its structure. Different organizations tend to have different nature of safety and associated risks and hazards depending on the work and industrial characteristics. However, the term safety is more universal as it can be understood as a condition or stage of being free from danger, risk and harm (Edwards et al., 2013). It is essential to identify the key components in the context of organizational safety culture through the explanation of safety related theories and models. Accident causation theories and models are widely used as an attempt to explain how and where accidents can be occurred and prevented. This study will apply Reason's Swiss Cheese Accident Causation model as a guideline framework to develop the measurement model of safety culture for Thai trucking industry, using truck drivers as exemplar.

2.4.1 Concept of Swiss Cheese Model

Swiss Cheese accident causation model - one of foundational safety principles - has been developed by the cognitive psychologist, James Reason, widely used in risk analysis and accident investigations in various industries especially aviation, engineering, power plants, and healthcare. In contradiction to Heinrich's classic Domino Theory (Gambatese & Aiomari, 2016) which attempt to explain that accidents are a result of unsafe conditions and individual errors, Reason's accident causation model, widely known as 'Swiss Cheese Model' has been developed to provide insightful reasons behind the human errors (Guo, Yiu, & González, 2016). Reason (1997) proposes two kinds of accidents based on the unit level of impact: individual accidents and organizational accidents. The shift from micro level; individuals, to focus at the macro level; organizations provides the new view on accident analysis (Guo et al., 2016). The impact and consequences to individual may be great, but the spread of impact is limited. In contrast, the consequences of organizational accidents may have devastating effects on uninvolved people, properties, assets and the environment as a whole (Reason, 1997).

Due to its complexity setting involving many people operating at different functions in organization, there are various causes influencing the organizational accident occurrence. In contrast with the idea that there are no underlying principles of accident causation, Reason beliefs in existence of such principles and put his effort to study and understand the exact causes of organizational accidents.

Reason (1997) has developed the basic assumption on accidents causation model as in Figure 2.2. The Figure 2.2 determines the relationship between three important elements of hazards and dangers, defenses and losses. Every organization require various forms of defensive protection to deprive the endangering of possible hazards. Therefore, organizational accidents derive from breaching these defensive barriers, and further damaging people and organizational assets which can be identified as losses. The intensity of protection can be varied from organization to organization. The more complex and extensive manufacturing operations, the higher the risk and hazards level may be addressed. On the other hand, the low-risk enterprise may require loosely protection in its operations. In the ideal world, the production and protection should be treated equally, however it rarely happens in reality as the priority in every business target in increasing productivity and profitability.

Many managers understand the importance of protection and agree that production and protection should be well managed together for the long-term management, somehow the conflicts may occur often on a daily basis, especially when the managers and supervisors have to make decision and choose whether they should drop the level of safeguard over the aim at achieving operational deadlines or other demands. When the short-cuts have been taken and no bad effects occur for a lengthy period, the level of protection is gradually dropped and such short-cuts become part of their working routines, which finally develop some undesirable habits on safety. Neglecting the defensive protection is then likely to increase risks and chance for hazards to be exposed as illustrated in Figure 2.2.

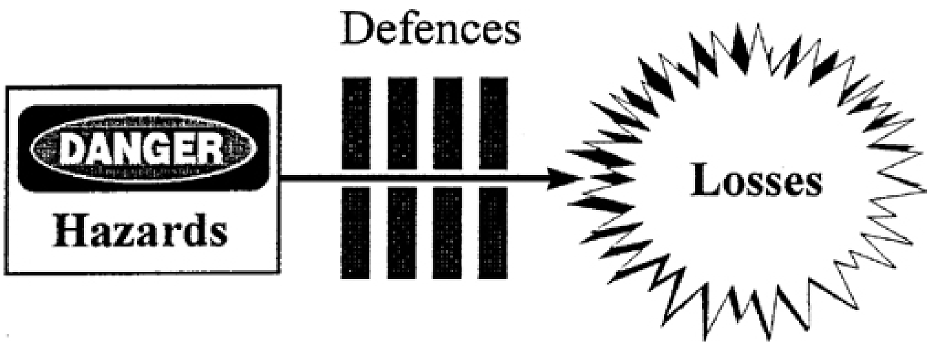

Figure 2.2 The Relationship Between Hazards, Defenses and Losses

Reason (1997) refers the term defenses as a various mean of ensuring the safety of people, properties and assets. He explains:

> All defenses are designed to serve one or more of the following functions: 1) to create understanding and awareness of the local hazards, 2) to give clear guidance on how to operate safety, 3) to provide alarms and warnings when danger is imminent, 4) to restore the system to a safe state in an off-normal situation, 5) to interpose safety barriers between the hazards and the potential

losses, 6) to contain and eliminate the hazards should they escape this barrier, and 7) to provide the means of escape and rescue should hazard containment fail. (Reason (1997, p. 6).

The above defensive functions can be successfully achieved through a mixture of both hard and soft applications. Reason (1997) identifies hard defenses as a protective object such as new technology, safety features in technical equipment, protective equipment, and improved system design. While the soft defenses term relies on a combination of people and documents (e.g. safety rules and regulations, safety procedures and manuals, safety training, safety controls, licensing, certification, supervisory monitoring, management commitment and values and front-line operators' safety behaviors).

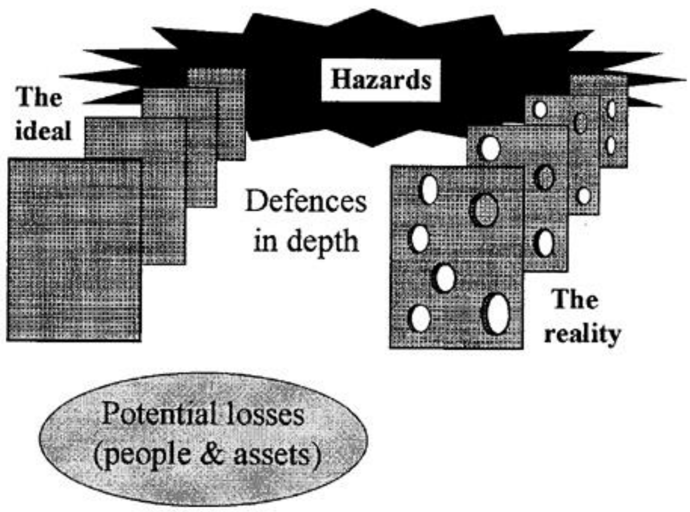

Figure 2.3 The Ideal and the Reality for Defenses-In-Depth

Reason (1997) propose that all the defensive shields in each layer in the ideal world would be inviolate, preventing harm from possible dangers and hazards, and thus no losses and accidents happen. Nevertheless, each layer appears to have weaknesses in reality, represents by the holes in Figure 2.3. Moreover, the layers and holes in the defensive shields are not fixed and static, they are moving around in and out of the frame, the size of the holes can be smaller or even greater in response to organizational demands and level of intensity operations.

2.4.2 Accident Causation in SCM

With an attempt to understand the creation of the holes in each defensive layer, Reason (1997) introduces two important terms that are essential for explaining the 'holes creation' phenomenon, that is -- active failures and latent conditions.

"Active failures" (Reason, 2000, p. 769) are referred to those errors and violations committed by human which in turn provide immediate negative consequences in particular working situation. The concept of active failures of Reason (2000, p. 768) is consistent with the notion of "human error" in many accident causation theories and models (e.g. Domino Theory), indicating that individual as a human being is a major cause of most accidents. When an accident happened, the worker who involved in the accident scenario will immediately be blamed for being careless, inattentive, incautious and so forth. The active failures by far has seen as a "symptom of defective systems".

Unlike the active failures, Reason (2000, p. 769) points that there are also some external factors driven human error toward accidents for example, the management's value, the organizational policies and procedures, professional standards, poor communication. These forces were named as "latent conditions" or 'latent failures' as they might or might not generate immediate effect to an accident, but create the long-lasting accumulative weakness in the layers. This latent conditions are seen as hidden factors, if they are undiscovered or uncorrected, could contribute to a great number of accidents (Reason, 1997).

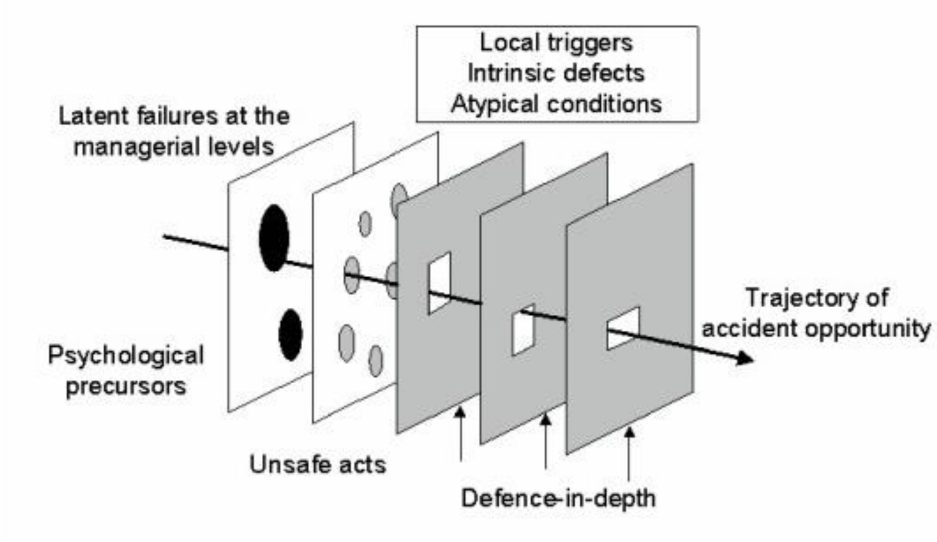

Figure 2.4 The Dynamics of Accident Causation: The Barriers

Figure 2.4 explains that when the holes in each layer are aligned, representing the failures in each defensive dimension. Chances that possible hazards can pass through these weak defenses, leading to the occurrence of undesirable accidents.

The concept of active failure and latent conditions in Swiss Cheese model underpins the principal stages in the development of organizational accident as illustrate in Figure 2. 5. This first model explained the linkage amongst various interrelated elements, running bottom-up and top-down in analysis (Reason, 1997). There were three principal stages in the model, start with organizational factors that influence the occurrence of accidents (e.g. strategic decisions, tight budgeting, scarce of resources, planning, communicating, and the like). This first stage concern with the way the organization value and run the business.

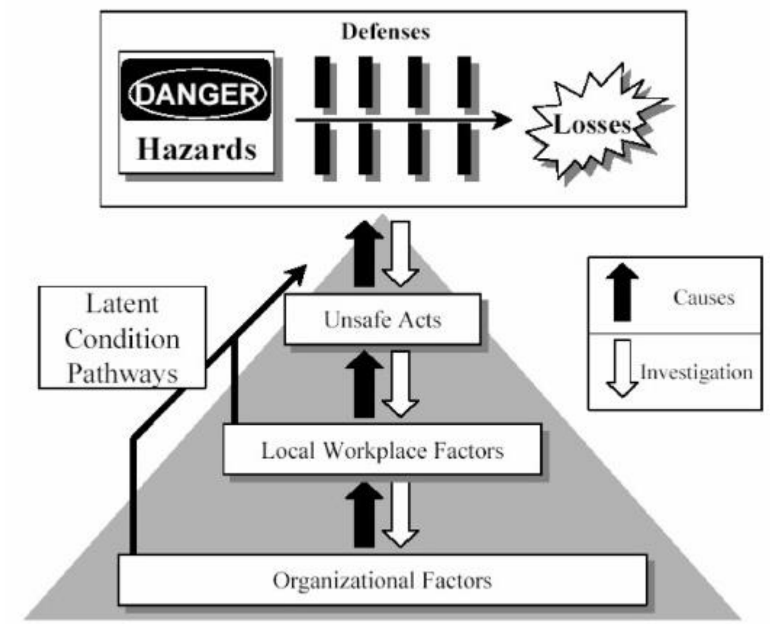

Figure 2.5 The Factor Level of Accident Causation

The result of first stage' s activities is then communicated to individual divisions and departments within the organization, determining a condition pathway for workers to follow. The local workplace comprises of number of individual workers who have a tendency to conduct either unintentional or intentional unsafe acts (Reason, 1997).

Reason (1990) identifies the basic elements that are common in all productive systems as: (a) decision makers, (b) line management in each department, (c) preconditions (e.g. knowledge and skill, reliable equipment, health condition), (d) productive activities between human and machines, and (e) defenses (e.g. safeguards to prevent injury).

According to Reason's framework of systems accidents, "the fallible decision" (Reason, 1990, p. 202) from top management is seen as a primary reason behind the incident, and can be categorized under organizational factors in Figure 2.5. The consequences of fallible decisions are cascaded to different line managers in local workplaces. Reason distinguish line management out of the high-level management, as they may propose certain competency to mitigate the unsafe effects of fallible decisions, which results in safer consequences. However, the deficiencies in line management level for example, ineffective training department may lead to variety of preconditions (e.g. workload, less awareness in safety and perception of hazards, and ignorance of safety system). The preconditions or psychological precursors for unsafe acts are also identified as latent failures in Swiss Cheese Model. It is described as "a complex function of the task being performed, the environmental influences and the presence of hazards" (Reason (1990, pp. 205-206). However, it should be noticed that not all precursors of unsafe act are consequence from fallible decisions, as many of these usually involved directly with human conditions, for instant: being fatigue, being stressed and failing to perceive hazards and dangers all around. Next is unsafe acts in which Reason defines it as an "errors or violations committed in the presence of a potential hazard: some mass, energy or toxicity that, if not properly controlled, could cause injury or damage". Unsafe acts involve unintended action and intended action as shown in Figure 2.6.

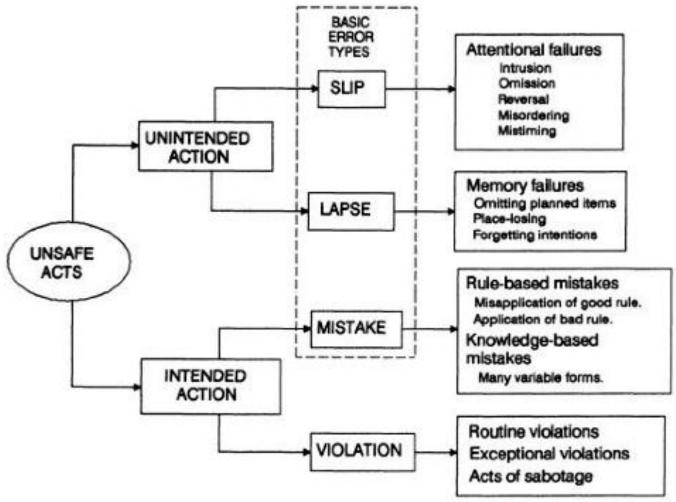

Figure 2.6 Summary of the Psychological Varieties of Unsafe Acts

The failure from organization perspective may consist of inadequate, incomplete or even non-existing of safety policy and procedures. And usually when the term organizational level has been proposed, it involves top management in this particular domain (Reason, 1998; Van der Schaaf, 1995).

The model was also implemented for train accident investigation in Indonesia, in which each layer of Swiss Cheese Model will help developing the overall understanding about train system and train-related accidents in the country (Suryoputro, Sari, & Kurnia, 2015). Short and colleagues state in their book regarding the role of safety culture in commercial motor carriers that Swiss Cheese model is essential for outlining the cause of vehicle crash through descriptions of each safety barriers breakdown, which represent by the hole in each defensive layers of the model (Short et al., 2007). The authors also point that Reason's Swiss Cheese model for motor carrier industry engage with three key barriers 1) defensive driving training, 2) vehicle maintenance, and 3) highway safety practices. When the holes or deficiencies in each barrier are aligned, a crash will occur. Suggestion from this theory is to engage people to learn how to close the holes in Reason's Swiss Cheese Model (Short et al., 2007).

Despite its popularity used of this model, Swiss Cheese model has gone under criticism by many researchers and practitioners as it is too simple concept and too abstractive (Li & Thimbleby, 2014). Some critics have argued that the Swiss Cheese model offers a simple linear approach to accident investigation which focus on human error study and attempt to trace back from active errors caused by human to identify the hidden organizational system failures without acknowledging the complexity of systems, organizational structures, industries and likewise (Carthey, 2013).

Since the publication of Human Error, Reason's Swiss cheese model has been adopted by a number of high-risk industries. Along with commercial aviation, it has become a key source of guidance in hospitals and nuclear power plants (Ahmad & Pontiggia, 2015). Unfortunately, outside of these high-profile industries — where human life is on the line — the Swiss cheese model is relatively unknown.

2.5 The Development of Safety Culture Framework

The SCM creates the new paradigm on human error as Reason (1980) claims that human error is seen as symptom of system failures, not a direct cause of the accident. the accidents are possibly derived from specific failure domains; organizational factors, supervision factors, preconditions and specific unsafe acts.The distinction between active and latent failures has strongly influenced efforts to understand the causes of error and incident investigation for the last two decades, both in healthcare and other industries (Carthey, 2013). Establishing strong and positive safety culture is beneficial to the reduction of accidents and injuries and to enhance safety level in the workplace. Thus, creating safety culture is centered around the assumptions that bring the best to minimize the opportunity for risks exposure and accident occurence. In order to achieve this aim, the organization should pay a great deal of attention on these four specific failure domains in SCM as they indicate the area of weakness in regard to safety and its management. Therefore, the four specific domains in SCM will be applied to form safety culture framework in this study.

2.5.1 Organizational Support for Safety

Based on the concept of SCM (Reason, 1980), organizational failures have a tendency to promote unsafe behaviors of employees. Many studies in safety literatures also exhibit the importance of top management and organizational characteristics on safety culture development. Therefore, in order to establish safety workplace or safety culture, the area of what is going on in the organizational aspect cannot be overlooked. The concept of organizational support for safety and key constructs will be elaborated as follow.

2.5.1.1 Concept of Organizational Support for Safety

According to SCM framework (Reason, 1990), accidents or unsafe outcomes are a consequence of organizational failures. These organizational failures were categorized into the organization factors in SCM (Reason, 1980), while Shappel and Wiegmann (2000) renamed it to organizational influences. This level of failures is one of the four failure dimensions exhibited in SCM (Reason, 1980). Reason elaborated that the organizational failures are latent errors found in organization which at certain point and time can influence people to commit unsafe acts. Reason (2000, p. 173) stated that “while operators can, and frequently do, make errors in their attempts to recover from an out-of-tolerance system state, many of the root causes of the emergency were usually present within the system long before these active errors were committed”. He refers organizational factors to people in top positions or known as top-management. These people are usually a policy maker as well as a decision maker. Their values, beliefs and commitment determine the direction of entire organization. He pointed that workers are not the main initiator of an accident but the servant of system defects. Such system defects are a product of, for example, poor design, bad management decision, poor maintenance and the like at organizational level.

Ahmad and Pontiggia (2015) revealed that accidents were a result of number of latent errors that mainly associated with specific organizational characteristics, thus the organizational characteristics had an influence on organizational safety outcomes. Reason (1990) initially identified organizational factors that influence the likelihood of workplace accidents as the management decision, as well as their attitudes and commitment on safety. Fallible decision in regard with safety issues may create negative consequences to overall workplace safety and may impact employees' well-being. Shappel and Wiegmann (2000) developed the Human Factors Analysis and Classification System (HFACS) based on the work of SCM, they elaborated that insufficient resource management (i.e. no budget for safety training), inappropriate organizational climate (i.e. top-management shows no commitment and values for safety) and organizational process (i.e. ineffective communication process) are key concerned factors that may impact workplace safety under organizational dimension.

A great deal of research emphasizes the need to engage top management in safety culture startup. However, the term organization factors in SCM (Reason, 1980) or organizational influences in HFAC (Shappel and Wiegmann, 2000) only refers to the broad area where latent failures may exist, but still lacking the ability to be an indicator for safety culture. It is important to refine the term that reflect the essence of organizational dimension toward safety culture development through extensive work on other organizational studies.

The notion of organizational factors as an influence to workplace safety, can also be further elaborated by organizational support theory. The organizational support theory proposes that "employees form a generalized perception concerning the extent to which the organization values their contributions and cares about their well-being" (Kurtessis et al., 2017, p. 1854). Organizational support theory is similar to social exchange theory as it explain employee-organization relationship, assuming that individual employee will fully contribute their time and effort with positive work-related outcomes in exchange for "valued resources" provided by employer (Michael et al., 2005, p. 173). In this sense, Eder and Eisenberger (2007, p. 55) summarize the concept of organizational support as to the degree to which "the employee–organization relationship is strengthened through the trade of positive outcomes between employees and their organization". Employees begin to form their beliefs toward how much the management values them and their well-being. Recent research on organizational support theory provides evidence that employees' perception on organizational support have an impact to several employee outcomes for example, increase job satisfaction, negatively related with turnover intentions, relate to safety communication, safety commitment level as well as decrease number of accidents in the workplace (Michael et al., 2005).

The study of Mearns and Hope (2005, as cited in Mearns & Reader, 2008) indicates the strong relationship between perceived organizational support and organizational commitment, as well as the level of unsafe behavior. When employees perceive high organizational support for their health and well-being, it leads to an increase in organizational commitment and lower level of unsafe behavior. (Mearns & Reader, 2008) affirm that high level of organizational support reflecting care and concern for employee's well-being can increase safety citizenship behavior as employees show willingness to report dangers at work and assist coworkers on safety matter. Research also suggests that safety climate will be improved if employees feel that their management values and acts upon a commitment to their safety (Michael et al., 2005).

Many research on safety culture and climate structure show some commonalities at the organizational level, the most common one is management commitment (Huang et al., 2013b; Zohar, 1980; Zohar & Luria, 2003). The rest are effective communication (Mearns et al., 2003; Zohar, 1980), participative management, organizational learning (Thompson, Hilton, & Witt, 1998), management attitudes (Cooper & Phillips, 2004), management values (Neal et al., 2000), safety policy and procedures created by top management (Cooper, 2000), resource management (i.e. safety training and management support) (Ostrom, Wilhelmsen, & Kaplan, 1993; Zohar, 1980). These characteristics of safety culture constructs are congruent with characteristics of organizational support. For example, the study of Neves and Eisenberger (2012) suggest that management communication is a message showing that organization cares about their well-being. Along with Michael and colleagues' study (2005), they exhibit the degree of top management commitment as a cursor to measure employee perceived organizational support on non-safety outcomes. Therefore, this present study shall follow the concept in organizational support theory together with evidences from existing studies on safety culture constructs to refine the term organizational factors as exhibited in SCM into organizational support for safety.

2.5.1.2 Constructs of Organizational Support for Safety

There are several safety culture constructs emerged under the category of organizational support for safety. Many research on safety culture and climate structure show some commonalities at the organizational level, the most common constructs that frequently found in great number of existing research are: management commitment (Huang et al., 2013b; Zohar, 1980; Zohar & Luria, 2003), management safety practices such as safety system, safety rules and regulations and safety training (Ostrom et al., 1993; Zohar, 1980). This present study shall follow the evidences in previous literature by focusing on these two main areas as an indicator for organizational support for safety.

Top managements have an important role in shaping and directing the whole organization. They are the key persons who shape the values in organization (Tzempelikos, 2015). Numbers of literature exhibit that top management commitment is a necessary condition behind successful implementation for all kind of organizationa processes and projects. Tzempelikos (2015, p. 33) refers the term top management commitment as "the demonstration of top management's beliefs in the implementation of event". Barling and Frone (2004, p. 27) defined management commitment to safety as "the extent to which management is perceived to place a high priority on safety, and communicate and act on safety issues effectively".

In safety literature, management commitment to safety has a tendency to influence safety-related outcomes as well as promote the level of workplace safety (Michael et al., 2005). Many research evidences prove that employee perception toward 'management commitment to safety' appear to be a stable construct of safety climate regardless of industry differences (Hayes et al., 1998; Williamson, Feyer, Cairns, & Biancotti, 1997; Zohar, 1980). Tam and Fung (1998) also point that many accidents in the workplace are due to the negligence of management. Thus, management commitment and support are important to the success of safety program implementation. Many research dispute the issue of little involvement of theory regarding to the development of safety climate measures as well as little consensus on its constructs and dimensions (Williamson et al., 1997). Management commitment is assessed in variety of areas. For example, many research emphasize on the act of top management toward particular subject, whether or not top management participates in particular event (Rodgers, Hunter, & Rogers, 1993). In highly safety firm, management is actively involved and participated in safety management and creates general administrative to support and control climate (Zohar, 1980). High top management commitment drives safety initiatives through creating values, goals and systems that leads to improve safety level and overall safety performances (Ahire & O'Shaughnessy, 1998). Previous research indicates the need for top management to exhibit high commitment to safety through several characteristics, for example: their reaction toward safety issues, management concern on safety, value the importance of safety, management activities and actions to improve safety problems, having positive attitudes toward safety and etc (Flin et al., 2000).

Moreover, among commonalities in safety culture constructs, safety training are found to be essential in order to improve the quality of safety and health for employees, that is the organization should consider to invest and institute a comprehensive safety training for employees as a mean to identify possible risks and hazards involved with their jobs (Vredenburgh, 2002). Adequate budget to support employees' training is another key component in organizational support theory. Artis (2007) argued that individual who has limited on-the-job experience and insufficient training tend to have a difficulty recognizing relevant risks and hazards. The author conducted the study to examine the effect of training on organizational support, the result showed that, regardless of what type of training, such safety training increase the level of employee's perception of organizational support.

Several studies on safety climate and culture indicate the importance of safety training as it helps minimizing the accident occurrence within the organization (Artis, 2007; Bentley & Haslam, 2001; Mearns, Flin, Gordon, & Fleming, 1998; Ostrom et al., 1993; Zohar, 1980). In low-accident rate organization, safty-related training is required for new employees, as well as the retraining is usually provided for old employees on a regular basis (Zohar, 1980). The study of Sawacha, Naoum, and Fong (1999) on factors affecting safety performance indicates that good training of operators are strongly relevant to high level of safety awareness and can lead to improve safety in the workplace. In trucking industry, driving safety training is one of the requirement for truck drivers to participate, this training has been noted to predict safety culture (Arboleda et al., 2003). Their study concluded that when safety training was inserted in the studied model, the drivers, dispatchers as well as safety director, all perceived strong safety culture in place. Therefore, safety training is considered to be an essential indicator for assessing safety culture in this present study.

Another common construct found under organizational level was safety rules, procedures and regulations. The role of safety rules have been studied widely across various industries and occupations (Borys, 2012; Hale & Borys, 2013). Great deal of research reveals that safety workplace is a product of encouraging people to comply with organization's safety rules (Borys, 2012). According to the work of Hale, Heijer, and Koornneef (2003, p. 2), they define rules as "a correct or preferred way of carrying out a task in defined circumstances to achieve a defined goal". (Hale & Swuste, 1998, p. 164) define safety rules as "a defined state of a system, or a defined way of behaving in response to a predicted situation, established before the even and imposed upon and/or accepted by those operating in the system as a way of improving safety". Key role of having safety rules and procedures in place is to have a certain safety standard as a guideline in which everyone can follow and comply with. According to organizational culture study, safety rules and procedures are viewed as cultural artifact component in safety culture. Research points that management establishes safety rules and procedures to reinforce safety compliance. Many organizations attempt to control employee behavior with the set of rules and procedures as they believe these will help minimizing number of accidents in the workplace. Without rules, people have a tendency to do whatever it takes to get their job done quickly which leads to the ignorance of safety issues.

Safety rules and procedures become one of the key constructs in various safety climate and safety culture measures (Cox & Cheyne, 2000; Lee & Harrison, 2000; Mearns et al., 1998). Simard and Marchand (1997) posit that safety rules and procedures are one of organizational factors derived from top management which may impact to safety behavior. However, some studies oppose that safety rules and procedures are futile as they bring negative attitudes toward safety (Guldenmund, 2000). Hale and Borys (2013, p. 222) propose two approaches of how work rules can be perceived. The first one is the "top-down approach" which rules are seen as non-dynamic that limit the freedom of choice, and violation of the rules is judged as negative behavior. The second one is the "bottom-up approach" which rules are seen as dynamic as they can be adapted within acceptable degree. This second approach attempts to elaborate that working safely does not associate with working the rules.

Hale et al. (2003) propose the key ingredients for an ideal rules establishment, that is, having rules user to get involved in deciding and evaluating rules, having clear system for monitoring rules compliance, rules must be linked to the tasks or functions as well as having a clear specification of objectives and area where rules will be applied.

Based on the definition of safety culture in this study, the culture is derived from basic assumption that the group learned as it solved its safety problems, and worked well enough to be taught to the new members as the correct way to think, feel, believe and act in relation to those problem. Together with the definition of safety rules and procedures provided by Hale et al. (2003) that rules and procedures are seen as a correct and preferred way employees should carry out to achieve the safety goal, thus safety rules and procedures are considered as important ingredients in this safety culture framework.

2.5.2 Social Support for Safety

According to the second dimension in SCM framework, Reason (1990) identified the departmental areas as another key aspect underlying latent failures. These functional areas are the place where all the operations are taken place. Line managers, supervisors and coworkers support have been said to provide direct impact on individual's performance and behavior.

2.5.2.1 Concept of Social Support for Safety

Reason (1990) exhibited in his SCM model that unsafe supervision was an area concerning the existance of latent failures within particular workplace.

Wiegmann and Shappel (2003) furthered developed the HFACF framework on the basis of SCM, they identified unsafe supervision into, for example, inadequate supervision, inappropriate operation planning by supervisor, as well as other characteristics of supervisor such as failed to correct safety-related problems, and commiting safety violations. The author found that concept of receiving support from people in the work community is congruent with the concept of social support in social science study. So the term social support will be used in this study to represent the departmental level of support.

The definition of support according to Webster's Dictionary is "an act or process that promotes assists, helps or holds up something else". The general definition of social support is "forces or factors in social environment that facilitate the survival or human beings" (Lin, Dean, & Ensel, 1986, p. 17). However, this definition has been argued as it is too broad and not specific enough for research purpose. Lin et al. (1986, p. 18) offered two definitions of social support in their book. The first one was derived from the inductive approach called "synthetic definition" which defined social support as "the perceived or actual instrumental and/or expressive provisions supplied by the community, social network, and confiding partners". According to this type of definition, social support can be seen as attachements among individuals and groups which can "1) promote emotional mastery, 2) offer guidance, and 3) provide feedback about one's identity and performance" (Caplan, 1974 as cited in Lin et al., 1986, p. 21). Cobb (1976, p. 30) proposed three distinct type of social support as 1) emotional support which refers to the degree to which one is care for and loved, 2) esteem support refers to the tendency one is valued and esteemed, and 3) network support that refers to the feeling one belong to the group. The second definition developed from deductive approach using social resource theory as a foundation for creating such definition. According to deductive approach, social support has been defined as "access to and use of strong and homophilous ties", which was argued to be rich in theoretical ideas but provide lesser degree of fit with empirical data as the synthetic definition could offer.

Number of research in social support usually involved a lot in health care studies and psychological studies (Allgower, Wardle, & Steptoe, 2001; Hefner & Eisenberg, 2009; Uhrig et al., 2012). Hefner and Eisenberg (2009) investigated the relationship between social support and well-being. The result indicated that decreased social support negatively associated with the well-being of human. Moreover, social support has an impact on life dissatisfaction as receiving less social support may increase the likelinood of dissatisfaction in life (Allgower et al., 2001). In addition, the benefits of social support have been explored in variety areas of studies. Great deals of research posit that social support helps minimizing psychological symptoms and stress related to illness (Ozbay et al., 2007). This social support variable has been well documented in safety science literature as a key factor driving positive safety climate and safety culture in the workplace (Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002; Ostrom et al., 1993; Tucker, Chmiel, Turner, Hershcovis, & Stride, 2008). There are two common types of social support addressed in safety science research, that is supervisor support and co-worker support. These two types of support will be explained in the next section.

2.5.2.2 Constructs of Social Support for Safety

Many studies attempt to explain the importance of supervisor support and co-woker support role in measuring safety climate. These two aspects of support are aligned with the social support theory, thus will be used to evaluate departmental level of support within the organization setting.

Supervisor support is another aspect in organizational support theory. Perceived supervisor support refers to the degree to which "employee's view that their supervisor values their contribution and cares about their well-being" (Kurtessis et al., 2015, p. 1861). Barling and Frone (2004, p. 27) defined supervisor support as "the extent to which supervisors are perceived to place a high priority on safety, respond to safety concerns, and provide support and encouragement for subordinates who comply with safety procedures and participate in safety activities".

Line managers and supervisors are an immediate person who directly engage with shop floor staffs, they play a great role in evaluating, controlling, and monitoring workers. Moreover, they provide the organizational rewards and proper resources to employees, thus exhibiting an important source of organizational support. The study of Kurtessis and colleagues (2017) provided the evidence that support from supervisor is significantly related to perceived organizational support, and more strongly related than coworker support. According to organizational support theory, when employee perceives high organizational support, it encourages the employees to favor a social exchange relationship with the organization over the economic exchange (Kurtessis et al., 2017). Mearns and Reader (2008) revealed the importance of high level of support from both organization and supervisor level as it can increase safety citizenship behavior of employees. The role of supervisor in regard with safety shall include identifying hazards, controlling workers, expressing concern for employee safety, and praising employees for safe work (Gillen et al., 2002). One of the finding in Gillen et al.'s study (2002) indicated that employee who perceived less safe in the workplace, also perceived less supervisor support.

In logistics and transportation business, supervisor is an immediate person who control the work of truck drivers. Supervisor receives the key massage from top management and is required to communicate the essences of safety matters to their subordinates as well as to ensure that employees are performing accordingly. In the study of Swedler, Pollack, and Gielen (2015) supported that truck drivers' supervisors play an important role in safety prevention. The organizational norms as well as the management value can create a culture that either advocates and discourages safe driving behaviors. Communication about safety between supervisor and subordinates is another mechanism that successfully propels safety management (Mearns et al., 2003; Neal et al., 2000; Zohar, 1980). Neal et al. (2000) pointed that if employee perceives that the organization have an effective and open communication, they may perceive that communication about safety is valued and very important in this workplace. Supervisor in logistics and transportation industry usually associate in the role of planning driving schedule, monitoring and controlling their staffs. Supervisor's commitment, attitudes toward safety and their actions provide impact to employees' safety behavior (Zohar, 2002). Zohar (2000, p. 591) developed group safety climate to assess the perception of employee in regard with supervisor support to safety. This questionnaire consists of two sub-scales, that is: supervisor action and supervisor expectation. Example questions are "my supervisor seriously considers any workers' suggestion for improving safety", " my supervisor pays less attention to safety problems than most other supervisors in this company".

Coworkers are often seen as an important source of information when employee seeks for advice or instruction about the job. Coworker support is an important source of social support that can influence individual employees to act or behave in a certain way. Offering to teach coworker safer work techniques is one of the example (Tucker et al., 2008). Several studies on coworker support attempt to explain the role of coworker support as a buffer for individual's stress derived from particular job. Susskind and colleagues reveals that receiving adequate support from coworker can create positive service atmosphere in the restaurant which leads to guest satisfaction (Susskind, Kacmar, & Borchgrevink, 2007).

Huang et al. (2013b, p. 6) identified truck driver occupation as a "lone worker" which required to perform the task alone, usually in isolation manner without close supervision. According to Huang et al. (2013), truck drivers are normally having less chance to work in corporation with other drivers, unless for long-hual trip that they have to drive with their co-partner. However, co-worker in this study do not limit to within-department, but covered the broad range of other co-workers in different functions, for example: the maintanence unit, wearhouse unit as well as safety representatives. These group of co-workers has a tendency to influence the perceived safety climate and culture of truck driver within the organization. Receiving full support from co-worker may increase job satisfaction, while receiving less support from co-worker may influence certain unsafe behaviors. Therefore, in order to establish good and positive safety culture, the essence of co-woker support will be addressed in this study.

2.5.3 Preconditions for Employee Safety Behavior

The third dimension in SCM indicates the importance of preconditions that may impact individual employee's safety. Variety of preconditions have been emerged psychologically (i.e. stress, attitudes toward safety) and physically (i.e. working conditions and work environments). The precondistions may be developed by the individual and/or influenced by others (i.e. top-management, supervisor, and co-worker). This variable appears to be another important factor driving safe or unsafe behavior of particular employee.

2.5.3.1 Concept of Preconditions for Safety Behavior

Reason (2000, p. 205) explain preconditions as a "latent states" of individual employee, as these precursors can contribute to a great variety of unsafe acts. Reason views the characteristics of preconditions that may influence the unsafe acts as mental and physical conditions of individual workers, for example, the capability for being stressed, exhaustion, fail to recognize hazards, as well as personal readiness prior to commence the work. In the study of safety climate, perceived level of risk at workplace is one of the key construct in several studies (Cooper & Phillips, 2004; Zohar, 1980). Failing to perceive level of risk in the workplace can also be identified in the category of this preconditions for unsafe acts according to Reason (1980). Reason points that even the best organization in this world cannot manage the harmful effects derived from employees' psychological problem (e.g. family conflict, sickness or family members, and other personal issues).

In the original work of Reason (1990), he named this component as "preconditions of unsafe acts" which attempts to explain the psychological conditions that may impact negatively on employee's performance. Reason further stated that many preconditions are introduced directly by human condition such as the capacities for being stressed, being unaware of safety. Any psychological effects of adverse life events such as family conflicts, sickness of family members, debts and the like, can also influence the psychological state of employee into certain level of risk during the work. Wiegmann and Shappel (2003), however, recategorized preconditions for unsafe acts into 1) environmental factors, 2) condition of operators, and 3) personnel factors.

Wiegmann and Shappel (2003) extended the scope of preconditions for unsafe acts from individual psychological conditions to include the area of environmental conditions. The authors explain the environmental factors as the compose of physical environment and technical environment which refers to operational environment such as weather, altitude, terrain in aviation industry. The operational environmental of truck driver include weather, the condition of the road and other road users which is an external factor out of the organizational control. Many research reveal that work environment is an important part of work condition. International Labor Organization (2016) point that work condition cover a broad range of topic and issues include working time (e.g. number of working hours, working time, working schedule), to remuneration as well as the physical and mental demand in the workplace. Additionally, many research reveals that work conditions

(Rundmo, 1992), work practices (Carroll, 1998), and work pressure (Janssens et al., 1995; Phillips et al., 1995; Zohar, 1980) are addressed in the underlying structure of safety climate and culture. Moreover, human failures are a consequence of work conditions and work environment such as lack of adequate safety training, poor management decision, malfunction equipment that, literary, influence the occurrence of accident (Fernández-Muñiz et al., 2007; Lee & Harrison, 2000; Reason, 1998).

2.5.3.2 Constructs of Preconditions for Employee Safety Behavior

Many safety climate and safety culture studies identified various factors that are congruent with preconditions for employee safety behavior. Mearns et al. (1998) included work pressure in their measurement of safety climate on offshore employees. They identified work pressure as time pressure. While, other studies addressed the issue of physical work environment as part of working conditions in their safety climate measures (Cox & Cheyne, 2000; Coyle et al., 1995; Rundmo, Hestad, & Ulleberg, 1998). In addition, the preconditions to safe or unsafe behavior are also derived at the individual level for example personal immunity and personal skeptism (Cox & Cox, 1998) as well as employee attitudes toward safety. In this present research, two major of preconditions for safety behavior will be addressed, that is working conditions and personal conditions.

According to International Labour Organization (ILO), working conditions cover variety areas of working time (i.e. working hours, rest time, work schedule), compensation (i.e. pay scheme, incentives), together with physical environment and mental demands existing in the organization.

Working hours is one of working condition that provide a great impact on employees' health and safety. Inappropriate working hours can adversely affect safety level in the workplace. Caruso and colleagues raise concern about risks involved with working long hours to the employees (Caruso et al., 2006). They revealed that poor management of working hour brings variety of human and economic burdens, for example work-related injuries, health care costs as well as greater number of employee turnover. Research indicates that excessive working hours have been associated with many safety outcomes, that is the vehicle crashes and medical operation errors.

In general, employee has a tendency to favor the shorter working hours, however many studies examine varieties of moderators that may impact worker's preference on the length of working hours. Overtime pay and incentive pay are one of the sources that can alter employees' preference on working hours. Research indicates that employees tend to favor longer hours when their income is more linked to number of hours worked. Many organizations use incentives to extend the hours of their employees instead of hiring additional staffs, so that the employer can optimize the cost of operation associated with each new hire (Caruso et al., 2006).

Most industrialized countries, include Thailand aim to control hours of work by setting standard or limit on total hours of work. As for Thailand, the Labour Protection ACT (No.12) B.E. 2551 (1998) was established to protect vehicle driver's occupation. According to this ACT, employer is required to determine the start and finish of working time not exceeding eight hours per day, unless receiving a consent statement from employee as stated in section two. Moreover, in section four of this ACT, employees are allowed to have at least one-hour rest time after driving for four hours. The exemption is applied when employer and employee shall have an agreement to have rest time less than one hour, but should not less than twenty minutes each time, the accumulation of total rest time should not less than one hour a day. However, many of Thai truck drivers have to work excessively longer than eight hours a day as directed by law (Trakarnvachirahut et al., 2014). Great deal of research proved that excessive working hours are strongly associated with crashes and accidents of truck drivers (Caruso et al., 2006; Loeb & Clarke, 2007; Maldonado et al., 2002). On the other hand, Mitchell and Williamson (2000) argued that there was no report increase in health and safety risks when comparing 8-hour shift and 12-hour shift work of their study. This could be due to the offsetting advantage that worker with 12-hour shift would have, for example more rest day during the week (Caruso et al., 2006). In the study of Maldonado and colleages reported that long working hours was a major cause of truck driver sleepiness while driving. The irregular work schedules also may find to reduce driver's alertness and increase fatigue.

Apart from the work environment and conditions, personal condition was found to be another key factors that lead how people behave toward safety. Reason (1980) explained that individual commit certain unsafe acts due to the influences of particular preconditions in which he refers these precondition as psychological states such as mental states. The adverse mental states refer to psychological conditions of individual that impact negatively on performance. It includes loss of awareness, some personality traits and attitudes (e.g. overconfidence, inattentive, careless). The adverse physiological states refer to medical and physiological condition such as fatigue, illness. Physical/mental limitations refer to those instances when operational requirements exceed the capabilities of the individual at the controls. For example, visual limitation when driving at night, inadequate experience for complexity of situation.

As for personnel factors, according to Wiegmann and Shappel (2003), compose of resource management and personal readiness. Even though there are some preconditions that can lead to commission of unsafe acts, there are number of personal factors that individual create by themselves as a contribution to preconditions state. As for personal readiness, employees are expected to show up at work with readiness to perform task at the optimum level. A breakdown in personal readiness can occur when employees fail to prepare physically or mentally for duty for example, for truck driver occupation, drinking alcohol, intendedly sleep late the night before, as well as excessive driving for more money.

In Donald and Canter's study (1994), the result revealed that safety attitudes of individual employee have significantly associated with company's safety performance. Budworth (1997) also addressed the importance of employee's safety attitude as one of the safety climate measure which has been used to diagnose safety management in the organization. The extent to which employee perceives that safety is a burden, may increase the likelihood they get involved with unsafe act.

Addtionally, consciousness is found to be an important personal mental state that affect the truck accidents. Findley, Weiss, and Jabour (1991) reviewed that lacking the consciousness while driving is one of the major causes of vehicle crashes on the road. However, none of the existing safety climate and culture address the issue of consciousness in the measurement. Encouraging truck driver to stay conscious during the drive helps minimizing the risk of involving with road accident for truck driver occupation. Therefore, this study shall include the consciousness into this personal conditions category in order to construct the safety culture assessment reflecting the context of truck drivers.

2.5.4 Employee Safety Behavior

The last component in SCM refers to unsafe acts of individual workers. Unsafe acts are the course of action committed by individual worker that result in accident or undesirable incident (Reason, 2000; Wiegmann & Shappel, 2003). In order to establish safety workplace, it is essential to mitigate the frequency of employees' unsafe acts by enhancing more safety behaviors (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004). As the essence of creating organizational safety culture is to have people perceive, think, feel and act (Fernández-Muñiz et al., 2007) in accordance with safety perspective, therefore, employee safety behavior is addressed as one component of safety culture in this study.

2.5.4.1 Concept of Employee Safety Behavior

Many studies reveal that the majority of accidents are caused by unsafe act or unsafe behavior of people (Wills, Watson, & Biggs, 2006; Wu, Liu, Zhang, Skibniewski, & Wang, 2015). Wrong behaviors of worker were found to be the major cause of industrial accidents; accounted for 76% in the United States in the past decade (McSween, 2003). Safety behaviors offer visible and recordable proof of employees' safety value. Safety behavior refers to "personal actions taken for self-protection, such as following safety regulations to prevent dangers to self or others" (Seo, Lee, Kim, & Jee, 2015, p. 161). Safety behavior has gain its popularity and widely used as an indicator when measuring safety-related outcomes instead of the frequency accident and injury rate because such accident data report is found to be a sensitive issue as well as more difficult to obtain from the organization (Seo et al., 2015). Thus, the term "safety behavior" will be operationalized in this present study instead of its original term of "unsafe acts".

The employee safety behavior is a positive term of employee unsafe acts in Reason's model (1990). The unsafe acts are identified as active errors in Swiss Cheese model. Reason (2000) classifies unsafe acts into two separate concepts as; unintended action and intended action. The unintended action simply refers to errors that committed by individual, while intended action refers to violation on particular thing, as well as mistakes which is considered as one type of error. Therefore, in the work of Shappel and Wiegmann (2000) has re-classified unsafe acts into error and violation. Human errors derive from various aspects, for example, due to the memory failures, negligence, absent mind, misfortune, forgetting, and lack of mindfulness. Violation, on the other hand, is a deliberate act of destruction. In the workplace, people are often committing to certain violations as a trade-off for something. The likelihood for the workers to intendedly breach the safety rules are high when the production deadline is short coming.

Changing unsafe acts to behave in a safe manner is the key in promoting safety behavior within the organization. Many studies conclude that the majority of accidents are caused by unsafe act or unsafe behavior of people (Wills et al., 2006; Wu et al., 2015). Wrong behaviors of worker were found to be the major cause of industrial accidents; accounted for 76% in the United States in the past decade (McSween, 2003). Safety behaviors offer visible and recordable proof of employees' safety value. Safety behavior refers to "personal actions taken for self-protection, such as following safety regulations to prevent dangers to self or others" (Seo et al., 2015, p. 161). Safety behavior has gain its popularity and widely used as an indicator when measuring safety-related outcomes instead of the frequency accident and injury rate because such accident data report is found to be a sensitive issue as well as more difficult to obtain from the organization (Seo et al., 2015).

There has been an attempt to identify safety behavior and safety performance as the same thing. Burke et al. (2011, p. 432) have defined safety performance as "actions or behaviors that individuals exhibit in almost all jobs to promote the health and safety of workers, clients, the public, and the environment". Four factors of safety performance have been identified as: 1) using protective equipment, 2) engaging in work practice to reduce risk, 3) communicating hazards and accidents, and 4) exercising employee rights and responsibilities (Burke et al.,2011). The well-known two-dimension safety performance model by Neal, Griffin, and Hart (2000, p. 101) distinguish the safety performance into "safety compliance and safety participation". Safety compliance involve the strongly commitment to comply with safety-related procedures and policies, while safety participation refers to the cooperation in participating any safety activities and safety programs set by the organization (Neal et al., 2000). According to Neal et al. (2000) workers demonstrate certain behaviors to follow the compliance and participation.

Lu and Yang (2011) propose the study with the aim at evaluating the safety climate and safety behavior of workers in passenger ferry companies in Taiwan. In this study, the self-report of safety behaviors was used to assess workers' behavior in both compliance and participation perspective (Neal et al., 2000). The result shows that two safety climate dimensions; safety training and emergency preparedness were positively affect both aspects of safety behaviors.

Many organizations attempt to use traditional safety campaign (e.g. poster campaigns, audio visual methods) on changing employees' attitudes and raising awareness to safety, however such campaigns are found to have a short-term effect rather than the long-term one. The underlying problems are 1) attitude is difficult to see, if it cannot be seen it cannot be measured then cannot be controlled, 2) people may behave differently with their expressed attitudes, and 3) raising safety awareness does not always direct the desired behavior (Sutherland et al., 2000).

2.5.4.2 Construct of Employee Safety Behavior

Employee safety behavior in this study shall follow the work of Neal and colleagues as they have identified safety behavior into safety compliance and safety participation (Neal et al., 2000). While unsafe acts in SCM framework means to violate on something that lead 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 being presented in different direction.

Safety compliance behavior centered around the tendency that employees are encouraged to pay attention on organization's safety rules and procedures (Griffin & Hu, 2013; Neal et al., 2000). Clarke (2013) carried out the meta-analysis on safety leadership, the result showed that transactional leadership plays a great role in monitoring and predicting safety compliance of employees. When leader involves in team activities, the employee shows higher degree of safety compliance (Griffin & Hu, 2013). The ultimate goal of safety compliance is to ensure that employees carry out their work adhereing to the organization's safety rules and regulations (Neal & Griffin, 2006).

Another safety behavior was identified as safety participation. Griffin and Hu (2013, p. 197) defines safety participation to "employee's voluntary pariticipation in safety activities, which aim to contribute to the development of supportive safety environment". Example of safety participation include voluntary participating in safety meeting, raiseing safety concerns and issues, encouraging co-worker to actively participate in company's safety programs (Griffin & Neal, 2000). Many studies have addressed employee involvement as a key constructs to measure safety climate and culture (Cox & Cheyne, 2000; Hayes et al., 1998). The employee involvement refers to the degree to which employees involve themselves in, for example, informing management and their immediate supervisor about important safety issue and participating in safety issues and activities. This involvement behavior provides same meaning with participation. Therefore, the area of employee involvement found in other studies shall be considered when developing safety participation scale.

According to SCM framework, Reason (2000) pointed that active failures as identified by unsafe acts are the consequences of latent failures lie in the organizational setting. Top management is a key person in organizational level who have a tendency to influence certain behavior of employees. Their values, attitudes and belifes are crtitical in shaping the organizational structure which foster how people behave. Policies and practices initated by top management are cascaded to departmental level where the actual act of operating is taken place. Manager, supervisor and co-workers also play a great role in influence ones' behavior. Subordinates are likely to follow the instruction of their immediate supervisor, in the mean time, they may follow their co-workers as they perceive that such particular action is the right way to do in the workplace.

In addition to this, individual unsafe acts may derive from any inappropriate conditions which Reason (2000) refered to precondition for unsafe acts. These preconditions include individual psychological state for example mental problem (Reason, 2000), physical state (e.g. fatigue) as well as physical environment (e.g. work conditions, hazardous environment) (Wiegmann & Shappel, 2000). Therefore, the interrelationship among these key safety culture components will be examined in this study.

Taken this together, it is suggested that the studied safety culture framework consists of four dimensions as: organizational support for safety, social support for safety, preconditions for employee safety behavior, and employee safety behavior. Therefore, the present study formulates the following hypothesis:

Hypothesis 1: The empirical data are consistent with the hypothesized model of four-dimension safety culture with a reasonable degree of certainty.

2.6 Safety Outcomes

Number of safety-related outcomes have been studied under safety literature (Huang et al., 2016b; Li & Itoh, 2014; Mearns & Reader, 2008). Huang and colleagues identifies safety outcomes in term of safety behavior instead of accidents and injuries (Huang, Lee, McFadden, Rineer, & Robertson, 2017). However, this present study has already included safety behavior in safety culture framework. The outcomes of having a good organizational safety culture in place are key attention in this present research. Major risks associated with truck drivers are the likelihood of involvement in accidents and near-miss accidents (Li & Itoh, 2014). Therefore, two safety outcomes addressed in this study shall focus on near-miss accident involvement and actual accident involvement.

2.6.1 Likelihood of Near-Miss Accident

In the past few decades the number of accidents per unit of time per employee was used as an indicator for industrial safety management (Van der Schaaf, 1995). It appears that number of accidents and injuries in many industries have been declined and there are too few accidents left to give fruitful information feedback on safety. The use of data from near-misses in safety management has been identified as an important practice in the prevention of accidents, especially in the area of civil aviation, the generation of nuclear power, the chemical industry, and more recently in railroad transport and medicine (Cambraia, Saurin, & Formoso, 2010). Van der Schaaf (1995) points the importance of using near miss reports as another indicator when assessing safety management as follow:

> "Near miss reports frequently contain the very reason for having extensive safety rules, training programs, and redundant safety equipment by showing these defenses 'in action' in stopping a possible accident sequence and turning it into a near miss situation. In this way, they provide a psychologically convincing reminder of the need to keep safety awareness for oneself and one's colleagues a top priority" (Van der Schaaf, 1995, p. 1238).

Unlike the accident which is an actual incident happened by any means, near miss accident is identified as an undesirable events that provides no actual damages or injuries, however under some circumstances it may lead people into danger later (Wu et al., 2010). Muermann and Oktem (2002, p. 30) refer near-miss as "a weak signal some of which contain a genetic signature of a serious, adverse effect". Muermann and Oktem (2002, p. 30) also propose the definition of near-miss as "an event, a sequence of events, or an observation of unusual occurrences that possesses the potential of improving a system's operability by reducing the risk of upsets some of which could eventually cause serious damage". Gnoni and Lettera (2012, p. 609) define near-miss as "a hazardous condition where the event sequence could lead to an accident if it had not been interrupted".

Many industrial accidents are seen as a tip of an iceberg, while a large number of near-miss accidents appear in a large scale under water, well explained as near-misses are happened more frequent than accidents (Cambraia et al., 2010; Wu et al., 2010). It has been observed that for most of major accident there usually have been a large number of incidents with no damages underlying (Muermann & Oktem, 2002). Unfortunately, many organizations treat safety activities as a reactive action rather than the preventive action. Near-miss events are often ignored and not reported as no damages happened. Many studies have revealed that most loss producing events (i.e. accidents) were preceded by warnings signal of near-miss accidents. The near-miss concept is used for assessing and managing risk in various industries: chemical, health, aviation, including banking (Muermann & Oktem, 2002).

Sagaspe et al. (2010) conducted the study to explore the factors related to near-miss driving accidents and actual accidents from driving in France. The result revealed that 10.7% of total drivers reported at least one near-miss accident association (i.e. near crashed). While about 5.8% of drivers reported at least one driving accident. Drowsiness and sleep-related factors while driving appears to be the major cause leading both near-miss and actual car accidents. Near-miss accidents occurred more frequent than the actual accidents case in the study. Quera-Salva and associates (2014) also pointed that sleep disorder and sleepiness are an essential influence of near-miss incident. Drivers who have problem with their sleep pattern tend to involve in variety number of near-miss situations because the sleepiness decrease the level of drivers' consciousness.

Gnoni and Lettera (2012) investigated and found close relationship between near-miss incidents and major accidents. Apparently, the result show that both of them share common causes. Thus, effective near-miss management is beneficial for recognizing weak signal (Gnoni & Lettera, 2012; Muermann & Oktem, 2002) from operations and helps in forming appropriate prevention strategies (Gnoni & Lettera, 2012). A detailed near-miss reporting system can represent a risk management strategy aiming at identifying risk sooner when they are small (Fabiano & Currò, 2012). Thus, an attempt to recognize and understand near-miss accidents will help improve overall safety level within the organization.

Many researches found close relationship between safety climate and culture with the frequency of accidents and injuries occurrence, however, at the time being of this present study, there is no single study investigating the relationship between safety culture and near-miss accidents. Since near-miss and actual accidents appear to have similarity in theirs underlying causes, this brings the author attention in seeking for examining the causal relationship between safety culture and near-miss accidents involvement.

Hypothesis 2(a): Safety culture has an effect on the likelihood of near-miss accidents of Thai truck drivers.

2.6.2 Likelihood of Accident

Traffic accidents represent an important cause of death and disability worldwide (Girotto et al., 2016). The same situation happened in Thailand as well where deaths and injuries associated with traffic collisions overall and especially among the occupants of commercial vehicles have constantly occurred on a daily basis. Traffic accidents involving trucks are more severe particularly when they occur on the roads where the speed of the vehicles tends to be higher and the size is bigger.

In addition to the condition of the vehicle, the behavior of truck drivers and their stress, together with irregular working hours may expose them to the risk of involvement in traffic accidents (Friswell & Williamson, 2010). In Girotto et al., (2016) study, the result showed that the experience of truck driver was inversely associated with involvement in accidents and near-miss accidents. The authors suggested the possible strategy for an organization to reduce the opportunity of accidents by improving training of truck drivers before joining the profession.

Apart from drivers' behavior, the condition of drivers while performing their job behind the wheel is also addressed as cause of accidents. Several studies suggest that insufficient sleep and fatigue are a serious issues that can result in reduced driving efficiency and safety (Catarino, Spratley, Catarino, Lunet, & Pais-Clemente, 2014; Dorrian, Sweeney, & Dawson, 2011; Maldonado et al., 2002). Catarino et al., (2014) carried out the study about sleepiness and sleep-disordered in truck drivers and result showed that 85.7% of drivers reported driving while feeling sleepy and 15.4% of drivers admitted to actually having fallen asleep at the wheel in the past year. The report also revealed that 42.5% of drivers experienced near-miss accident and 16.3% of drivers experienced in actual driving accidents that they considered to be sleep related. Maldonado et al. (2002) reported that three-quarters of the drivers in their study were being tired at work because of working long hours due to insufficient sleep. As a consequence, truck drivers admitted that they nodding off at the wheel. Driving with insufficient sleep poses a danger to all on the road, thus responsible trucking companies should ensure that drivers have adequate rest times in conditions. Strictly follow state and company's safety regulation will substantially improve working conditions, as well as driver performance and well-being (Maldonado et al., 2002).

Drivers in developing countries are more likely to drive while fatigue for economic/ financial reasons and meeting work schedule, especially commercial vehicle drivers. Surveys of commercial and public road transport in developing countries have revealed that transport owners, in pursuit of increased profits, frequently force their drivers to drive at excessive speeds, to work unduly long hours and to work when exhausted as well as ignoring speed limits and other safety regulations (WHO, 2004).

According to Reason (1998, 2000) unsafe behavior of individual worker is a decisive factor for accident to occur. Unsafe behavior often occurs because safety measures are likely to entail modest benefits but immediate costs, such as slower pace, extra effort and attention as well as personal discomfort. If the likelihood of injury is underestimated in a seemingly safe environment, the expected utility of the unsafe behavior exceeds that of the safe behavior. Unsafe behavior is also naturally reinforced because people tend to place higher value on short-term results. In this sense, inhibiting unsafe behavior is a significant managerial challenge (Hon, Chan, & Yam, 2014). The chain of relationship is found in the work of Fernández-Muñiz et al. (2007), as they suggest that management commitment on safety should be taken as the first step of improving safety outcomes. Their good intentions are required to transform into daily production exercise. Sufficient financial and human resources should be allocated to enhance safety management establishment. Without the strong management commitment and positive attitudes on safety, the chance to have people involve in safety seems to be low.

Several research reported the relationship between safety climate factors as a predictor on safety behavior and occupational injuries and accidents (Christian, Bradley, Wallace, & Burke, 2009; Liu et al., 2015). Clarke (2006) study found that safety climate did not predict accident involvement in the plant of his research, however the perception of the work environment was a significant predictor, indicating that a work environment perceived as ambiguous and highly pressurized was associated with accident involvement.

Previous research indicates that employee alone is not the main cause of organizational accident. Various aspects within the organizational setting also influencing the level of safety as well as the accident involvement. This present study will attempt to examine the causal relationship between organizational safety culture and accident involvement.

Hypothesis 2(b): Safety culture has an effect on the likelihood of accident of Thai truck driver.

2.7 Conceptual Frameworks

Below are the hypothesized models based on the literature review described in the previous section.

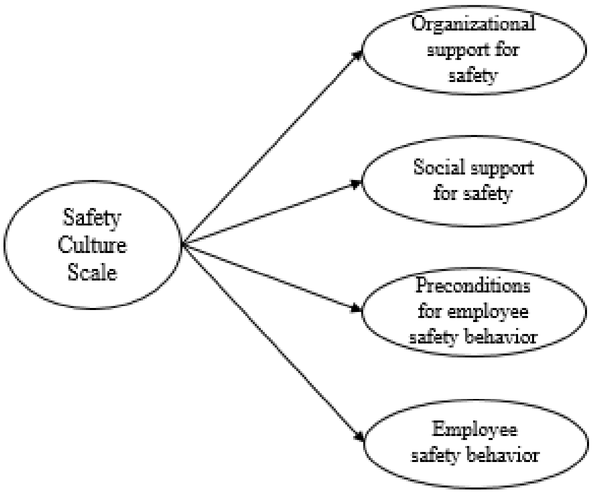

Figure 2.7 Conceptual Framework of Four-Dimension Safety Culture

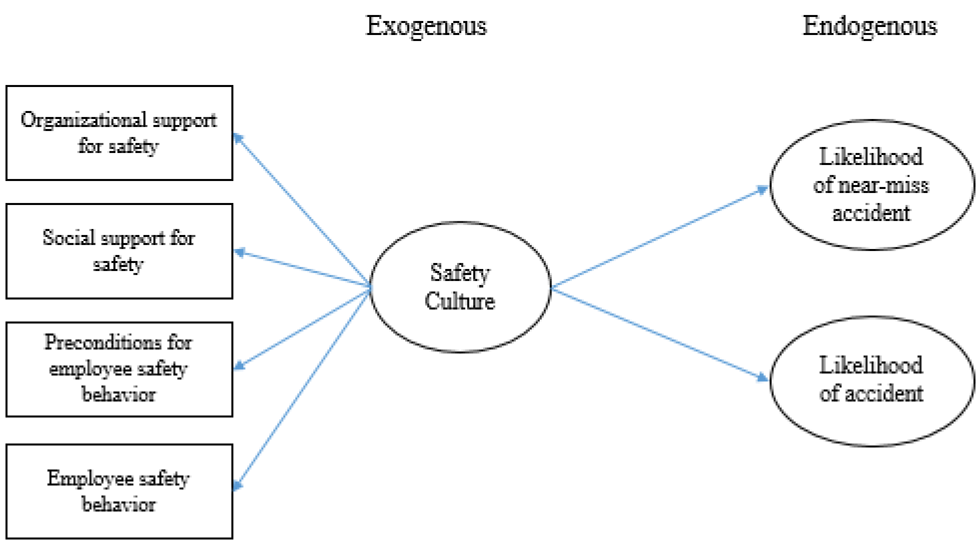

Figure 2.8 The Structural Equation Modeling of Safety Culture Influences Safety Outcomes

2.8 Hypotheses

Below are all hypotheses based on the literature review described in the previous section.

Hypothesis 1: The empirical data are consistent with the hypothesized model of four-dimension safety culture with a reasonable degree of certainty.

Hypothesis 2: Safety culture influences the likelihood of near-miss accident and the likelihood of accident of Thai truck drivers.

Hypothesis 2(a): Safety culture has an effect on the likelihood of near-miss accidents of Thai truck drivers.

Hypothesis 2(b): Safety culture has an effect on the likelihood of accident of Thai truck driver.

CHAPTER 3

RESEARCH METHODOLOGY

The purposes of this study are to develop and validate a measure of safety culture assessment for Thai truck drivers and seek for its relationship with safety outcomes (i.e. the likelihood of near miss accidents and the likelihood of accident). The unit of analysis is individual commercial truck driver who operates heavy truck on a daily basis from private logistics and trucking companies in Thailand. The research framework of safety culture in this study was designed based on Swiss Cheese Accident Causation Model. The qualitative data collection and analysis were performed to identify key theme for sub-constructs as well as for item generation as part of an instrument development. The quantitative data collection and analysis were conducted to (a) extract the factor structure, (b) refine the measurement scales, and (c) to examine the reliability and validity of the newly developed scale. Finally, the structure equation modeling (SEM) was performed to examine the effect of safety culture on two safety outcomes (i.e. near-miss accidents involvement and actual accidents involvement).

3.1 Qualitative Method

Since most of the safety culture instruments and research were developed in western countries with little involvement in logistics area. Therefore, to understand and discover the key factors of safety culture in Thai context, especially for Thai truck drivers, an indepth interview with subject matter experts was conducted using semi-structured dialogue to obtain the information from participants.

3.1.1 Key Informants' Profiles

Participants in this study were logistics personnel who were working for private logistics companies in Thailand including truck drivers, defensive driving trainer, safety director and safety officers. This study employed the purposive sampling in which the individual or groups of individuals who are knowledgeable or having experience related to a phenomenon of interest were selected (Cresswell & Clark, 2011).

Table 3.1 The Informants' Profiles

No	Age (Years)	Experience (Years)	Position	Company	Interview Methods
1	25	5	Truck driver A	A	Telephone
2	28	6	Truck driver B	B	Telephone
3	29	3	Truck driver C	C	Face-to-Face
4	33	6	Truck driver D	D	Telephone
5	36	15	Truck driver E	E	Telephone
6	26	5	Truck driver F	F	Telephone
7	46	10	Safety Director	G	Face-to-face
8	31	7	Safety officer A	G	Face-to-face
9	29	6	Safety officer B	G	Face-to-face
10	28	4	Safety officer C	H	Telephone
11	47	9	Defensive driving trainer	I	Face-to-face
12	50	15	Defensive driving trainer	J	Telephone

3.1.2 Instrument

All interviews were based on semi-structured questions using open-ened questions to allow participants to share their own opinions based on their true experiences. Sample of questions may include; (a) tell me about your job? (b) apart from your driving skill, what are the key factors that may affect your safety driving? (c) what does your company do to promote safety for truck driver and how? (d) please explain the situation when you feel that when this happened you feel unsafe. Probing was used during the interview to dig for more details. Field notes were made during the interview as well as the voice recording with permission from the participants was recorded.

3.1.3 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 this 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 as presented in table 3.1. 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.

The first group of key informants was Thai truck drivers. The main researcher requested to join the Thai truck driver's Facebook (FB) group and explained the objectives of the research to the representatives of FB group admins who are also full-time truck drivers. These FB group admins joined together to create the FB group for Thai truck driver with an aim to establish safe driving community as well as friendship among drivers across the nation. The second group of informants was logistics personnel, including safety director, who work in safety department. And the last group of informants was defensive driving trainer. Each of participant was contacted for interview either via telephone or face-to-face depends on their convenient. All of them were informed that the interview will be kept confidentially without disclosure of name and company to public.

Content analysis from all interviews were performed to extract common themes emerging from the interview process.

3.1.4 Data Analysis

Data analysis process was adapted from Halcomb and Davidson (2006) in term of data management process. Field notes were taken during the interviews. Reflection was made after each interview with an attempt to clearify understanding and allowed informants to generate more ideas, comments, or express their concern in regard with truck drivers' safety while the memory remained fresh. Next step, the audio recordings were reviewed in accordance with field notes. Then data transcription was made into written form. Transcribed data was put in the meaning condensation table for thematic analysis purpose. The meaning unit condensation table in this study was consisted of meaning unit, condensed meaning unit, code, category, and theme. Data was analyzed step by step, key categories were identified and key themes were emerged accordingly as presented in chapter 4.

3.2 Quantitative Method

The quantitative method was employed with an attempt to 1) conduct item analysis, 2) refine the measurement scales, 3) to examine reliability and validity of the measurement models, 4) to validate concurrent validity by examining the relationship between safety culture dimensions and safety outcomes.

3.2.1 Population and Sample

The populations in this present research were truck drivers who operated heavy truck from private logistics and trucking companies in Thailand. These truck drivers should hold Thai citizenship with at least three years of working experience as a truck driver. They should hold specific Transport Personnel Licence (i.e. class II, class III or class IV) which is the required licence to operate heavy trucks in Thailand. Due to the difficulty to get the actual number of current truck drivers in the labour market, this study will use number of registered Transport Personnel Licence issued by Department of Land Transport in the past three years during December 2013 to December 2016. The accumulative number of registered Transport Personnel Licence for commercial truck drivers from 2013-2016 are 142,494 units (Department of Land Transport, 2017), which will be used as a representative number of populations in this study.

According to Hinkin (2005, p. 169), he suggests that "selection of an appropriate type and size is very important to assure enough variance in responses and avoid the effects of an idiosyncratic context". Therefore, this study refered the formula of Yamane (1976) and Kline's rule of thumb (Kline, 2011) for calculating an appropriate sample size of population. As a consequence, with the refered population size of 142,494 units, the Yamane (1976) formula suggested that the number of participants should be approximately 399. On the other hands, Kline (2011) suggests that the appropriate sample size per parameters estimated ratio would be minimum at 10:1 or 20:1 for the maximum. This study contained approximately 33 parameters estimated, thus the sample size should fall within the range of 330 to 660.

The participants were purposively selected from large logistics /transportation organizations in Thailand where safety practices have been implemented. The sampling participant was structured into two groups. The first group of participants was selected for pilot group for item analysis purpose. The second group of participants was selected to 1) extract factor structure and refine the measurement, and 2) examine reliability and validity of measurement scales, as per below details.

3.2.2 Instruments

3.2.2.1 Organizational Support for Safety

The organizational support for safety scale in this study was primary structured based on the concept of Swiss Cheese Moel (Reason, 1997). This construct was seen as one of the key latent factor at the organizational level that may influence employee to commit certain behavior toward safety. Several studies addressed the important of various facets at this level for example, the management commitment to safety, safety rules, safety procedures, safety policy, adequate safety training, safety communication and so forth. According to literature reviews and the interview results, several sub-factors were identified under this construct. Some of the items were adapted from existing safety climate and safety culture studies (Cox & Cheyne, 2000; Huang et al., 2013b; Zohar & Luria, 2005), and some was newly developed from the interview in qualitative part. Sample of items under this construct were presented in table 3.2.

Table 3.2 Sample of Items for Organizational Support to Safety Scale

Items	Sources
1. This company solves safety issues in a fast and efficient manner.	Adapted from Cox & Cheyne (2000); Lu (2008); Huang et al. (2013); Zohar & Lauria (2005)
2. This company pays more attention to driver safety than any other companies that I used to work with.	Newly developed from interview
3. This company do not care when employees violate safety rules.	Newly developed from interview
4. This company has incentives for employees who comply with safety rules.	Adapted from Lu (2008): Williamson et al. (1997)
5. This company open to feedback for improving employee safety and take it seriously.	Adapted from Cox & Cheyne (2000); Dollard & Kang (2007); Kines (2011)
6. This company has a constant communication that promotes safety at work.	Cox & Cheyne (2000); Dollard & Kang (2007)
7. This company cares about the profitability rather than employees' safety.	Adapted from Huang et al. (2013); Williamson et al. (1997)

Table 3.2 (Continued)

Items	Sources
8. This company has safety rules and safety procedures as a guideline for employee to follow.	Adapted from Cox & Cheyne (2000);
9. I believe the company's safety rules and procedures can prevent errors in the work.	Newly developed from interview
10. The rules and procedures for safe operation of this company are practicable.	Adapted from Cox & Cheyne (2000);
11. This company encourages drivers to regularly attend safe driving and safe operation training.	Adapted from Huang et al. (2013); Lu (2008); Williamson et al. (1997)
12. Training enables me to know the limitations of driving a large truck that I've never known before (i.e. the blind spot of a truck).	Adapted from Lu (2008); Williamson et al. (1997)
13. I can work confidently and safely after I receive safe driving training.	Newly developed from interview
14. The safe driving training courses that I attend are useful and applicable to my work.	Adapted from Lu (2008)

3.2.2.2 Social Support for Safety

The social support for safety scale in this study was primary structured based on the concept of Swiss Cheese Moel (Reason, 1997). This construct was seen as another key latent factor at the functional level where actual work was operated. Key persons involved with truck drivers were supervisor and colleagues, who may influence employee to commit certain behavior toward safety. Several studies addressed the important of various facets at this level for example, supervisor support, supervisor management, and co-worker. According to literature reviews and the interview results, key sub-factors were identified under this construct as supervisor support and co-worker support. Some of the items were adapted from existing safety climate and safety culture studies (Cox & Cheyne, 2000; Y. Huang et al., 2013b;

Zohar & Luria, 2005), and some items were newly developed from the interview in qualitative part. Sample of items under this construct were presented in table 3.3.

Table 3.3 Sample of Items for Social Support to Safety Scale

Items	Sources
1. My supervisor often overlooks the driver's safety problems.	Adapted from Huang et al. (2013)
2. My supervisor allows staffs to change the work schedule if sick or too fatigue to drive.	Adapted from Huang et al. (2013)
3. My supervisor properly manages work schedule which allows enough time to safely delivery.	Adapted from Huang et al. (2013)
4. Mostly, I have received information about the work safety from my supervisor.	Adapted from Cox and Cheyne (2000); Zohar and Lauria (2005)
5. I can openly talk about safety issues with my supervisor.	Newly developed from interview
6. My supervisor usually monitors the work in accordance with the rules and policies of the company.	Adapted from Zohar (2000); Zohar and Lauria (2005)
7. During the urgent task, my supervisor will order me to work faster rather than to follow safety practice.	Adapted from Zohar (2000); Zohar & Lauria (2005)
8. My co-workers here advise me to work more safely.	Adapted from Cox and Cheyne (2000)
9. My co-workers warn me when I try to violate the company's safety rules.	Newly developed from interview
10. My co-workers here do not care to follow the safety rules and policies of the company.	Adapted from Lu (2008)
11. At this company, the technician team rarely cooperates in the care of equipment and vehicle's maintenance as it should.	Newly developed from interview

3.2.2.3 Preconditions for Employee Safety Behavior

The preconditions for employee safety behavior scale in this study was primary structured based on the concept of Swiss Cheese Moel (Reason, 1997). This construct was seen as another key latent factor as some conditions derived at work level (i.e. work environment, working conditions) and personal level (i.e. physical and mental readiness). Therefore, key areas of preconditions involved with truck drivers in this study were working conditions and personal conditions, which may influence employee to commit certain behavior toward safety. Several studies addressed the important of various facets at this level for example, supervisor support, supervisor management, and co-worker. According to literature reviews and the interview results, key sub-factors were identified under this construct as supervisor support and co-worker support. Some of the items were adapted from existing safety climate and safety culture studies (Cox & Cheyne, 2000; Williamson et al., 1997), and some items were newly developed from the interview in qualitative part. Sample of items under this construct were presented in table 3.4.

Table 3.4 Sample of Items for Preconditions for Employee Safety Behavior Scale

Items	Sources
1. There are enough drivers to handle the workload of the company so I do not have to perform rush-driving.	Adapted from Cox and Cheyne (2000)
2. The truck that I use here is always in good condition with regular maintenance.	Adapted from Williamson et al. (1997)
3. My recent driving schedule is too tight which giving me less time to rest.	Newly developed from interview
4. I put accidents down to bad luck which cannot be avoid or prevent.	Adapted from Lu (2008); Williamson et al. (1997)
5. Personally, work safety is most important to me.	Adapted from Cox and Cheyne (2000)

Table 3.4 (Continued)

Items	Sources
6. If worry too much about safety, my job will not be done in time.	Adapted from Williamson et al. (1997)
7. Getting enough rest before driving is very important to me.	Newly developed from interview
8. I have strong physical and mental health before driving.	Newly developed from interview

3.2.2.4 Employee Safety Behavior

The employee safety behavior scale in this study was primary structured based on the concept of Swiss Cheese Model (Reason, 1997). According to SCM model of Reason, employee may be the one who commit certain behavior toward safety such as safe or unsafe act. However, those behavior may be influenced by the three latent factors as stated earlier. Several studies identified safety behavior as safety performance (Neal et al., 2000). According to literature reviews and the interview results, key sub-factors were identified under this construct as safety compliance and safety participation (Neal et al., 2000). Some of the items were adapted from existing safety climate and safety culture studies (Cox & Cheyne, 2000; Lu, 2008; Neal et al., 2000), and some items were newly developed from the interview in qualitative part. Sample of items under this construct were presented in table 3.5.

Table 3.5 Sample of Items for Employee Safety Behavior Scale

Items	Sources
1. I adhere to the safety rules and strictly follow the safety procedures of the company.	Adapted from Neal et al. (2000)
2. I violate the traffic rules while driving a truck.	Adapted from Lu (2008)
3. I take a shortcut and accept the risk of accident in exchange for convenience working.	Adapted from Lu (2008)

Table 3.5 (Continued)

Items	Sources
4. I ensure the highest leves of safety when I carry out my job.	Adapted from Neal et al. (2000)
5. I help guiding my co-workers to work safely.	Adapted from Neal et al. (2000)
6. I dare to speak or suggest a solution to safety-related issues with the management.	Adapted from Cox & Cheyne (2000)
7. I drive carefully and mind the safety of other road users.	Newly developed from interview
8. Even there is no safety rules, I still care about safe driving.	Newly developed from interview

3.2.2.5 Likelihood of Near-miss Accident

The likelihood of near-miss accident is usually measured using self-reported near-miss accident involvement (Girotto et al., 2016; Powell et al., 2007a). There is usually only one question to assess near-miss involvement, that is "Were you involved in any near-miss accidents while driving your truck during the last 12 months?" (Girotto et al., 2016) or "Have you ever experienced any near-miss accident in the past 12 months?" (Powell et al., 2007a). However, in Powell study, the assessment of near-miss involvement is only due to driving sleepy. This present study attempted to examine the possible likelihood of near-miss accidents that might happen in truck driver occupation, thus the identification of near-miss types was carried out through the interview with truck drivers and experts. Key likelihood of near-miss accident events were identified as for example; suddenly hard braking with almost crash, suddenly pull over with almost crash, sleep driving with almost lost control, absentminded driving with almost lost control, and lost balance with almost fall from the height. The questionnaire was designed using 5 frequency rating scale from 1 = never, 2 = sometimes, 3 = not often, 4 = quite often, and 5 = always.

3.2.2.6 Likelihood of Accidents

Similar to the likelihood of near-miss accident, the likelihood of accident was measured using self-report assessment (Girotto et al., 2016). The question is "Were you involved in any accidents while driving your truck during the last 12 months?". The identification of the likelihood of accident types was carried out through the interview with truck drivers and experts. As a consequence, Key likelihood of near-miss accident events were identified as for example; unable to brake, unable to control the steering wheel, accident due to sleep driving, accident due to absentminded, and accident due to fall from the height. The questionnaire was designed using 5 frequency rating scale from 1 = never, 2 = sometimes, 3 = not often, 4 = quite often, and 5 = always.

3.2.3 Development of Assessment Instrument

The study examined and defined the psychometric of safety culture assessment in terms of four components derived from SCM framework: the organizational support to safety, social support to safety, preconditions for employee safety behaviors, and employee safety behavior. An initial version of the instrument measuring safety culture of Thai truck driver was developed based on the conceptual framework in Thai language as follows:

3.2.3.1 Item Generation

After the key constructs and sub-constructs were identified in accordance with the qualitative results, extensive literature reviews were carried on to seek for appropriate items under each constructs. Several studies on safety climate and safety culture instruments were reviewed, list of relevant items were selected. Some of the items were newly developed according to the interview with subject matter experts as a reflection to the context of Thai truck drivers. As a result, the initial version of safety culture instrument was consisted of 60 items altogether. Brisling et al.'s (1973) back-translation procedure was employed by the present study to ensure the accuracy of the translation from the original English to the Thai version of each item.

Next, the newly developed questionnaires were sent to two truck drivers to check the face validity and verify the quality of language used in questionnaire, whether the instrument was understandable or not. According to this stage, truk drivers commented that they were confused by the questionnaires with back-translation version. Therefore, the questionnaires were rewritten with more understandable phrases and resent to truck drivers again to repeat the same process. Then the questionnaire was sent to the main advisor for adjustment and ensuring that items can cover the operational definition of each constructs. Afther that, all of defined items were assessed by five subject matter experts in trucking business for the examination of content validity. The purpose of this expert review was to investigate whether the instrument and its instruction are understandable as the way it should perform as a mean to seek for content validity. Five experts were identified based on following criteria; having a direct experience as a practioner in logistics and transportation business (i.e. manager, supervisor, truck driver, and safety driving trainer) as well as university lecturers who have background in related to the studied topic.

The safety outcomes instrument in this study consists of two variables; the likelihood of near-miss accident and the likelihood of accident. These two scales were adapted using the work of Girotto et al. (2016) and Powell et al. (2007) and was adjusted to align with the context of truck driver occupation that derived from the interview session.

3.2.3.2 Index of Congruence (IOC)

The content validity was assessed by five content experts as previous stated to judge the construct relevancy of items, the wording clarity, and design of items using the Index of congruence (IOC). They were required to review each item and then use three scale to judge the items. Experts will be asked to rate the quality of item as “+1”, “0” and “-1”.

+1 when agree that the item was relevant with the construct and behavior

0 when hesitate that the item was relevant with the construct and behavior

-1 when disagree that the item was relevant with the construct and behavior

Table 3.6 Example of IOC

Factor	Item	Opinion			Remark
		+1	0	-1	
1. Organizational support for safety	Top management in this company tries to continually improve safety levels in each department.				
	Top management in this company reacts quickly to solve the problem when told about safety hazards.				

The items were adjusted according to the recommendation from the subject matter experts. The items with IOC value less than 0.50 will be removed from this questionnaire. At this stage, none of the 60 items were removed, however required some rephrase and adjustment. Therefore, the 60-item safety culture instrument was used in the pilot trial. The results after pilot study suggested to removed 19 items, thus 41 items were retained for further analysis which were described in part 3.2.5. The sample of 41-item developed questionnaire was presented in table 3.x.

Table 3.7 Item Generation for 41-Item Safety Culture Version

Key Dimension	Items	Sources
Organizational support for safety	1. This company solves safety issues in a fast and efficient manner.	Adapted from Cox and Cheyne (2000); Lu (2008); Huang et al. (2013); Zohar & Lauria (2005)
	2. This company pays more attention to driver safety than any other companies that I used to work with.	Newly developed from interview

Table 3.7 (Continued)

Key Dimension	Items	Sources
	3. This company do not care when employees violate safety rules.	Newly developed from interview
	4. This company has incentives for employees who comply with safety rules.	Adapted from Lu (2008): Williamson et al. (1997)
	5. This company open to feedback for improving employee safety and take it seriously.	Adapted from Cox and Cheyne (2000); Dollard and Kang (2007); Kines (2011)
	6. This company has a constant communication that promotes safety at work.	Cox and Cheyne (2000); Dollard and Kang (2007)
	7. This company cares about the profitability rather than employees' safety.	Adapted from Huang et al. (2013); Williamson et al. (1997)
	8. This company has safety rules and safety procedures as a guideline for employee to follow.	Adapted from Cox and Cheyne (2000);
	9. I believe the company's safety rules and procedures can prevent errors in the work.	Newly developed from interview
	10. The rules and procedures for safe operation of this company are practicable.	Adapted from Cox and Cheyne (2000);

Table 3.7 (Continued)

Key Dimension	Items	Sources
	11. This company encourages drivers to regularly attend safe driving and safe operation training.	Adapted from Huang et al. (2013); Lu (2008); Williamson et al. (1997)
	12. Training enables me to know the limitations of driving a large truck that I've never known before (i.e. the blind spot of a truck).	Adapted from Lu (2008); Williamson et al. (1997)
	13. I can work confidently and safely after I receive safe driving training.	Newly developed from interview
	14. The safe driving training courses that I attend are useful and applicable to my work.	Adapted from Lu (2008)
Social support for safety	15. My supervisor often overlooks the driver's safety problems.	Adapted from Huang et al. (2013)
	16. My supervisor allows staffs to change the work schedule if sick or too fatigue to drive.	Adapted from Huang et al. (2013)
	17. My supervisor properly manages work schedule which allows enough time to safely delivery.	Adapted from Huang et al. (2013)
	18. Mostly, I have received information about the work safety from my supervisor.	Adapted from Cox and Cheyne (2000); Zohar and Lauria (2005)
	19. I can openly talk about safety issues with my supervisor.	Newly developed from interview

Table 3.7 (Continued)

Key Dimension	Items	Sources
	20. My supervisor usually monitors the work in accordance with the rules and policies of the company.	Adapted from Zohar (2000);
	21. During the urgent task, my supervisor will order me to work faster rather than to follow safety practice.	Adapted from Zohar (2000); Zohar and Lauria (2005)
	22. My co-workers here advise me to work more safely.	Adapted from Cox and Cheyne (2000)
	23. My co-workers warn me when I try to violate the company's safety rules.	Newly developed from interview
	24. My co-workers here do not care to follow the safety rules and policies of the company.	Adapted from Lu (2008)
	25. At this company, the technician team rarely cooperates in the care of equipment and vehicle's maintenance as it should.	Newly developed from interview
Preconditions for employee safety behavior	26. There are enough drivers to handle the workload of the company so I do not have to perform rush-driving.	Adapted from Cox and Cheyne (2000)
	27. The truck that I use here is always in good condition with regular maintenance.	Adapted from Williamson et al. (1997)
	28. My recent driving schedule is too tight which giving me less time to rest.	Newly developed from interview

Table 3.7 (Continued)

Key Dimension	Items	Sources
	29. I put accidents down to bad luck which cannot be avoid or prevent.	Adapted from Lu (2008); Williamson et al. (1997)
	30. Personally, work safety is most important to me.	Adapted from Cox & Cheyne (2000)
	31. If worry too much about safety, my job will not be done in time.	Adapted from Williamson et al. (1997)
	32. Getting enough rest before driving is very important to me.	Newly developed from interview
	33. I have strong physical and mental health before driving.	Newly developed from interview
Employee safety behavior	34. I adhere to the safety rules and strictly follow the safety procedures of the company.	Adapted from Neal et al. (2000)
	35. I violate the traffic rules while driving a truck.	Adapted from Lu (2008)
	36. I take a shortcut and accept the risk of accident in exchange for convenience working.	Adapted from Lu (2008)
	37. I ensure the highest leves of safety when I carry out my job.	Adapted from Neal et al. (2000)
	38. I help guiding my co-workers to work safely.	Adapted from Neal et al. (2000)
	39. I dare to speak or suggest a solution to safety-related issues with the management.	Adapted from Cox and Cheyne (2000)

Table 3.7 (Continued)

Key Dimension	Items	Sources
	40. I drive carefully and mind the safety of other road users.	Newly developed from interview
	41. Even there is no safety rules, I still care about safe driving.	Newly developed from interview

3.2.4 Data Collection

The main researcher primarily contacted the target company seeking for permission to collect data from truck drivers. Letters of data collection for this research were prepared and issued by the institute's authority. For the company S, Field trip was performed to distribute and collect data during the big driving contest among Thai truck drivers organized by company S (i.e. Smart Driver Contest) which allowed researcher to access to approximately 550 truck drivers from many regions all at once during the contest period. After the first round of the contest, 100 questionnaires were distributed with 75 completed in return, accounted for 75%. The first data set was used for pilot study as a mean to check the quality of items and to examine the internal consistency. Any item with item-total correlation with r less than 0.03 were removed. As a result, 19 items were deleted. The questionnaires were revised into 41 items and distributed to Thai truck driver who attended the second round of Smart Driver Contest. 450 questionnaires were distributed on the second round of the field trip with 280 completed questionnaires were returned. Next, the questionnaires were sent to company Y which is also another large logistics company in Thailand. The company Y was selected because this company has implemented ISO18000 which is the certification for occupational health and safety area, indicating that the company has adopted safety practices. 550 of questionnaires together with letter of data collection were sent to the logistics manager, and 133 completed questionnaires were returned. Taken this together, total of 1,010 questionnaires were distributed after the pilot test with 413 completed ones were returned and used for the reliability and validity analysis.

3.2.5 Analysis

Several levels of analyses were performed in order to refine the measurement as well as to examine the reliability and validity of the studied instruement as per below details.

3.2.5.1 Item Analysis

Item-total correlation was performed as a mean to eliminate those items that seems to be poorly correlated with the total (Howard and Forehand, 1962). As suggested by Everitt (2002), coefficient value (*r*) less than 0.3 indicates that the corresponding items do not correlate well with the total set, thus any item with an empirical evidence of (*r*) less than 0.03 were considered to remove at this stage. As a result, 19 items were removed and 41 items of safety culture instrument were retained for further analysis. Moreover, an initial scale reliability was conducted, the Cronbach's alpha was used as an indicator to determine the level of reliability. In most studies, the acceptable Cronbach's alpha should greater than 0.70 (Nunnally, 1978) to indicate good reliability of the scale and reflects strong item covariance and adequate domain sampling (Hinkin, 2005).

3.2.5.2 Preliminary Factor Analysis

Even though, the key dimensions of safety culture in this study were structured according to accident causation model, however there is a need for exploring the factors that underlie a group of observed variables that reflect a phenomenon under study (Yang, 2005). In order to achieve this aim, the exploratory factor analysis (EFA) was performed using principal component analysis with varimax rotation was used to extract the factor structures under each of four-dimesion safety culture. This method was used to reduce large variable sets into smaller groups while retaining the original total variance as much as possible as well as exhibits uncomplicated patterns (Conway & Huffcutt, 2003). 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 (Thompson, 2004). At the end of this analysis, 4 sub-factors with total of 11 negative-items were considered to remove because those negative items were grouped together under one variable which produced no meaning to the measurement scales. Therefore, 30 items were retained for the next level of confirmatory factor analysis.

3.2.5.3 First Order Factor Analysis

At this stage, the first order factor analysis was performed using confirmatory factor analysis (CFA). CFA was conducted to test how well the actual data conformed to each measurement model as a mean to confirm the factor structure derived from previous EFA study (De Villis, 2003). The sample used in this CFA was 413 Thai truck drivers. CFA was performed six times in accordance with each measurement model that is (1) organizational support to safety modle, (2) social support to safety model, (3) preconditions for employee safety behavior model, (4) employee safety behavior model, (5) the likelihood of near-miss accident, and (6) the likelihood of accident. The goodness-of-fit measures indicating that the hypothesized measurement model fits the collecting data satisfactory, which included χ^2, χ^2/df, RMSEA, RMR, SRMR, CFI, NFI, NNFI, GFI, AGFI, PGFI, The internal consistency: Construct reliability (ρ_C) and Average variance extracted (ρ_V). The criteria of goodness-of-fit indices was presented in table 3.8. After the first order factor analysis, the results suggested that the empirical data was congruent with all hypothesized models mentioned previously.

3.2.5.4 Second Order Factor Analysis

The validation of construct validity of four-dimension safety culture model was carried on using the second order confirmatory factor analysis. The second order CFA indicated that all sub-factors were under one main factor and identified which sub-factors most important and to measure a construct model as well as validated a good fit between the conceptual model and the empirical data. Data analysis showed value of the factor loading (λ_i), standard error (SEλ_i), significant test (t), square multiple correlation (SMC), goodness of fit indices such as χ^2, χ^2/df, RMSEA, RMR, SRMR, CFI, NFI, NNFI, GFI, AGFI, PGFI, The internal consistency: Construct reliability (ρ_C) and Average variance extracted (ρ_V). The criteria of goodness-of-fit indices was presented in table 3.8.

3.2.5.5 Preliminary Concurrent Validity Analysis

The purpose of this analysis was to examine the criterion validity (i.e. concurrent validity) of the safety culture instrument. In order to achieve this aim, testing the relationship between each component of safety culture scale with safety outcomes using Pearson's Correlation Coefficient was performed. Apparently, due to the high correlation between four dimensions of safety culture, the correlation results were misleading due to some effects among four independent variables occurred. Therefore, in this study, partial correlation was introduced in order to examine the relationship between each safety culture dimension and safety outcomes. At this stage, only employee safety behavior variable was found to have a negative relationship with only the likelihood of near-miss accident ($r = 0.132$, $p < 0.01$).

3.2.5.6 Structural Equation Modeling

In this study, SEM was conducted to also examine concurrent validity, a form of criterion-related validity, which could be examine whether the studied safety culture has a relationship with safety outcomes by any mean. The objective of this part of the study was to test the congruency of hypothesis model with empirical data. The SEM in this study was conducted using LISREL program. The PRELIS procedure was used to create a matrix system file to be used as a data source for LISREL, the minimum likelihood estimates derived from covariance matrices and the likelihood ratio chi – square test statistic to evaluate goodness of fit. Data were analyzed into three levels as: 1) examine the factor loading (λ_x) in standardize form, standard error (SE$^{\lambda_x}$), significant test (t) and square multiple correlation (SMC) of the exogenous observed variables, 2) examine the factor loading (λ_y) in standardize form, standard error (SE$^{\lambda_y}$), significant test (t) and square multiple correlation (SMC) of the endogenous observed variables, and 3) examine the path coefficients, direct effects, indirect effects and total effect from the exogenous variables to the endogenous variables and the effect from endogenous variables to endogenous variables.

There are several goodness-of-fit measures that specify a good fit of a model, such as high *P* value of χ^2, χ^2/df, high value of CFI, NFI, NNFI, GFI, AGFI. and low values for the RMSEA, RMR and SRMR.

A wide range of goodness –of- fit indices have been developed that can be used as summary measures of the model's overall fit (Diamantopoulos & Signaw, 2000).

Chi- square statistics is the measure for evaluating overall model fit in covariance structure models (Diamantopoulos & Signaw, 2000). Furthermore, it provides a test of perfect fit in which the null hypothesis is that the model fits the population data perfectly. A statistically significant chi - square causes rejection of the null hypothesis, implying imperfect model fit and possible rejection of the model (Jeccard & Wan, 1996).

This study relied on number of fit indices to test the studied model, such as the Root mean square error of approximation (RMSEA), Normed fit index (NFI), Non-normed fit index (NNFI), Comparative fit index (CFI), Root mean square residual (RMR), Standardized root mean square residual (SRMR), Goodness of fit index (GFI), Adjusted goodness of fit index (AGFI), Parsimony goodness of fit index (PGFI).

Root Mean Squared Error of Approximation (RMSEA) is a measure of fit that could be expected if the model were estimated from the entire population, not just from the samples drawn for estimation. The RMSEA shows how well the model, with unknown but optimally chosen parameter values, would fit the population covariance matrix if it were available (Browne & Cudeck, 1993). LISREL provides a test of significance of the RMSEA by testing whether the value obtained is significantly different from 0.05. In detail, values of less than 0.05 are indicative of good fit, between 0.05 and under 0.08 of reasonable fit, between 0.08 and 0.10 of mediocre fit and > 0.10 of poor fit.

Comparative fit index (CFI) is defined as the ratio of improvement in non-centrality when moving from the null to a considered model, to the non-centrality of the null model (Raykov & Marcoulidex, 2006). The comparative or relative fit refers to a situation where two or more models are compared to see which on provides the best fit to the data. The null-hypothesis model or one of the models that is totally independent is a poor fit (Diamantopoulos & Siguaw, 2000). Values of CFI range from 0 to 1, and values close to 1 are considered likely to be indicative of a reasonably well-fitting model (Raykov & Marcoulides, 2006). In addition, values about 0.9 are considered to indicate a good fit (Diamantopoulos & Siguaw, 2000)

Table 3.8 The Criterion of Model Fit Indices

Fit indices	Criterion
1. Chi-square: $\chi 2$	No significant
2. p-value	$p > .05$
3. Relative Chi-square: χ^2/df	$\chi 2/df < 2.00$
4. Root Mean Square Error of Approximation: RMSEA	RMSEA < .05
5. Normed Fit Index: NFI	NFI >.90
6. Non-Normed Fit Index: NNFI	NNFI > .90
7. Comparative Fit Index: CFI	CFI > .90
8. Root Mean Square Residual: RMR	RMR < .05
9. Standardized Root Mean Square Residual: SRMR	SRMR < .05
10. Goodness of Fit Index: GFI	GFI > .90
11. Adjusted Goodness of Fit Index: AGFI	AGFI > .90
12. Parsimony Goodness of Fit Index: PGFI	PGFI > .49

Source: Diamantopoulos and Siguaw, 2000.

Standardized Root Mean Squared Residual (Standardized RMR) is a summary measure of standardized residuals. The values below 0.05 are indicative of acceptable fit (Diamantopoulos & Siguaw, 2000).

Goodness-of-fit index (GFI) is based on a ratio of the sum of the squared discrepancies to the observed variances. The goodness-of-fit index ranges from 0 to 1 and is usually fairly close to 1 for a well-fitting model (Raykov &

Marcoulides, 2006). According to Raykov and Marcoulides (2006), values exceeding 0.9 indicate a good fit to the data.

Adjusted goodness-of-fit index (AGFI). The adjusted goodness of fit is differentiated from regular goodness of fit in that it adjusts for degrees of freedom in the particular model. The range for AGFI is also 0 to 1, and is usually fairly close to 1 for a well-fitting model (Raykov & Marcoulides, 2006). The values larger than 0.9 indicate a good fit to the data. All of the key criteria for goodness of fit indices were presented in table 3.8.

CHAPTER 4

RESULTS

This chapter reports the results of both qualitative and quantitative data analyses for safety culture scale development and validation (i.e. CFA, Cronbach's alpha, AVE, CR, and SEM) as well as the results of an effect of safety culture on two safety outcomes (i.e., SEM).

4.1 Qualitative Research Findings

This section presents the findings of the quantitative research phase that aims to discover the factors of safety culture of Thai truck drivers working for private truck fleets in Thailand.

4.1.1 Demographic Characteristics of the Key Informants

Key informants who participated in the interviews were 12 logistics personnel (i.e. truck drivers, safety director, safety officers, safe-driving trainer) between the age of 25 and 50, from various companies. The details are presented in Table 4.1.

Table 4.1 Demographic Characteristics of the Key Informants

No	Age (Years)	Experience (Years)	Position	Company	Interview Methods	Duration (mins)
1	25	5	Truck driver A	A	Telephone	40
2	28	6	Truck driver B	B	Telephone	45
3	29	3	Truck driver C	C	Face-to-Face	95
4	33	6	Truck driver D	D	Telephone	49
5	36	15	Truck driver E	E	Telephone	
6	26	5	Truck driver F	F	Telephone	42

Table 4.1 (Continued)

No	Age (Years)	Experience (Years)	Position	Company	Interview Methods	Duration (mins)
7	46	10	Safety Director	G	Face-to-face	90
8	31	7	Safety officer A	G	Face-to-face	35
9	29	6	Safety officer B	G	Face-to-face	30
10	28	4	Safety officer C	H	Telephone	60
11	47	9	Defensive driving trainer A	I	Face-to-face	58
12	50	15	Defensive driving trainer B	J	Telephone	65

4.1.2 Key Factors for Safety Culture and Safety Outcomes

The results below were from the main, as well as the follow-up interviews and the themes were summarized and included after the content validity assessment by the experts.

Table 4.2 Meaning Unit Condensation Analysis Table

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: Tell me the situation when you think your boss put concern about truck driver safety? A: "There was a serious accident which one of our driver found death on the spot. My big boss called a meeting with all truck drivers, and he told us that from now on he was going to send all of us to take defensive driving class. He said that the damaged truck could be fixed or he could buy the new one, but he could not bring back the lost life to their family and loved one." (Truck driver C).	Due to the severe accident, top management express intention to improve safety by sending truck driver to attend defensive driving.	Management take concern of safety seriously and addresses the importance of safety training	-Management with safety mindset -important of safety training	Management commitment Safety training
Q: How do you know that your Taokae care for safety? A: "My Taokae was angry when he knew that the customer asked me to unload the goods. He told the customer to not let me doing the unloading job because it is dangerous. He said that I was hired to drive the truck not the loader person. He did not want me to risk myself doing thing that I was not familiar with in order to avoid any accident. I really like my Taokae for being so concern about me." (Truck driver D)	Truck fleet owner does not want the driver to do unloading task because it is risky and dangerous.	The owner concern about truck driver safety	The owner with safety mindset	Management commitment

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: What is the key factor for successful safety management in your company? A: "I do really believe that the top management support on safety bring about the great benefit to the company. When our top management first started to implement several safety practices there were many complaints from our partners. But the top management insisted that we must do it. And later on, our partners realized that such safety practices did work. The accident rate decreased and our partners were really happy with the result." (Safety Director)	Top management establish safety policy and practices even though receiving complain from business partner	Management insists to implement safety policy and practice	-Management with strong safety mindset -Important of having safety policy and procedures	Management commitment Safety policy, rules and procedures
Q: What is the key factor for successful safety management in your point of view? A: "We cannot establish good safety system without the strong support from the top management. It is the most important factor. If they involve, then thing would be a lot easier." (Defensive driving trainer B)	Involvement of top management is a key for successful implementation of safety system	Management commitment and involvement is important	Management commitment and involvement	Management commitment

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: Does your company have safety rules or safety procedures? A: "I have to say there are too many safety rules in my company because you know my company is an international company where safety rules were created and enforced by the headquarter. But I know that these rules are set in order to protect us from such accident. So, I guess it is ok to follow those rules" (Truck driver B) A: "Yes, there are many safety rules to follow" (Truck driver F)	Even though there are many safety rules to comply, but driver understand that rules are establish to protect them from accident	Truck driver understand the importance of setting up safety rules	company set up the safety rules	Safety rules
Q: How do you know whether the driver follow the rules or not? A: "We have the control room to monitor our drivers whether they follow our safety rules or not. We do not mean to pressure them, but we just want them to be safe under these rules. Most of them do not like to be watched but believe me…the safety rules keep them away from possible accidents." (Safety Director)	Control room was built to monitor truck driver while driving and check if they follow safety rules or not	Strictly monitoring safety rules using the control room	Strong implementing of safety rules	Safety rules

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
A: “There is GPS in my truck where my boss can monitor if I drive over the speed limit or not” (Truck driver E)	GPS was used in the truck to monitor driving speed	Strictly monitoring safety rules using the GPS	Strong implementing of safety rules	
Q: What the management do to support your safety? A: “My boss said he would pay for us to take defensive driving class. He believes that by attending proper driving course will make us drive more safely.” (Truck driver C) A: “They sent me to driving school when I first joined the company” (Truck driver B)	Boss believes that training will help the driver drive more safely	Management express intention to invest in safety training	Safety training investment	Support on safety training
Q: What do you think about safe driving training? A: “Many people think driving truck is easy, but you know… there are many things that we think we know but we actually not knowing until we attend the driving course. The safe driving training really gives me details where to pay special attention to while driving. It is really good that my company support me for such training.” (Truck driver A)	Driver acknowledge the importance of safe driving course and appreciate the company that provide support in safety training	Acknowledgement of important of training and company support on such training	Company provide support for safety training	Support on safety training

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: How often do you attend safe driving training? A: "In this company we have to attend the defensive driving every now and then to keep us driving more professionally. (Truck driver B) A: "In my company, we need to recurrent this training every year." (Truck driver F)	Drivers have to attend defensive driving regularly	Company promote continuous training on defensive driving	Company provide support for safety training regularly	Support on safety training
Q: How do they (truck driver) feel after attend your safe driving training course? A: "Many of my trainees did not understand why they have to attend this training class. But once they have finished the class, it is like open up their eyes. They told me that they feel more confident to drive after taking the class, and they were really thankful for that." (Defensive driving trainer A)	Truck drivers change their thought about safe driving training after attend the class as they become more confident to drive	Attend the training open the truck drivers' world	Safe driving training keeps them confident	Safety training
Q: What need to be improved in your company? A: "Mostly my company is good, except for the fact that I have received lack of support from maintenance team. Many times, that I felt my truck was not in good condition and I wanted them to check, but they refused and told me that I was too panic. I did not have	Maintenance team refused to check the truck which makes driver feel less confident to drive	Lack of maintenance impact truck driver's feeling	Lack of support from maintenance team	Support from maintenance team

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
much confident to drive in such condition you know…" (Truck driver E) A: "It would be good if they buy new truck. You know, I feel less confident when driving this truck that is older than 10 years" (Truck driver B)	New truck will make drivers work more confidently	The truck conditions affect drivers' confidence	Lack of new truck	Investment support from organization
A: "Fairness in scheduling, sometimes I feel that my schedule is too tight compare to my colleagues" (Truck Driver C)	Truck driver feels unfair when receiving the work schedule	Managing work schedule from supervisor is not fair	Unfairness supervisor	Supervisor management
Q: How your supervisor manages the driving schedule? A: "My supervisor is quite ok. But I have heard that some supervisor is not fair when he arranges work schedule. Some of my friends' schedule is very tight, too tight. I think I am so lucky that I can ask my supervisor to adjust the schedule so that I don't feel too rush for my work." (Truck driver F)	Some of supervisor managed schedule unfairly resulting in tight schedule for some truck driver	Adjustability schedule is preferred to avoid tight schedule	Supervisor management	Supervisor support

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: Is it possible to not accepting the work schedule when you feel sick or too tired? A: "It depends on your supervisor. For me, if I am really sick I will ask them. But if just being tired, I will not ask for reschedule because I feel "Krengjai" to my supervisor and my co-worker that he has to drive instead of me." (Truck driver B)	Requesting for reschedule depends on supervisor and sometimes truck driver feel "Krenjai" to do so	Truck driver trade off their risk with being "Krengjai"	The importance of Krengjai in Thai truck driver	Krengjai attitude
Q: How do you feel about your co-driver? A: "My co-driver is great. We will help each other during the long-distance drive. So, it is very important that you have a good partner with you." (Truck driver C) A: "My brother is my co-driver. So there is really no problem between us. We always support each other" (Truck driver A)	Having good co-driver will help each other during the long-distance drive	The importance of having good co-driver	Good support from co-driver	Co-driver support
Q: What is the key factor effecting your safe driving? A: "The condition of the truck is very important. Nobody would want to drive the very old truck that lacking of well maintenance, right? The good conditions of truck will keep me confident while driving." (Truck driver B)	Truck driver feel less confident while driving the less maintenance truck	Good condition of truck effect the driver's confident while driving	Good condition truck is important	Work-related conditions

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: What is the key factor effecting your safe driving? A: "Long hour drive, especially a night drive really affects my physical and mental health. When I have to drive across cities where I have to park my truck and sleep on the roadside is really dangerous. I really cannot have a good sleep during my trip and sometimes I will feel sleepy while driving." (Truck driver A)	Long hour drive at night effects truck driver health as one cannot have enough sleep or rest during the trip	Inappropriate driving condition impacts driver physical and mental condition	Fatigue driving due to lack of sleep	Personal conditions
Q: What is the key factor effecting your safe driving? A: "It is really important to have us a safe place to park our truck and take some sleep at night time. We do not have a good parking spot for truck in Thailand. Parking and sleeping along the roadside are too dangerous for accident and robbery." (Truck driver C)	Truck driver needs appropriate truck parking spot for sleep and rest in safe environment	Lack of appropriate truck parking sport	The importance of appropriate truck parking spot	Work-related conditions
A: "My tight schedule made me tired, I need more rest before driving the next trip." (Truck diver E)	Truck driver needs more rest time before start the next driving	Tight schedule impact rest time	The importance of rest time	Working conditions

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: What is your concern about truck driver safety? A: "Many companies pay the truck drivers based on number of trips they have been driven each month which is not a really good idea coz' the truck drivers who value money over safety will do whatever it takes to drive more in order to earn more. In such condition, many truck drivers are risking themselves with fatigues driving." (Safety officer A)	Truck driver is risking themselves with fatigue driving due to driving too many trips per day in order to earn more money	Trip-base payment scheme stimulate driver to drive more	Fatigue driving due to inappropriate payment system	Inappropriate payment system
Q: Tell me, how do you think you have complied with safety rules? A: "I drive according to the required speed limit at all time" (Truck driver A) A: "I never break the rules." (Truck driver C)	Truck driver strictly drive within the speed limited determined by the company Truck driver strictly follow with all the rules determined by the company	Truck driver strictly follow the safety rules	Act in compliance with safety rules	Safety compliance behavior

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: When you found the safety problems what would you do? A: "I will report my supervisor and share my suggestion to solve the problem."	Truck driver do not neglect the safety problems and involeve in reporting and sharing suggestion	Taking action on reporting and sharing information	Involvement action to safety issues	Safety involvement
Q: What are the good quality of truck driver do you think one should have? A: "Drive carefully and always mind for the safety of other road users." (Truck driver E) A: "I want them to drive safely even when there is no control with rules and legislation." (Safey officer C)	Truck driver should drive carefully and care for other road users. Drive safely regardless of rules.	Being attentive toward safety while driving	Attentive behavior is important	Driving behavior
Q: What do you think about road accident and truck driver? A: "Road accidents are one of the major issues for people like us. I used to have some small accidents, not big one though. But I have to say I have lost many of my friends from truck accidents on the road. It just happened." (Truck driver D)	Many truck drivers died due to road accidents.	Truck driver's safety is concerned with road accidents	Lost due to road accident	Risk of road accidents

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: How often you witness the truck accidents? A: "Every single day that I drive for work, I will always see the truck accidents. I always keep telling myself that I will not be one of those, but who knows? Anything could happen, don't you think?" (Truck driver F)	Truck accidents occur everyday and can happen to any truck driver	Truck accidents happen everyday	Frequency of truck accidents	Risk of truck accidents
Q: What is the major cause of truck driver accident? A: "Sleep driving is one of the major causes of truck accidents. Not only that, driving whole day long could be boring, so they usually talk on the phone with friends or families to stay awake, but that could distract their ability to drive safely. I have heard that some truck drivers do some Facebook live recording while driving the truck, which I think it is very dangerous and risky." (Safety officer B.	Sleep driving, using mobile phone while driving is dangerous and considered as major causes of truck driver accidents	Unsafe behavior is dangerous and risky to accident	Risky driving behaviors	Risk of road accidents Unsafe behavior
Q: How does your company record the safety incident? A: "In my company, there is a system which can record driving behavior such as the hard braking. We consider the hard braking as a near-miss incident in here." (Safety officer C)	There is a tool to record driving behavior such as hard braking	Hard braking is an indicator for near-miss accident	Type of near-miss accident	Near-miss accident

Table 4.2 (Continued)

Meaning Units	Condensed Meaning Units	Code	Category	Theme
Q: Please tell me about your last near-miss incident				
A: "When I was about to have a near-miss last time, it was when I tried to pull away my truck immediately to avoid crashing with the crazy motorbike. It was pretty close, thanks to myself that I could control my truck." (Truck driver A)	Ability to control truck to avoid crashing with other road users	Pull away the truck immediately to avoid crashing is an indicator of near-miss	Risk to near-miss accident	Near-miss accident
Q: Please tell me the risky behavior when driving A: "well, when driving a long distance, it is normal to feel sleepy or having absent minded. And yes, I used to have some near-miss experience due to absent-minded driving coz' I could not concentrate." (Truck driver B)	Truck driver cannot concentrate on driving due to sleepy or absent-minded	Sleepy and absent minded while driving is risky to near-miss accident	Risk to near-miss accident	Near-miss accident
Q: Apart from road accident, is there any accident involved with truck drivers? A: "Falling from the truck, I would say. As you can see the truck is huge and many times they have to get up there to load and unload goods, they could fall from the truck" (Truck driver C)	Road accident is not the only concerned issue but also include falling from the height	Truck driver may fall from the truck during their work	Risk to accident	Accident

Table 4.2 demonstrated that several themes were emerged from the interviews' result. In accordance with safety climate and safety culture literature reviews, relevant themes were assigned to each of four safety culture dimensions.

Table 4.3 Comparison of Factor in Key Dimensions of Safety Culture

Key Dimensions	Interview's Finding	Literature Reviews
1. Organizational support for safety	-Management commitment -Safety rules and policy -Safety training	-Management commitment -Communication -Management action for safety -Safety rules & procedures -Safety management system
2. Social support for safety	-Supervisor management and support -Co-worker support	-Supervisor support -Relationship with colleague
3. Preconditions for employee safety behavior	-Work-related conditions -Personal conditions	-Work environment -Work pressure -Supportive environment -Personal priority and need for safety
4. Employee safety behavior	-Safety compliance -Safety participation and involvement	-Involvement -Demonstrating actively caring to safety -Safety compliance -Safety participant

Apparently, there are too many factors emerged from previous literatures as presented in Table 4.3. In order to manage this complexity and make this research more concise and consistent with the objectives, the sub-factors emerged from interview with Thai truck drivers were strongly focused.

4.1.3 Item Generation

According to the results from previous content analysis in qualitative part, key sub-factors emerged from the interview were strongly focused for item generation process. Loads of items from existing safety climate and safety culture instruments were selected and applied into this study. In addition, the newly developed item derived from the interview were generated. As a consequent, total of 60 items were generated for the overall safety culture instrument.

In regard with organizational support for safety, 19 items were generated covering the area of management commitment, safety rules & procedures, and safety training. For social support for safety, total of 15 items were generated covering the area of supervisor management & support, and co-worker support. For preconditions for employee safety behavior, total of 15 items were generated covering the area of working conditions and personal conditions. And for employee safety behavior, 11 items were generated covering the area of safety compliance and safety participation. The back-translation procedure was conducted by two translators.

Later, the 60-item questionnaire was sent to two truck drivers for face validity purpose as well as to check their understanding of the language. The results showed that the back-translated version of items was hard to understand. Therefore, the items were revised and re-checked with the truck drivers again. After the initial face validity was found, all of 60 defined items were distributed to five subject matter experts (i.e. university professors and experts in trucking business) for the examination of content validity using Index of Congruence (IOC) process. The five experts reviewed each item using three rating scale to judge the item from +1 (when agree that the item was relevant with the construct and behavior), 0 (when hesitate that the item was relevant with the construct and behavior) and -1 (when disagree that the item was relevant with the construct and behavior). The results suggested that all of the 60 items were relevant, however required some adjustments according to experts' comments and feedback. Subsequently, the preliminary set of 60-item safety culture assessment was ready for pilot trail in order to examine the reliability of the scale as well as the quality of items.

4.2 Quantitative Research Findings

This section presents the findings involving the refinement and assurance of the validity and reliability of the newly developed safety culture scales. Firstly, 75 completed questionnaires (60 tiems) were used for pilot trial in order to examine initial Cronbach's alpha reliability analysis. The refinement of questionnaire was performed resulted in 41 items remaining. The 41-item safety culture questionnaires were sent to participant of 1,010 Thai truck drivers. The 413 completed questionnaires were used for further analysis to examine convergent validity and concurrent validity of newly developed instrument.

4.2.1 Item Analysis

In order to examine the quality of items, the item-total correlation was performed to verify if any of the item in the developed instrument was inconsistent with the averaged set of items. Any item with the empirical evidence of an item-total correalation value less than 0.3 was removed.

4.2.1.1 Pilot Participants

The first group of samples included 75 truck drivers with completed questionnaire. All of them were male at the age between 20 and 50 years old. Mostly had primary school and high school degree (90%) with 2-5 years of experience in current company.

4.2.1.2 Results of Item-total Correlation

Due to the nature of this instrument was multidimensional scale, the process of examining item-total correlation was performed separately by each scale. As a result, 19 itmes of organizational support for safety showed initial Cronbach's alpha at 0.824, 5 items with *r* value less than 0.3 was removed (i.e. ORG5, ORG6, ORG9, ORG14, and ORG 15) and this increased the Cronbach's alpha to 0.846 for the first sub-scale as presented in table 4.4.

Table 4.4 Item-Total Correlation for Organizational Support for Safety Scale

	Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**	**Selection**
ORG1	73.14	59.694	.435	.816	Yes
ORG2	73.02	59.732	.395	.817	Yes
ORG3	73.86	53.516	.426	.818	Yes
ORG4	74.14	52.123	.493	.812	Yes
ORG5	75.11	57.739	.201	.836	No
ORG6	73.11	60.203	.252	.820	No
ORG7	73.49	54.969	.619	.804	Yes
ORG8	73.19	58.944	.507	.814	Yes
ORG9	73.67	56.262	.290	.821	No
ORG10	74.04	52.892	.512	.810	Yes
ORG11	73.05	57.122	.666	.807	Yes
ORG12	73.12	56.895	.602	.808	Yes
ORG13	73.19	57.730	.528	.811	Yes
ORG14	74.79	58.526	.204	.831	No
ORG15	73.16	60.707	.289	.821	No
ORG16	72.89	60.167	.420	.817	Yes
ORG17	72.96	58.999	.520	.814	Yes
ORG18	72.91	59.010	.574	.813	Yes
ORG19	72.95	58.872	.539	.813	Yes

Next, 15 items of social support for safety showed initial Cronbach's alpha at 0.838, 4 items with *r* value less than 0.3 was removed (i.e. SOC1, SOC3, SOC8, and SOC13), this increased the Cronbach's alpha to 0.848 for the second sub-scale as presented in table 4.5.

Table 4.5 Item-Total Correlation for Social Support for Safety Scale

	Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**	**Selection**
SOC1	55.34	54.918	.188	.841	No
SOC2	56.20	47.717	.481	.829	No
SOC3	55.51	52.771	.262	.841	Yes
SOC4	56.46	45.046	.618	.818	Yes
SOC5	55.47	50.254	.525	.825	Yes
SOC6	55.46	53.149	.476	.831	Yes
SOC7	55.44	51.802	.607	.825	No
SOC8	55.44	53.733	.290	.834	Yes
SOC9	56.25	44.917	.608	.819	Yes
SOC10	56.12	45.106	.639	.816	Yes
SOC11	55.36	50.992	.669	.822	Yes
SOC12	55.27	52.822	.484	.830	No
SOC13	55.49	53.634	.250	.840	Yes
SOC14	56.07	46.650	.583	.821	Yes
SOC15	55.61	51.001	.395	.833	Yes

Next, 15 items of preconditions for employee safety behavior showed initial Cronbach's alpha at 0.618, 7 items with *r* value less than 0.3 was removed (i.e. PRE1, PRE3, PRE6, PRE7, PRE12, PRE13 and PRE15) and this increased the Cronbach's alpha to 0.782 for the third sub-scale, as presented in table 4.6.

Table 4.6 Item-Total Correlation for Preconditions for Employee Safety Behavior Scale

Item-Total Statistics					
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**	**Selection**
PRE1	55.25	39.546	-.512	.739	No
PRE2	54.40	29.674	.314	.593	Yes
PRE3	54.18	31.326	.239	.606	No
PRE4	55.02	24.910	.582	.532	Yes
PRE5	55.04	24.249	.566	.529	Yes
PRE6	54.46	31.538	.141	.615	No
PRE7	54.04	30.677	.283	.600	No
PRE8	54.82	25.112	.502	.546	Yes
PRE9	55.12	26.181	.432	.563	Yes
PRE10	53.89	31.167	.390	.603	Yes
PRE11	54.89	27.024	.393	.573	Yes
PRE12	53.91	31.224	.177	.611	No
PRE13	54.18	32.683	-.042	.642	No
PRE14	55.40	26.066	.447	.560	Yes
PRE15	54.04	32.106	.107	.618	No

Lastly, 11 items of employee safety behavior showed initial Cronbach’s alpha at 0.658, 3 items with *r* value less than 0.3 was removed (i.e. EMP5, EMP7 and EMP9) and this increased the Cronbach’s alpha to 0.761 for the last sub-scale as presented in table 4.7.

Table 4.7 Item-Total Correlation for Employee Safety Behavior Scale

	Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**	**Selection**
EMP1	42.03	21.219	.364	.644	Yes
EMP2	41.80	19.451	.449	.610	Yes
EMP3	42.67	18.972	.326	.636	Yes
EMP4	42.22	20.749	.350	.630	Yes
EMP5	42.37	19.965	.216	.664	No
EMP6	41.98	19.271	.572	.592	Yes
EMP7	42.02	21.237	.270	.643	No
EMP8	41.90	19.888	.376	.623	Yes
EMP9	42.57	24.182	-.112	.714	No
EMP10	41.53	21.168	.560	.617	Yes
EMP11	41.58	20.451	.521	.610	Yes

According to item analysis results, the safety culture instrument was refined to 41-item questionnaire consisted of; 14 items of organizational support for safety with Cronbach's alpha 0.846, 11 items of social support for safety with Cronbach's alpha 0.848, 8 items of preconditions for employee safety behavior with Cronbach's alpha 0.782, and 8 items of employee safety behavior with Cronbach's alpha 0.761. Therefore, the findings indicated an acceptable reliability for the four sub-scales.

4.2.2 Preliminary Factor Analysis

The revised 41-item questionnaires were sent to 1,010 truck drivers and 413 completed questionnaires (accounted for 40.89%) were returned for further analysis.

4.2.2.1 Demographic Statistics

This session provided the information in regard with demographic statistics which included the demographic of pariticipants (n = 413), descriptive statistic of four-dimension safety culture, demographic statistic of each sub-factor, and demographic statistic of safety outcomes.

Table 4.8 Sample Participants Demographic (n=413)

Demographic	Frequency	Percentage
Gender		
Male	412	99.758
Female	1	0.242
Total	**413**	**100.000**
Status		
Single	118	28.571
Married	279	67.554
Others	16	3.874
Total	**413**	**100.000**
Age		
Less than 31 year	70	16.949
31-40 year	165	39.952
41- 50 year	142	34.383
More than 50 year	36	8.717
Total	**413**	**100.000**
Education level		
Primary school	160	38.741
High school	201	48.668
Vocational School	46	11.138
Bachelor Degree	2	0.484
No education	4	0.969
Total	**413**	**100.000**

Table 4.8 (Continued)

Demographic	Frequency	Percentage
Truck type		
6-wheel	68	16.626
10-wheel	34	8.313
Tow-truck	80	19.560
Trailer-truck	225	55.012
Others	2	0.489
Total	**409**	**100.000**
License		
GE type 3	139	33.820
GE type 4	181	44.039
PE type 3	30	7.299
others	2	0.487
Total	**411**	**100.000**
Work experiences for current company		
Not more than 2 years	94	23.267
More than 2 years - 5 years	140	34.653
More than 5 years - 9 years	90	22.277
More than 9 years	80	19.802
Total	**404**	**100.000**
Work experiences for driving		
Not more than 5 years	74	18.317
More than 5 years - 10 years	163	40.347
More than 10 years - 15 years	56	13.861
More than 15 years - 20 years	60	14.851
More than 20 years	51	12.624
Total	**404**	**100.000**
Time drive (Hours per day)		
Not more than 6 hours	83	20.097

Table 4.8 (Continued)

Demographic	Frequency	Percentage
7 – 8 hours	157	38.015
9 – 10 hours	80	19.370
More than 10 hours	93	22.518
Total	**413**	**100.000**
Distance drive (km. per day)		
Not more than 100 km.	68	16.465
More than 100 – 200 km.	97	23.487
More than 200 – 300 km.	97	23.487
More than 300 – 400 km.	55	13.317
More than 400 km.	96	23.245
Total	**413**	**100.000**
Number of trucks in this company		
Not more than 20 trucks	45	15.101
More than 20 - 60 trucks	97	32.550
More than 60 - 100 trucks	67	22.483
More than 100 trucks	89	29.866
Total	**298**	**100.000**
Driving style		
Short-haul in one day	226	54.722
Long - haul domestic	42	10.169
Long - haul international	16	3.874
Mixed	129	31.235
Total	**413**	**100.000**
Number driver		
1 driver	341	82.567
2 drivers	72	17.433
Total	**413**	**100.000**

Table 4.8 showed that the majority of respondents were male (99.758%). Most of them were found to be at the age between 31 to 50 years old (74.33%). Only few of the respondents held a bachelor degree (0.48%) as they mainly completed primary school (38.74%) and high school (48.67%). The main vehicles that the majority of the respondents used were the trucks that larger than six-wheel truck accounted for 83.37% (i.e. trailer truck (55.01%), tow-truck (19.56%) and 10-wheel truck (8.31%) respectively). Most of them held the driving license that allowed them to operate the large trucks (GE-3 license, 33.82%) and large truck that carried dangerous goods (GE-4 license, 44.04%). Report also shows that they had total work experiences in driving more than five years which is accounted for 81.68% . Approximately 80% of the respondents appeared to drive more than 6 hours a day with the distance more than 100 kms per day (83.54%). Mainly, the respondents were found to drive alone without co-driver (82.57%). Domestic short-haul driving style was the majority driving style for most of the respondents (54.72%), followed by the mix between short-haul and long-haul driving style (31.24%).

4.2.2.2 Results of Sampling Adequacy

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. The result in table 4.9 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. Next, the Exploratory Factor Analysis (EFA) was performed to identify factor structure of each safety culture dimension.

Table 4.9 Result of KMO and Barlett's Test of Sphericity

Factor Structure of Safety Culture	Number of items	Barlett's Test of Sphericity			Kaiser –Mayer-Olkin Measure of Sampling Adequacy (KMO)		
		Approx. Chi-Square	**df**	**Sig.**	**Criterion**	**KMO Value**	**Result**
1. Organizational support for safety	14	2952.64	91	0.00	> 0.50	0.91	Very Good
2. Social support for safety	11	1284.82	55	0.00	> 0.50	0.82	Very Good
3. Pre-conditions to Employee Safety Behavior	8	774.72	28	0.00	> 0.50	0.67	Fair
4. Employee Safety Behavior	8	745.33	28	0.00	> 0.50	0.70	Good

4.2.2.3 Results of Exploratory Factor Analysis

The EFA was conducted using principal component analysis with varimax rotation to perform factor extraction in each four-safety culture scale. First, started with EFA for organizational support for safety and the results as shown in table 4.9 and 4.10.

Table 4.10 Eigenvalues and Reliability Organizational Support for Safety

Sub-Factor	Number of items	Eigen values	% of variance	Cumulative % of variance	Reliability
1	5	6.53	46.66	46.66	0.90
2	2	1.38	9.88	56.55	
3	7	1.10	7.84	64.39	

The result demonstrated that the 14 items under organizational support for safety construct were grouped into 3 factors with Eigen value more than 1.00. The cumulative % of variance was 64.39% and reliability of this 14-item scale was 0.90. However, the second factor was grouped by all the negative items that produced no meaning to the scale, thus the researcher removed these negative items (item 3 and item 7) out of the scale and the reliability increased to 0.91. As a consequent, the Factor 1: Organizational support for safety was composed of 2 sub-factors that is – management commitment (5 items), and safety rules & training (7 items).

Table 4.11 Factor Extraction of Organizational Support for Safety

Sub-Factor		Items	Factor Loading	Mean	SD	Level
Management Commitment	1	This company solves safety issues in a fast and efficient manner.	0.77	4.08	0.97	high
	2	This company pays more attention to driver safety than any other companies that I used to work with.	0.65	4.15	0.95	high
	4	This company has incentives for employees who Comply with safety regulations.	0.74	3.80	1.05	high
	5	This company open to feedback for improving employee safety and take it seriously.	0.80	3.91	0.96	high
	6	This company has a constant communication that promotes safety at work.	0.70	4.15	0.86	high
Negative items	3	This company do not care when employees violate safety regulations. (-)	0.86	3.91	0.92	high

Table 4.11 (Continued)

Sub-Factor	Items	Factor Loading	Mean	SD	Level	
	7	This company cares about the profitability rather than employees' safety. (-)	0.70	3.44	1.21	high
Safety Rules & Training	8	This company has safety rules and safety procedures as a guideline for employee to follow.	0.61	4.31	0.79	highest
	9	I believe the company's safety rules and procedure can prevent errors in the work.	0.75	4.31	0.73	highest
	10	The rules and procedures for safe operation of this company are practicable.	0.79	4.21	0.70	highest
	11	This company encourages drivers to regularly attend safe driving and safe operation training.	0.63	4.22	0.96	highest
	12	Training enables me to know the limitations of driving a large truck that I've never known before (i.e. the blind spot of a truck)	0.81	4.34	0.69	highest
	13	I can work confidently and safely after I receive safe driving training.	0.83	4.42	0.67	highest
	14	The safe driving training courses that I attend are useful and applicable to my work.	0.63	4.41	0.68	highest

Next, followed with EFA for social support for safety and the results as shown in table 4.12 and 4.13. Again, the EFA was conducted using principal component analysis with varimax rotation to perform factor extraction in this factor 2.

Table 4.12 Eigenvalues and Reliability of Social Support for Safety

Sub-Factor	Number of items	Eigen values	% of variance	Cumulative % of variance	Reliability
1	5	3.91	35.57	35.57	0.79
2	4	1.51	13.75	49.33	
3	2	1.02	9.27	58.60	

The result in table 4.13 demonstrated that the 11 items under social support for safety construct were grouped into 3 factors with Eigen value more than 1.00. The cumulative % of variance was 58.60% and reliability of this 11-item scale was 0.79. However, the second factor was grouped by all the negative items that produced no meaning to the scale, thus the researcher removed these negative items (item 15, item 21, item 24 and item 25) out of the scale and the reliability (Cronbach's Alpha if item deleted) increased to 0.82. As a consequent, the Factor 2: Social support for safety was composed of 2 sub-factors that is – supervisor support (5 items), and co-worker support (2 items).

Table 4.13 Factor Extraction of Social Support for Safety

Sub-Factor		Items	Factor Loading	Mean	SD	Level
Supervisor Support	16	My supervisor allows staffs to change the work schedule if sick or too fatigue to drive.	0.60	3.89	0.99	high
	17	My supervisor properly manages work schedule which allows enough time to safely delivery.	0.77	4.01	0.86	high

Table 4.13 (Continued)

Sub-Factor		Items	Factor Loading	Mean	SD	Level
	18	Mostly, I have received information about the work safety from my supervisor.	0.79	3.95	0.80	high
	19	I can openly talk about safety issues with my supervisor.	0.74	4.08	0.77	high
	20	My supervisor usually monitors the work in accordance with the rules and policies of the company.	0.54	4.09	0.66	high
Negative items	15	My supervisor often overlooks the driver's safety problems. (-)	0.70	3.70	0.93	high
	21	During the urgent task, my supervisor will order me to work faster rather than to follow safety practice. (-)	0.61	3.79	0.98	high
	24	My co-workers here do not care to follow the safety rules and policies of the company. (-)	0.80	3.68	0.98	high
	25	At this company, the technician team rarely cooperates in the care of equipment and vehicle's maintenance as it should. (-)	0.54	3.50	1.06	high
Co-worker Support	22	My co-workers here advise each other to help me work more safely.	0.80	4.21	0.72	highest
	23	My co-workers warn me when I try to violate the company's safety rules.	0.87	3.97	0.88	high

Next, followed with EFA for preconditons for employee safety behavior and the results as shown in table 4.14 and 4.15. Again, the EFA was conducted using principal component analysis with varimax rotation to perform factor extraction in this factor 3.

Table 4.14 Eigenvalues and Reliability of Preconditions to Employee Safety Behavior

Sub-Factor	Number of items	Eigen values	% of variance	Cumulative % of variance	Reliability
1	2	2.64	33.01	33.01	0.67
2	3	1.62	20.19	53.20	
3	3	1.10	13.78	66.98	

The result in table 4.15 demonstrated that the 8 items under preconditions to employee safety behavior construct were grouped into 3 factors with Eigen value more than 1.00. The cumulative % of variance was 66.98% and reliability of this 8-item scale was 0.67. However, the second factor was grouped by all the negative items that produced no meaning to the scale, thus the researcher removed these negative items (item 28, item 29, and item 31) out of the scale and the reliability (Cronbach's Alpha if item deleted) increased to 0.72. As a consequent, the factor 3: preconditions to employee safety behavior was composed of 2 sub-factors that is – work conditions (2 items), and personal conditions (3 items).

Table 4.15 Factor Extraction of Employee Safety Behavior

Sub-Factor		Items	Factor Loading	Mean	SD	Level
Work Conditions	26	There are enough drivers to handle the workload of the company so I do not have to perform rush-driving.	0.85	3.76	0.96	high
	27	The truck that I use here is always in good condition with regular maintenance.	0.81	3.96	1.01	high
Negative items	28	My recent driving schedule is too tight which giving me less time to rest. (-)	0.67	3.43	1.03	high
	29	I put accidents down to bad luck which cannot be avoid or prevent. (-)	0.79	3.73	1.14	high
	31	If worry too much about safety, my job will not be done in time. (-)	0.82	3.58	1.19	high
Personal Conditions	30	Personally, work safety is most important to me.	0.77	4.50	0.73	highest
	32	Getting enough rest before driving is very important to me.	0.88	4.48	0.77	highest
	33	I have strong physical and mental health before driving.	0.78	4.37	0.78	highest

Lastly, followed with EFA for employee safety behavior and the results as shown in table 4. 16 and 4. 17. Again, the EFA was conducted using principal component analysis with varimax rotation to perform factor extraction in this factor 4.

Table 4.16 Eigenvalues and Reliability Employee Safety Behavior

Sub-Factor	Number of items	Eigen values	% of variance	Cumulative % of variance	Reliability
1	3	2.82	35.20	35.20	0.70
2	2	1.41	17.63	52.83	
3	3	1.08	13.45	66.28	

The result in table 4. 17 demonstrated that the 8 items under preconditions to employee safety behavior construct were grouped into 3 factors with Eigen value more than 1.00. The cumulative % of variance was 66.28% and reliability of this 8-item scale was 0.67. However, the second factor was grouped by all the negative items that produced no meaning to the scale, thus the researcher removed these negative items (item 35 and item 36) out of the scale and the reliability (Cronbach's Alpha if item deleted) increased to 0.72. As a consequent, the Factor 4: Employee Safety Behavior was composed of 2 sub-factors that is – attentive action to safety (3 items), and supportive action to safety (3 items).

Table 4.17 Factor Extraction of Employee Safety Behavior

Sub-Factor		Items	Factor Loading	Mean	SD	Level
Attentive Action to Safety	34	I adhere to the safety rules and strictly follow the safety procedures of the company.	0.63	4.57	0.81	highest
	40	I drive carefully and mind the safety of other road users.	0.79	4.68	0.65	highest
	41	Even there is no safety rules, I still care about safe driving.	0.86	4.67	0.69	highest
Negative items	35	I violate the traffic rules while driving a truck. (-)	0.89	4.17	0.89	high

Table 4.17 (Continued)

Sub-Factor		Items	Factor Loading	Mean	SD	Level
Supportive Action to Safety	36	I take a shortcut and accept the risk of accident in exchange for convenience working. (-)	0.79	4.35	0.92	highest
	37	I often report safety-related issues to the team.	0.74	3.98	1.05	high
	38	I help guiding my co-workers to work safely.	0.71	4.02	0.85	high
	39	I dare to speak or suggest a solution to safety-related issues with the management.	0.83	3.70	1.19	high

In summary, the EFA results suggested that the four-dimension safety culture instrument in this study was consisted of 8 sub-factors with 30 items in total. The organizational support for safety scale was composed of 2 sub-factors as (1) management commitment, and (2) safety rules & training, produced the Cronbach's alpha at 0.91. The social support for safety scale was composed of 2 sub-factors as (1) supervisor support, and (2) co-worker support, produced the Cronbach's alpha at 0.82. The preconditions for employee safety behavior scale was composed of 2 sub-factors as (1) working conditions, and (2) personal conditions, produced the Cronbach's alpha at 0.72. Finally, the employee safety behavior scale was composed of 2 sub-factors as (1) attentive action to safety, and (2) supportive action to safety, produced the Cronbach's alpha at 0.72. As a consequent, the 30-item safety culture scale was used in Confirmatory Factor Analysis (CFA) to confirm the factor structure as well as to examine the validity of the scales.

4.2.3 Validation of Measurement Model

The purpose of this level of analysis is to confirm the factor structure derived from EFA which an aim to identify adequate items for further analysis. Principal component factor analysis was separately run on each factor. The factor analysis was run to determine the appropriate assignment of an individual item to a factor. Factor loading score will be used to assign the items to each factor. It is suggested that the top of that factor is contributing significantly to the construct. Results for descriptive statistics and each factor analysis models were explained below.

4.2.3.1 Descriptive Statistics

The results shown in Table 4 . 18 suggested that, the overall score of safety culture was considered high level ($\overline{X}$ = 4.17). The result also revealed that 'employee safety behavior' has the highest mean ($\overline{X}$ = 4.27, SD = 0.58), followed by 'preconditions for safety behavior' ($\overline{X}$ = 4.21, SD = 0.59), 'organizational support to safety' ($\overline{X}$ = 4.19, SD = 0.60), and 'social support to safety' ($\overline{X}$ = 4.03, SD = 0.56) respectively.

Table 4.18 Descriptive Statistic of Four-Dimension Safety Culture (30 Items)

Main Factors "Safety Culture"	$\overline{X}$	SD	Level	Order
1. Organizational support to safety	4.19	0.60	high	3
2. Social support to safety	4.03	0.56	high	4
3. Preconditions for safety behavior	4.21	0.59	highest	2
4. Employee safety behavior	4.27	0.58	highest	1
Over all	**4.17**	**0.49**	**high**	

The result from table 4.10 showed the overall eight sub-factors of safety culture. The top three highest mean were found in 'personal conditions' ($\overline{X}$ = 4.45, SD = 0.69), followed by 'supportive action to safety' ($\overline{X}$ = 4.35, SD = 0.61), and 'safety rules & training' ($\overline{X}$ = 4.31, SD = 0.58) respectively. In addition, there were five sub factors considered as high level as follow: Attentive Action to Safety ($\overline{X}$ = 4.19, SD = 0.69), Co-worker support ($\overline{X}$ = 4.09, SD = 0.70), Supervisor support ($\overline{X}$ =

4.01, SD = 0.61), Management commitment ($\overline{X}$ = 4.01, SD = 0.77) and Working conditions ($\overline{X}$ = 3.86, SD = 0.84) respectively.

Table 4. 19 Descriptive Statistic of Sub-Factors Safety Culture

Sub factors of Safety Culture	$\overline{X}$	**SD**	**Level**	**Order**
Factor 1: Organizational Support for Safety				
Management commitment	4.01	0.77	high	7
Safety rules and training	4.31	0.58	highest	3
Factor 2: Social Support for Safety				
Supervisor support	4.01	0.61	high	6
Co-worker support	4.09	0.70	high	5
Factor 3: Preconditions to employee safety behavior				
Working conditions	3.86	0.84	high	8
Personal conditions	4.45	0.63	highest	1
Factor 4: Employee Safety Behavior				
Attentive Action to Safety	4.19	0.69	high	4
Supportive Action to Safety	4.35	0.61	highest	2

Finally, the results shown in Table 4 . 4 revealed that both of safety outcomes were reported at the lowest level (i.e. 'likelihood of near-miss accidentt' ($\overline{X}$ = 1.26, SD = 0.29) and 'likelihood of accident' ($\overline{X}$ = 1.08, SD = 0.19).

Table 4.20 Descriptive Statistic of Safety Outomes

Safety Outcomes	**Mean**	**SD**	**Level**	**Order**
1. Likelyhood of Near-miss Accident				
1.1 Suddenly hard breaking with almost crash	1.45	0.53	lowest	1
1.2 Suddenly pull over with almost crash	1.32	0.48	lowest	2

Table 4.20 (Continued)

Safety Outcomes	Mean	SD	Level	Order
1.3 Sleep driving with almost lost control	1.22	0.45	lowest	3
1.4 Absentminded driving with almost lost control	1.21	0.42	lowest	4
1.5 Lost balance with almost fall from the height	1.14	0.35	lowest	5
Overall	**1.26**	**0.29**	**lowest**	
2. Likelyhood of Accident				
1. Unable to break	1.17	0.39	lowest	1
2. Unable to control the steering wheel	1.07	0.26	lowest	3
3. Accident due to sleep driving	1.03	0.17	lowest	5
4. Accident due to absentminded	1.08	0.30	lowest	2
5. Accident due to fall from the height	1.07	0.29	lowest	4
Overall	**1.08**	**0.19**	**lowest**	

4.2.3.2 CFA of Organizational Support for Safety Scale

First of all, the instrument was examined using a factor analytic technique (FA) to determine whether the hypothesized two-factor structure of the organizational support for safety fit the data for the current study and to discover the latent factor. The instrument was comprised of 12 items measuring two constructs termed as: management commitment to safety (MANAG), safety rules & training (RULE). Management commitment (MANAG) was measured by the first 5 items, and safety rules and training (RULE) was measured by the last 7 items. Following factor analysis, LISREL were used to prepare organizational support for safety model. Results for factor analysis models are explained below.

Table 4.21 Pearson's Correlation Coefficient of Organizational Support for Safety Model

	MANAG1	**MANAG2**	**MANAG3**	**MANAG4**	**MANAG5**	**RULE1**	**RULE2**	**RULE3**	**RULE4**	**RULE5**	**RULE6**	**RULE7**
MANAG1	1.000											
MANAG2	0.606*	1.000										
MANAG3	0.537*	0.413*	1.000									
MANAG4	0.605*	0.531*	0.576*	1.000								
MANAG5	0.582*	0.611*	0.473*	0.625*	1.000							
RULE1	0.444*	0.447*	0.390*	0.382*	0.509*	1.000						
RULE2	0.460*	0.439*	0.340*	0.418*	0.467*	0.579*	1.000					
RULE3	0.432*	0.434*	0.319*	0.395*	0.429*	0.529*	0.707*	1.000				
RULE4	0.431*	0.354*	0.445*	0.400*	0.384*	0.519*	0.469*	0.480*	1.000			
RULE5	0.414*	0.390*	0.341*	0.388*	0.429*	0.487*	0.519*	0.624*	0.560*	1.000		
RULE6	0.448*	0.404*	0.351*	0.415*	0.503*	0.526*	0.625*	0.629*	0.577*	0.723*	1.000	
RULE7	0.352*	0.390*	0.283*	0.398*	0.475*	0.371*	0.457*	0.427*	0.420*	0.560*	0.635*	1.000

Note: * Significant at the 0.05 level

Table 4.22 Factor Loading of the Organizational Support for Safety Model

Organizational support for safety	Factor loading (λ_i)	Standard Error (SE_{λ_i})	Significant test (t)	(SMC)
MANAG1	0.807*	-	-	0.651
MANAG2	0.758*	0.070	13.455	0.575
MANAG3	0.653*	0.069	11.633	0.426
MANAG4	0.749*	0.066	14.087	0.561
MANAG5	0.836*	0.067	15.313	0.699
RULE1	0.741*	-	-	0.549
RULE2	0.743*	0.078	12.954	0.552
RULE3	0.742*	0.083	12.107	0.551
RULE4	0.680*	0.073	12.503	0.462
RULE5	0.816*	0.084	13.097	0.666
RULE6	0.840*	0.087	13.108	0.706
RULE7	0.663*	0.082	10.911	0.440
Construct reliability (ρ_c) = 0.94				
Average variance extracted (ρ_v) = 0.57				

Note: * Significant at the 0.05 level

From the table 4.22 revealed that all factors loading was significant at the 0.05 level, range of factor loading between 0.653 - 0.840, Standard error 0.066 - 0.087 and square multiple correlations (SMC) 0.426 - 0.706. The factor loading data of each construct was further analyzed to identify the value of average variance extracted (AVE) and construct reliability (CR) which indicating the level of validity and reliability of the constructs. The analysis revealed that the construct reliability (ρ_c) was 0.94, indicated convergent validity which is higher than 0.60 (Hair et al., 2010, p. 680) that means the reliability of model structure is 94% . The average variance extracted (ρ_v) was 0. 57, indicated that the organizational support for safety (ORGAN) model could explain 57% of observed variables variance (Diamantopoulos & Siguaw, 2000, p. 91). The AVE in this model is higher than the suggested criteria of 0. 5 demonstrated the convergent validity of the studied model. The result was shown in the figure 4.1.

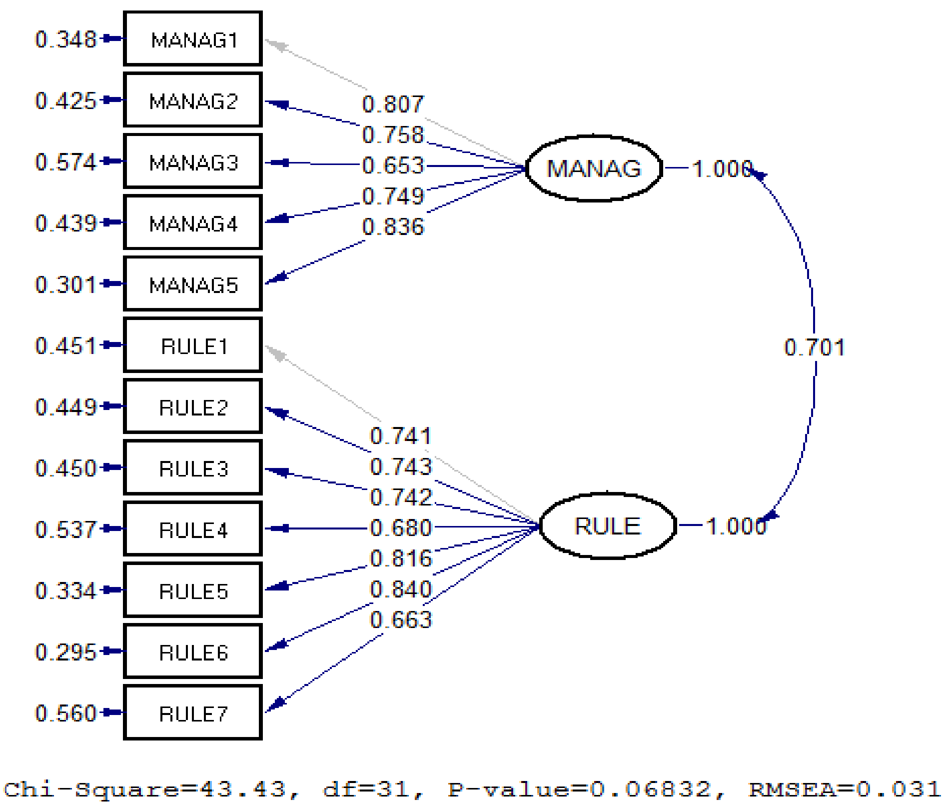

Figure 4.1 Organizational Support for Safety Measurement Model

The validation of organizational support for safety (OGAN) measurement model were presented by goodness of fit indices as shown in table 4.23. The 2 sub-factors with a total of 12 items were run. The results of the CFA for the organizational support for safety (OGAN) showed the following statistics: χ^2= 43.428, df = 31, p = 0.068, χ^2/df = 1.401, RMSEA = 0.031, NFI = 0.993, NNFI = 0.995, CFI = 0.998, RMR = 0.024, SRMR = 0.024, GFI = 0.983 and AGFI = 0.957. The CFA results of 2 sub-factor of organization support for safety model revealed that the goodness of fit was adequate and acceptable. The results indicated that the management commitment to safety (MANAG) was measured by 5 observed variables, safety rules & training (RULE) was measured by 7 observed variables, which might be concluded that the convergent validity of this construct was adequate.

Table 4.23 Goodness of Fit Indices of the Organizational Support for Safety Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	43.428	-	-
2. *df*	31.000	-	-
3. *p*	0.068	$p > .050$	Support
4. χ^2/df	1.401	$\chi^2/df < 2.000$	Support
5. RMSEA	0.031	RMSEA < .050	Support
6. NFI	0.993	NFI >.900	Support
7. NNFI	0.995	NNFI > .900	Support
8. CFI	0.998	CFI > .900	Support
9. RMR	0.024	RMR < .050	Support
10. SRMR	0.024	SRMR < .050	Support
11. GFI	0.983	GFI > .900	Support
12. AGFI	0.957	AGFI > .900	Support

4.2.3.3 CFA of Social Support for Safety Scale

This instrument was comprised of 7 items measuring two constructs termed as: supervisor support (SUPER) and co-worker support (CO-WOR).

Supervisor support (SUPER) was measure by 5 items and Co-worker support (CO-WOR) was measured by 2 items. Following factor analysis, LISREL were used to prepare social support for safety model. Results for factor analysis models are explained below.

Table 4.24 Pearson's Correlation Coefficient of Social Support for Safety Model

	SUPER1	SUPER2	SUPER3	SUPER4	SUPER5	CO-WOR1	CO-WOR2
SUPER1	1.000						
SUPER2	0.548*	1.000					
SUPER3	0.290*	0.471*	1.000				
SUPER4	0.377*	0.528*	0.592*	1.000			
SUPER5	0.357*	0.477*	0.405*	0.518*	1.000		
CO-WOR1	0.287*	0.301*	0.309*	0.449*	0.493*	1.000	
CO-WOR2	0.346*	0.220*	0.189*	0.299*	0.421*	0.533*	1.000

Note: * Significant at the 0.05 level

Results of the Pearson's correlation coefficient and factor analysis for the social support for safety (SOCIAL) factor as shown below in table 4.24.

Table 4.25 Factor Loading of the Social Support for Safety Model

Social support to safety	**Factor loading (λ_i)**	**Standard Error (SE λ_i)**	**Significant test (t)**	**(SMC)**
SUPER1	0.526*	-	-	0.277
SUPER2	0.706*	0.154	8.702	0.498
SUPER3	0.627*	0.167	7.127	0.393
SUPER4	0.767*	0.185	7.854	0.588
SUPER5	0.671*	0.177	7.202	0.450
CO-WOR1	0.919*	-	-	0.845
CO-WOR4	0.576*	0.091	6.908	0.332
Construct reliability (ρ_c) = 0.86				
Average variance extracted (ρ_v) = 0.48				

Note: * Significant at the 0.05 level

Result from the table 4.25 revealed that all factors loading was significant at the 0.05 level, range of factor loading between 0.526 - 0.919, Standard error 0.041 - 0.087 and square multiple correlations (SMC) 0.277 - 0.845. The factor loading data of each construct was further analyzed to identify the value of average variance extracted (AVE) and construct reliability (CR) which indicating the level of validity and reliability of the constructs. The analysis revealed that the overall of 'social support for safety' factor has AVE = 0.48 and CR = 0.86. Even though, AVE should be higher than 0.50, it is acceptable at 0.40 if the CR is higher than 0.60 because the convergent validity of the construct remains adequate (Fornell & Larcher,1981). Thus, it is reasonable to accept the 'social support for safety' construct in this study. The overall result of the 'social support for safety' measurement model demonstrated the reliability as well as the convergent validity of the studied model.

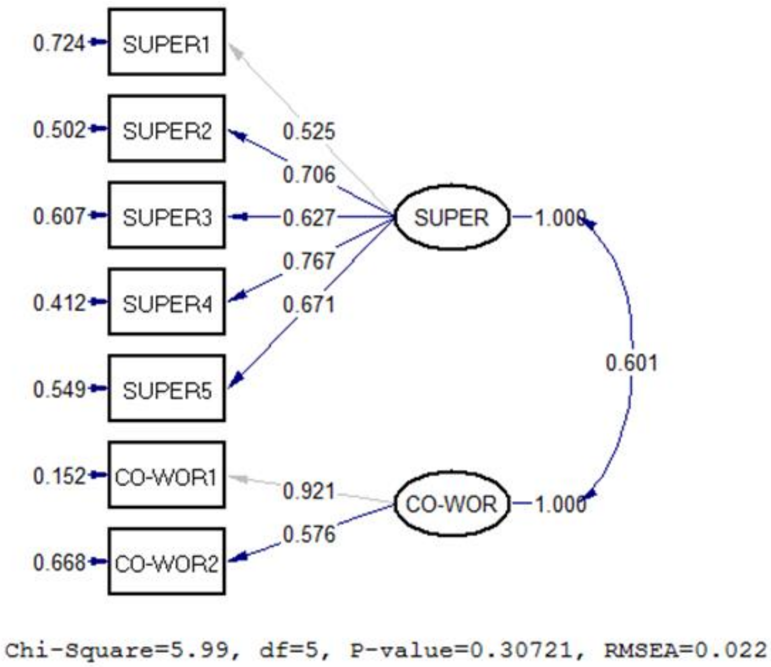

Figure 4.2 Social Support for Safety Model

The validation of social support for safety (SOCIAL) measurement model was presented by goodness of fit indices as table 4.26. The 2 sub-factor with a total of 7 items were run. The results of the CFA for the social support for safety

(SOCIAL) 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 CFA results of 2 sub-factor of social support for safety model revealed that the goodness of fit was adequate and acceptable. The results indicated that the supervisor support was measured by 5 observed variables and the co-worker support was measured by 2 observed variables, which might be concluded that the convergent validity of this construct was adequate.

Table 4.26 Goodness of Fit Indices of the Social Support for Safety Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	5.990	-	-
2. *df*	5.000	-	-
3. *p*	0.307	$p > .050$	Support
4. χ^2/df	1.198	$\chi^2/df < 2.000$	Support
5. RMSEA	0.022	RMSEA < .050	Support
6. NFI	0.996	NFI >.900	Support
7. NNFI	0.997	NNFI > .900	Support
8. CFI	0.999	CFI > .900	Support
9. RMR	0.015	RMR < .050	Support
10. SRMR	0.015	SRMR < .050	Support
11. GFI	0.996	GFI > .900	Support
12. AGFI	0.977	AGFI > .900	Support

4.2.3.4 CFA of Preconditions for Employee Safety Behavior Scale

This instrument was comprised of 5 items measuring two constructs termed as: working conditions (WORK) and personal conditions (PERSON).

Working conditions (WORK) was measured with the by 2 items and personal conditions (PERSON) was measured by 3 items. Following factor analysis, LISREL were used to prepare preconditions for safety behavior model. Results for factor analysis models were explained below.

Table 4.27 Pearson's Correlation Coefficient of the Preconditions for Employee Safety Behavior Model

	WORK1	WORK2	PERSON1	PERSON2	PERSON3
WORK1	1.000				
WORK2	0.443*	1.000			
PERSON1	0.192*	0.342*	1.000		
PERSON2	0.213*	0.273*	0.612*	1.000	
PERSON3	0.268*	0.192*	0.412*	0.578*	1.000

Note: * Significant at the 0.05 level

Results of the Pearson's correlation coefficient and factor analysis for the preconditions for employee safety behavior factor as shown in table 4.27.

Table 4.28 Factor Loading of the Preconditions for Employee Safety Behavior Model

Pre-conditions to employee safety behavior	**Factor loading (λ_i)**	**Standard Error (SE$_{\lambda_i}$)**	**Significant test (t)**	**(SMC)**
WORK1	0.588*	-	-	0.346
WORK2	0.739*	0.271	4.636	0.546
PERSON1	0.665*	-	-	0.442

Table 4.28 (Continued)

Pre-conditions to employee safety behavior	**Factor loading (λ_i)**	**Standard Error (SE_{λ_i})**	**Significant test (t)**	**(SMC)**
PERSON2	0.920*	0.129	10.740	0.846
PERSON3	0.627*	0.085	11.157	0.393

Construct reliability (ρ_c) = 0.84

Average variance extracted (ρ_v) = 0.51

Note: * Significant at the 0.05 level

Result from the table 4. 28 revealed that all factors loading was significant at the 0.05 level, range of factor loading between .0588 - 0.920, Standard error 0.085 - 0.271 and square multiple correlations (SMC) 0.346 - 0.846. The factor loading data of each construct was further analyzed to identify the value of average variance extracted (AVE) and construct reliability (CR) which indicating the level of validity and reliability of the constructs. The analysis revealed that the construct reliability (ρ_c) was 0. 84, indicated convergent validity which is higher than 0. 60 (Hair et al., 2010, p. 680) that means the reliability of model structure is 84% . The average variance extracted (ρ_v) was 0.51, indicated that the organizational support for safety (ORGAN) model could explain 51 % of observed variables variance (Diamantopoulos & Siguaw, 2000, p. 91). The AVE in this model is higher than the suggested criteria of 0.5 demonstrated the convergent validity of the studied model. The result was shown in the figure 4.3.

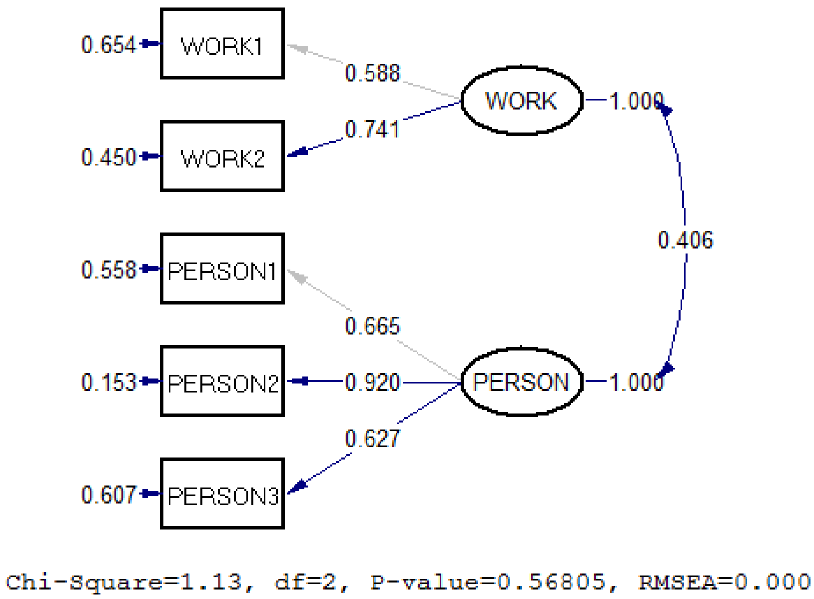

Figure 4.3 Preconditions for Employee Safety Behavior Model

The validation of preconditions for employee safety behavior (FAC3) measurement model were presented by goodness of fit indices as table 4.29. The 2 sub-factor with total of 5 items were run. The results of the CFA for the preconditions for employee safety behavior 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 CFA results of 2 sub-factor of preconditions for employee safety behavior model revealed that the goodness of fit was acceptable. The results indicated that work condition was measured by 2 observed variables and personal conditions was measured by 3 observed variables, which might be concluded that the convergent validity of this construct was adequate.

Table 4.29 Goodness of Fit Indices of the Preconditions for Employee Safety Behavior Measurement Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	1.131	-	-
2. *df*	2.000	-	-
3. *p*	0.568	$p > .050$	Support
4. χ^2/df	0.566	$\chi^2/df < 2.000$	Support
5. RMSEA	0.000	RMSEA < .050	Support
6. NFI	0.998	NFI >.900	Support
7. NNFI	1.007	NNFI > .900	Support
8. CFI	1.000	CFI > .900	Support
9. RMR	0.010	RMR < .050	Support
10. SRMR	0.010	SRMR < .050	Support
11. GFI	0.999	GFI > .900	Support
12. AGFI	0.992	AGFI > .900	Support

4.2.3.5 CFA of Employee Safety Behavior Scale

This instrument was comprised of 6 items measuring two sub-factors termed as: attentive action to safety (ATTEN) and supportive action to safety (SUPPO). Attentive action to safety (ATTEN) was measure by 3 items and and supportive action to safety (SUPPO) was measured by 3 items. Following factor analysis, LISREL were used to prepare employee safety behavior model. Results for factor analysis models are explained below.

First, the results of the Pearson's correlation coefficient and factor analysis for the employee safety behavior (BEHAV) factor as shown in table 4.30.

Table 4.30 Pearson's Correlation Coefficient of the Employee Safety Behavior Model

	ATTEN1	ATTEN2	ATTEN3	SUPPO1	SUPPO2	SUPPO3
ATTEN1	1.000					
ATTEN2	0.274*	1.000				
ATTEN3	0.336*	0.466*	1.000			
SUPPO1	0.115*	0.381*	0.445*	1.000		
SUPPO2	0.278*	0.289*	0.347*	0.164*	1.000	
SUPPO3	0.420*	0.256*	0.369*	0.152*	0.601*	1.000

Note: * Significant at the 0.05 level

Table 4.31 Factor Loading of the Employee Safety Behavior Model

Employee safety behavior	**Factor loading (λ_i)**	**Standard Error (SE$_{\lambda_i}$)**	**Significant test (t)**	**(SMC)**
ATTEN1	0.450*	-	-	0.203
ATTEN2	0.604*	0.197	6.783	0.365
ATTEN3	0.739*	0.240	6.799	0.546
SUPPO1	0.223*	-	-	0.050
SUPPO2	0.771*	0.888	3.906	0.594
SUPPO3	0.767*	0.873	3.928	0.588
Construct reliability (ρ_c) = 0.78				
Average variance extracted (ρ_v) = 0.40				

Note: * Significant at the 0.05 level

Result from the table 4. 31 revealed that all factors loading was significant at the 0.05 level, range of factor loading between 0.23 - 0.771, Standard error 0.197 - 0.888 and square multiple correlations (SMC) 0.050 - 0.594. The factor loading data of each construct was further analyzed to identify the value of average variance extracted (AVE) and construct reliability (CR) which indicating the level of validity and reliability of the constructs. The analysis revealed that the overall of 'employee safety behavior' factor has AVE = 0.40 and CR = 0.78. Even though, AVE should be higher than 0.50, it is acceptable at 0.40 if the CR is higher than 0.60 because the convergent validity of the construct remains adequate (Fornell & Larcher, 1981). Thus, it is reasonable to accept the 'employee safety behavior' construct in this study. The overall result of the ' employee safety behavior' measurement model demonstrated the reliability as well as the convergent validity of the studied model.

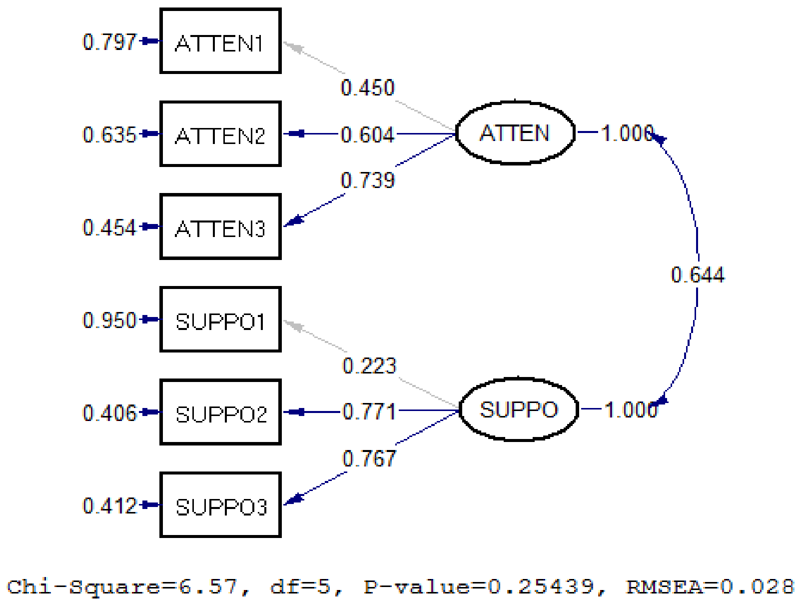

Figure 4.4 Employee Safety Sehavior Measurement Model

The validation of preconditions for employee safety behavior (BEHAV) measurement model were presented by goodness of fit indices as table 4.32. The results of the CFA for the employee safety behavior (BEHAV) measurement model showed the following statistics: ^{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 CFA results of 2 sub-factor of employee safety behavior model revealed that the goodness of fit was acceptable. The results indicated that attentive action to safety (ATTEN) was measure by 3 observed variables and supportive action to safety (SUPPO) was measure by 3 observed variables, which might be concluded that the convergent validity of this construct was adequate.

Table 4.32 Goodness of Fit Indices of the Employee Safety Behavior Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	6.573	-	-
2. *df*	5.000	-	-
3. *p*	0.254	$p > .050$	Support
4. χ^2/df	1.315	$\chi^2/df < 2.000$	Support
5. RMSEA	0.028	RMSEA < .050	Support
6. NFI	0.991	NFI >.900	Support
7. NNFI	0.993	NNFI > .900	Support
8. CFI	0.998	CFI > .900	Support
9. RMR	0.023	RMR < .050	Support
10. SRMR	0.023	SRMR < .050	Support
11. GFI	0.995	GFI > .900	Support
12. AGFI	0.978	AGFI > .900	Support

4.2.3.6 CFA of Safety Outcomes Scale

The instrument was examined using a factor analytic technique (FA) to determine whether the hypothesized two-factor structure of the safety outcome fit the data for the current study and to discover the latent factor. The instrument was comprised of 10 items measuring two constructs termed as: likelihood of near-miss accident (NEAR) and likelihood of accident (ACTU).

Likelihood of near-miss accident (NEAR) was measured by 5 items and likelihood of accident (ACTU) measured by 5 items. Following factor analysis, LISREL were used to prepare safety performance model. Results for factor analysis models are explained below.

Table 4.33 Pearson's Correlation Coefficient of the Safety Outcomes Model

	NEAR1	NEAR2	NEAR3	NEAR4	NEAR5	ACTU1	ACTU2	ACTU3	ACTU4	ACTU5
NEAR1	1.000									
NEAR2	0.397*	1.000								
NEAR3	0.198*	0.325*	1.000							
NEAR4	0.234*	0.355*	0.362*	1.000						
NEAR5	0.131*	0.325*	0.206*	0.332*	1.000					
ACTU1	0.229*	0.197*	0.126*	0.117*	0.205*	1.000				
ACTU2	0.151*	0.240*	0.175*	0.240*	0.263*	0.432*	1.000			
ACTU3	0.099*	0.095*	0.236*	0.121*	0.138*	0.186*	0.285*	1.000		
ACTU4	0.095*	0.143*	0.195*	0.295*	0.126*	0.221*	0.270*	0.099*	1.000	
ACTU5	0.102*	0.158*	0.222*	0.245*	0.123*	0.138*	0.259*	0.160*	0.845*	1.000

Note: * Significant at the 0.05 level

Results of the Pearson's correlation coefficient and factor analysis for the safety outcomes factor as shown in table 4.33

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Table 4.34 Factor Loading of the Safety Outcomes Model

Safety performance	**Factor loading (λ_i)**	**Standard Error (SE$_{\lambda_i}$)**	**Significant test (t)**	**(SMC)**
NEAR1	0.352*	-	-	0.124
NEAR2	0.590*	0.079	6.009	0.348
NEAR3	0.540*	0.091	5.104	0.292
NEAR4	0.648*	0.079	5.279	0.420
NEAR5	0.491*	0.081	4.953	0.241
ACTU1	0.453*			0.205
ACTU2	0.562*	0.076	6.048	0.316
ACTU3	0.417*	0.090	4.395	0.174
ACTU4	0.506*	0.080	4.662	0.256
ACTU5	0.521*	0.078	4.655	0.271
Construct reliability (ρ_c) = 0.84				
Average variance extracted (ρ_v) = 0.44				

Note: * Significant at the 0.05 level

All factors loading was significant at the 0.05 level. Ranged of factor loading 0.352 - 0.648, Standard error 0.078 - 0.091 and square multiple correlations (SMC) 0.124 - 0.420. The construct reliability (ρ_c) = 0.84, indicated convergent validity which is the ratio of observed variables covariance in the same latent variable (Should higher than 0.60, (Hair et al., 2010, p. 680)) that means the reliability of model structure is 84%. The average variance extracted (ρ_v) = 0.44 indicated that the safety performance model could explain 44% of observed variables variance. (Diamantopoulos & Siguaw, 2000, p. 91). The result was shown in the figure 4.5

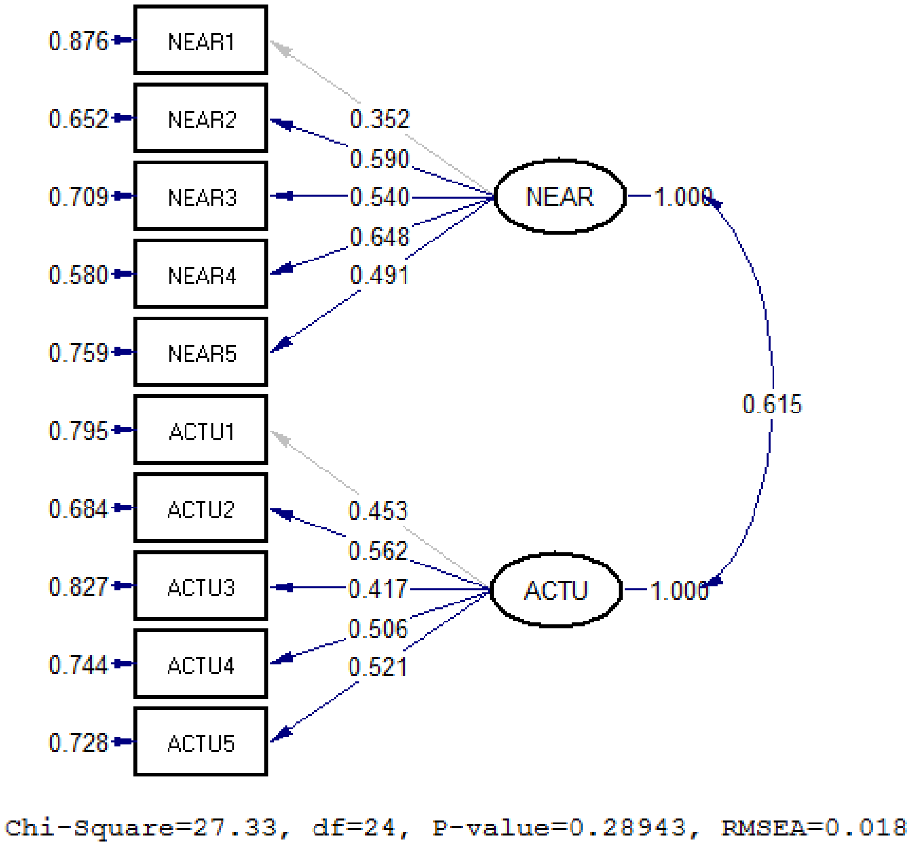

Figure 4.5 Safety Outcomes Measurement Model

The validation of safety performance measurement model was presented by goodness of fit indices as table 4.35.

Table 4.35 Goodness of Fit Indices of the Safety Outcomes Model

Fit indices	Value	Criterion	Meaning
1. χ^2	27.327	-	-
2. *df*	24.000	-	-
3. *p*	0.289	$p > .050$	Accurate

Table 4.35 (Continued)

Fit indices	Value	Criterion	Meaning
4. χ^2/df	1.139	$\chi^2/df < 2.000$	Accurate
5. RMSEA	0.018	RMSEA < .050	Accurate
6. NFI	0.978	NFI >.900	Accurate
7. NNFI	0.995	NNFI > .900	Accurate
8. CFI	0.997	CFI > .900	Accurate
9. RMR	0.028	RMR < .050	Accurate
10. SRMR	0.028	SRMR < .050	Accurate
11. GFI	0.987	GFI > .900	Accurate
12. AGFI	0.970	AGFI > .900	Accurate

Results of the CFA for the safety outcomes measurement model validation indicated a good fit between the conceptual model and the observed data with the goodness of fit statistics: χ^2= 27.327, df = 24, p = 0.289, χ^2/df = 1.139, RMSEA = 0.018, NFI = 0.978, NNFI = 0.995, CFI = 0.7 RMR = 0.028, SRMR = 0.028, GFI = 0.987, AGFI = 0.970 and PGFI = 0.531. The CFA model tested that the safety outcomes sample data would support the 2 latent variables structure, indicated that; likelihood of near-miss accident (NEAR) was measured by 5 observed variables and likelihood of accident (ACTU) was measured by 5 observed variables.

4.2.4 Construct Validity

The validation of construct validity for the safety culture model was performed using second-order confirmatory factor analysis. The second-order CFA indicated that all sub-factors were under one main factor and to measure a construct model and validated a good fit between the conceptual model and the empirical data. Data analysis will show the Factor loading (λ_i), Standard Error (SE_{λ_i}), Significant test (t), Square multiple correlation (SMC), Goodness of fit indices such as χ^2, χ^2/df, RMSEA, RMR, SRMR, CFI, NFI, NNFI, GFI, and AGFI. The internal consistency: Construct reliability (ρ_C) and Average variance extracted (ρ_V) . Safety culture construct model consisted of four factors and nine observed variables. Data analysis showed the factor loading (λ_i) , standard error (SE_{λ_i}) , significant test (t) , square multiple correlation (*SMC*).

Table 4.36 Factor Loading of Safety Culture Model

Observed Variables	**Factor Loading**			
	***B*(λ_y)**	***SE*λ_y**	***t***	***R^2***
1. Management commitment (MANAG)	0.735*	-	-	0.540
2. Safety rules and training (RULE)	0.887*	0.077	15.717	0.787
3. Supervisor support (SUPER)	0.733*	-	-	0.537
4. Co-worker support (CO-WOR)	0.667*	0.069	13.128	0.445
5. Working conditions (WORK)	0.669*	-	-	0.448
6. Personal conditions (PERSON)	0.546*	0.085	9.671	0.298
7. Attentive Action to Safety (ATTEN)	0.687*	-	-	0.472
8. Supportive Action to Safety (SUPPO)	0.848*	0.134	9.203	0.719

Note: * Significant at the 0.05 level

The table 4.36 indicated that the standard factors loading of observed variables were significant at the 0.05 level. Ranged of factor loading 0.546 - 0.887, Standard error 0.069 – 0.134 and square multiple correlations (SMC) 0.298 – 0.787.

Table 4.37 Factor Loading of Latent Variables of Safety Culture Model

Latent Variables	Factor Loading			***SMC***
	B **(** γ **)**	***SE*** γ	***t***	
1. Organizational support for safety	0.975*	0.053	13.572	0.951
2. Social support for safety	0.997*	0.050	14.584	0.994
3. Preconditions to employee safety behavior	0.964*	0.056	11.499	0.929
4. Employee safety behavior	0.610*	0.051	8.171	0.372

Note: * Significant at the 0.05 level

The result in table 4.37 indicated that standard factors loading of four latent variables were significant at the 0.05 level. Social support for safety (SOCIAL) has the highest factor loading which is γ = 0.997, $SE\,\gamma_y$= 0.050, SMC = 0.994. The second is Organizational support for safety (ORGAN) which is γ = 0.975, $SE\,\gamma_y$= 0.053, SMC = 0.951, Preconditions to employee safety behavior (PRECON) which is γ = 0.964, $SE\,\gamma_y$= 0.056, SMC = 0.929 and Employee safety behavior (BEHAV) which is γ = 0.610, $SE\,\gamma_y$= 0.051, SMC = 0.372 respectively.

The validation of safety culture construct model was presented by goodness of fit indices as table 4.38. 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 construct reliability (CR) of the scale were 0.53 and 0.90, which were higher than the recommended level of .50 and .70 (Fornell & Larcker, 1981; Hair et al., 1998), respectively, where it might be concluded that the convergent validity of the instrument was adequate. The results were presented in figure 4.6.

Table 4.38 Goodness of Fit Indices of Safety Culture Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	17.816	-	-
2. *df*	10.000	-	-
3. *p*	0.058	$p > .05$	Support
4. χ^2/df	1.782	$\chi^2/df < 2.00$	Support
5. RMSEA	0.044	RMSEA < .05	Support
6. NFI	0.992	NFI >.90	Support
7. NNFI	0.991	NNFI > .90	Support
8. CFI	0.997	CFI > .90	Support
9. RMR	0.020	RMR < .05	Support
10. SRMR	0.020	SRMR < .05	Support
11. GFI	0.989	GFI > .90	Support
12. AGFI	0.961	AGFI > .90	Support
Construct reliability (ρ_c) = 0.90			
Average variance extracted (ρ_v) = 0.53			

Note: * Significant at the 0.05 level

As a conclusion, the results from second-order factor analysis indicated that safety culture measurement model was comprised with four main constructs and eight sub-constructs as; 1) the organizational support for safety construct that comprised of 2 sub-factors (i.e. management commitment to safety, safety rules and training), 2) the social support for safety construct that comprised of 2 sub-factors (i.e. supervisor support and co-worker support), 3) the preconditions for employee safety behavior construct that comprised of 2 sub-factors (i.e. working conditions and personal conditions), and 4) the employee safety behavior construct that comprised of 2 sub-factors (i.e. attentive action to safety and supportive action to safety).

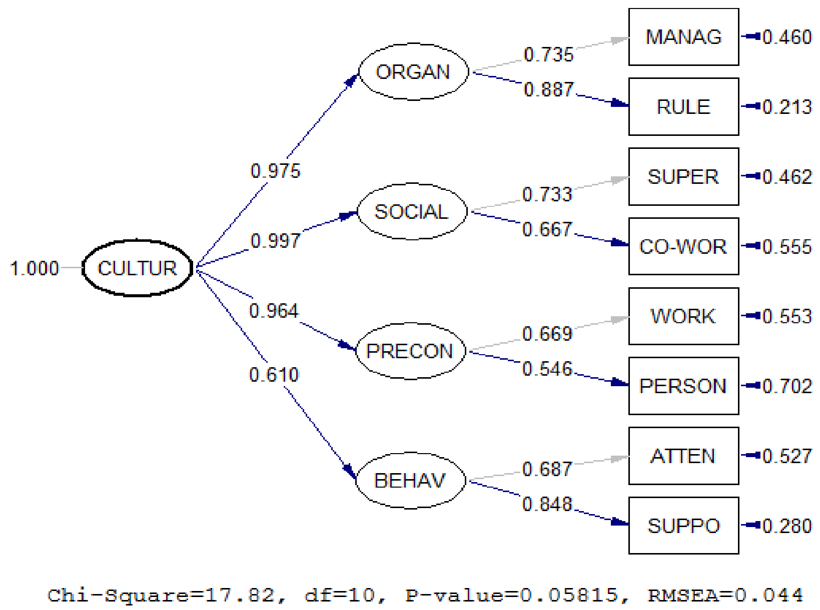

Figure 4.6 Safety Culture Measurement Model

4.2.5 Relationship Between Safety Dimensions and Safety Outcomes

The purpose of this analysis was to examine the criterion validity (i. e. concurrent validity) of the safety culture instrument. In order to achieve this, testing the relationship between each component of safety culture scale with safety outcomes using Pearson's Correlation Coefficient was performed and the results were presented in table 4.39.

According to the result, organizational support for safety component had positive relationship at low level with likelihood of near-miss accident ($r = 0.132$, $p < 0.01$), but no relationship found with likelihood of accident. Social support for safety, preconditions for employee safety behavior and employee safety behavior variable had no relationship with both likelihood of near-miss accident and likelihood of accident. Additionally, the results also revealed that the likelihood of near-miss accident had positive relationship with the likelihood of accident at moderate level ($r = 0.394$) with significant at 0.01 level.

Table 4.39 Pearson Correlation Coefficients Among the Safety Culture Constructs and Safety Outcomes

	ORGAN	SOCIAL	PRECON	EMPLOY	NEAR	ACTU
ORGAN	1.000					
SOCIAL	0.748**	1.000				
PRECON	0.642**	0.649**	1.000			
EMPLOY	0.440**	0.455**	0.469**	1.000		
NEAR	0.132**	0.091	0.026	-0.092	1.000	
ACTU	-0.051	-0.038	-0.054	-0.068	0.394**	1.000

Note: ** Significant at the 0.01 level

Interestingly, the correlation result showed no relationship between each safety culture sub-scale with safety outcomes. At this level of analysis, each sub-scale was treated as an independent variable in determining safety outcomes. Notably, there was moderate to high level of positive correlation among four variables. According to Kenett, Huang, Vodenska, Havlin, and Stanley (2014) there is a chance of one variable effect one another in the analysis. Such confounding variables may create misleading information in the analysis. Therefore, partial correlation was performed and measured correlation remaining between two variables when removing the effect of other control variables. First, the partial correlation on each of four safety culture variable and the likelihood of near-miss accident were tested as presented in table 4.40.

Table 4.40 Partial Correlation Between Each Safety Culture Variable and Likelihood of Near-miss Accident

Control Variables			**ORGAN**	**Likelihood of Near-miss Accident**
EMPLOY & PRECON & SOCIAL	ORGAN	Correlation	1.000	.131
		Significance		.008
		df	0	408
	Likelihood of Near-miss Accident	Correlation	.131	1.000
		Significance	.008	
		df	408	0
Control Variables			**SOCIAL**	**Likelihood of Near-miss Accident**
EMPLOY & PRECON & ORGAN	SOCIAL	Correlation	1.000	.037
		Significance		.457
		df	0	408
	Likelihood of Near-miss Accident	Correlation	.037	1.000
		Significance	.457	
		df	408	0
Control Variables			**PRECON**	**Likelihood of Near-miss Accident**
EMPLOY & ORGAN & SOCIAL	Likelihood of Near-miss Accident	Correlation	-.042	1.000
		Significance	.395	
		df	408	0
	PRECON	Correlation	1.000	-.042
		Significance		.395
		df	0	408
Control Variables			**EMPLOY**	**Likelihood of Near-miss Accident**
ORGAN & SOCIAL & PRECON	Likelihood of Near-miss Accident	Correlation	-.157	1.000
		Significance	.001	
		df	408	0
	EMPLOY	Correlation	1.000	-.157
		Significance		.001
		df	0	408

Next, partial correlation on each of four safety culture variable and the likelihood of accident were tested as presented in table 4.41.

Table 4.41 Partial Correlation Between Each Safety Culture Variable and Likelihood of Accident

Control Variables			**ORGAN**	**Likelihood of accident**
EMPLOY & PRECON & SOCIAL	ORGAN	Correlation	1.000	-.019
		Significance		.706
		df	0	408
	Likelihood of accident	Correlation	-.019	1.000
		Significance	.706	
		df	408	0
Control Variables			**SOCIAL**	**Likelihood of accident**
EMPLOY & PRECON & ORGAN	SOCIAL	Correlation	1.000	.016
		Significance		.752
		df	0	408
	Likelihood of accident	Correlation	.016	1.000
		Significance	.752	
		df	408	0
Control Variables			**PRECON**	**Likelihood of accident**
EMPLOY & ORGAN & SOCIAL	Likelihood of accident	Correlation	-.018	1.000
		Significance	.711	
		df	408	0
	PRECON	Correlation	1.000	-.018
		Significance		.711
		df	0	408
Control Variables			**EMPLOY**	**Likelihood of accident**
ORGAN & SOCIAL & PRECON	Likelihood of accident	Correlation	-.046	1.000
		Significance	.350	
		df	408	0
	EMPLOY	Correlation	1.000	-.046
		Significance		.350
		df	0	408

The results from table 4.40 revealed that organizational support for safety dimension had positive relationship with likelihood of near-miss accident ($r = 0.131$, $p < 0.001$), while employee safety behavior showed negative relationship with likelihood of near-miss accident ($r = -0.157$, $p < 0.01$). Preconditions for employee safety behavior and social support for safety showed no relationship with likelihood of near-miss accident. Moreover, table 4.41 showed that none of safety culture dimensions had relationship with likelihood of accident. Therefore, this analysis suggested that concurrent validity was partialy found in the pair of employee safety behavior and the likelihood of near-miss accident.

4.2.6 Structural Equation Modeling (SEM) of Safety Culture influencing Likelihood of Near-miss Accident and Likelihood of Accident (Initial Model)

The objective of this part of the study was to test the congruency of hypothesis model of safety culture influences on safety outcomes and the empirical data. Data analysis using path analysis by LISREL program. In this analysis, safety culture was exogenous variables while the likelihood of near-miss accident and the likelihood of accident were endogenous variable. SEM was used to test whether safety culture has an influence on the likelihood of near-miss accident and the likely hood of accident. The conceptual SEM model was presented in figure 4.7.

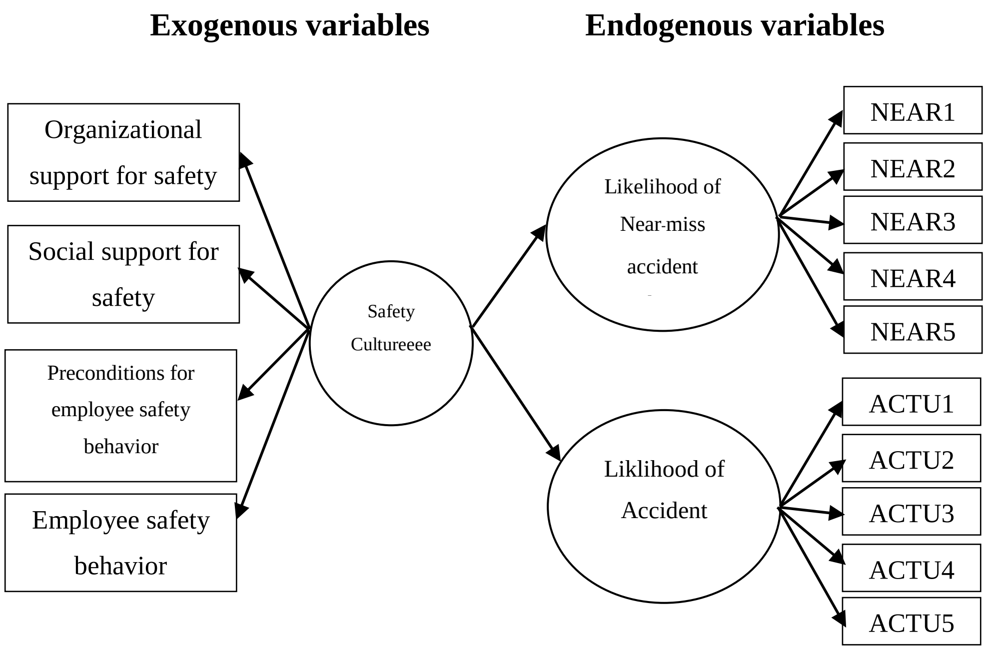

Figure 4.7 Conceptual Structural Equation Modeling of Safety Culture Influencing Safety Outcomes

First, the analysis was carried on to examine the Factor loading (λ_x) in standardize form, Standard Error (SE_{λ_x}) , Significant test (t) and Square multiple correlation (*SMC*) of the exogenous observed variables.

Exogenous observed variables contained one latent variable as safety culture (CULTUR) with four observed variables as organizational support for safety (ORGAN) , social support for safety (SOCIAL) , preconditions to employee safety behavior (PRECON) and employee safety behavior (BEHAV).

Table 4.42 Factor Loading of the Exogenous Observed Variables (Initial Model)

Exogenous Latent variables	**Exogenous observed variables**	**Factor loading (λ_x)**	**Standard Error ($SE\lambda_x$)**	**Significant test (t)**	**SMC**
Safety Culture	ORGAN	0.829*	0.043	19.399	0.687
	SOCIAL	0.918*	0.041	22.401	0.843
	PRECON	0.707*	0.045	15.734	0.500
	BEHAV	0.501*	0.048	10.332	0.251

Note: *Significant at the 0.05 level

The results in table 4.42 indicated that all factors loading was significant at the 0.05 level. Ranged of factor loading 0.501 - 0.918, Standard error 0.041 - 0.048 and square multiple correlations (SMC) 0.251 - 0.843.

Secondly, the analysis was carried on to examine the Ffctor loading (λ_y) in standardize form, standard error (SE_{λ_y}), significant test (t) and square multiple correlation (SMC) of the endogenous observed variables. Endogenous observed variables contained two latent variables as likelihood of near-miss accident (NEAR) with five observed variables and likelihood of accidents (ACTU) with five observed variables.

Table 4.43 Factor Loading of the Endogenous Observed Variables (Initial Model)

Endogenous Latent variables	**Endogenous observed variables**	**Factor loading (λ_x)**	**Standard Error ($SE\lambda_x$)**	**Significant test (t)**	**SMC**
NEAR	NEAR1	0.556*	-	-	0.309
	NEAR2	0.753*	0.094	7.976	0.567
	NEAR3	0.424*	0.067	6.317	0.180

Table 4.43 (Continued)

Endogenous Latent variables	**Endogenous observed variables**	**Factor loading (λ_x)**	**Standard Error ($SE\,\lambda_x$)**	**Significant test (t)**	**SMC**
	NEAR4	0.492*	0.070	7.015	0.242
	NEAR5	0.417*	0.067	6.236	0.174
ACTU	ACTU1	0.197*	-	-	0.039
	ACTU2	0.363*	0.106	3.440	0.132
	ACTU3	0.189*	0.071	2.674	0.036
	ACTU4	0.901*	0.236	3.819	0.812
	ACTU5	0.901*	0.236	3.819	0.812

Note: * Significant at the 0.05 level

The results from table 4.43 indicated that all factors loading were significant at the 0.05 level. Ranged of factor loading 0.189 - 0.901, Standard error 0.067 - 0.236 and square multiple correlations (SMC) ranged between 0.036 - 0.812.

Next, the analysis was carried on to examine the path coefficients, direct effects, indirect effects and total effect from the exogenous variables to the endogenous variables. The results were presented in the table 4.28.

Table 4.44 Path Coefficients for Initial Model

Cause Variables	**Effect Variables**					
	Near-miss accident involvement			**Actual accident involvement**		
	DE	**IE**	**TE**	**DE**	**IE**	**TE**
Safety Culture	0.200*	-	0.200*	0.073	-	0.073
Squared Multiple Correlations for Structural Equations	**0.040**			**0.005**		

Note: * Significant at the 0.05 level

From table 4.44, the structural equation model suggested that an effect from safety culture (CULTUR) was significantly direct to likelihood of near-miss accident (NEAR) at 0.05 level with path coefficient 0.200. An effect from safety culture (CULTUR) to likelihood of accident (ACTU) had no significant. The result of model was shown in the figure 4.8.

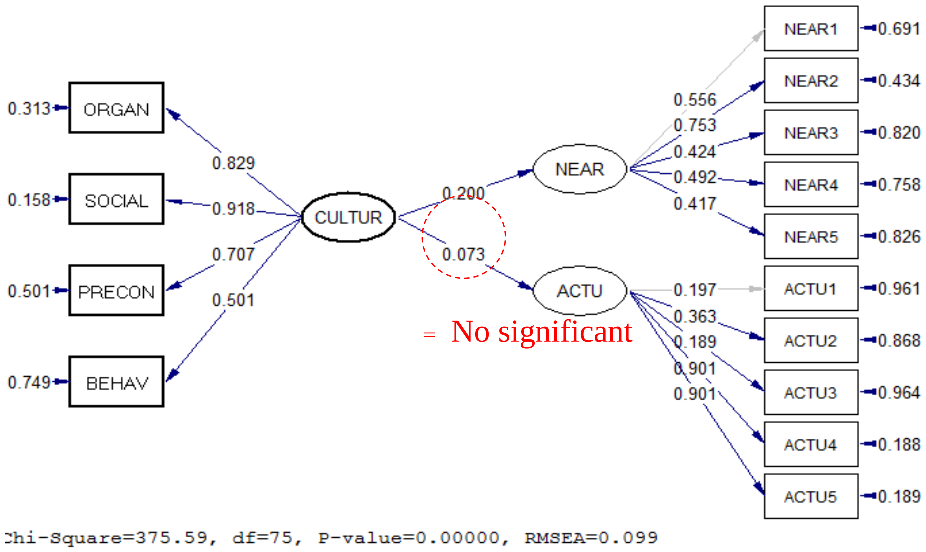

Figure 4.8 Structural Equation Modeling of Safety Culture Influencing Likelihood of Near-miss Accident and Likelihood of Accident (Initial Model)

The validation of construct model was presented by goodness of fit indices as illustrated in table 4.45.

Table 4.45 Goodness of Fit Indices of Safety Culture Influencing Near-miss Accident Involvement and Lielihood of Accident (Initial Model)

Fit indices	Value	Criterion	Meaning
1. χ^2	375.591	-	-
2. *df*	75	-	-
3. *p*	0.000	*p*> .050	Inaccurate
4. χ^2/df	5.008	$\chi^2/df < 2.000$	Inaccurate
5. RMSEA	0.099	RMSEA < .050	Inaccurate

Table 4.45 (Continued)

Fit indices	Value	Criterion	Meaning
6. NFI	0.835	NFI >.900	Inaccurate
7. NNFI	0.834	NNFI > .900	Inaccurate
8. CFI	0.864	CFI > .900	Inaccurate
9. RMR	0.110	RMR < .050	Inaccurate
10. SRMR	0.110	SRMR < .050	Inaccurate
11. GFI	0.885	GFI > .900	Inaccurate
12. AGFI	0.839	AGFI > .900	Inaccurate

Results of the structural equation modeling (SEM) for the initial model of Safety Culture influencing Near-miss accident involvement and Actual accident involvement indicated a poor fit between the conceptual model and the empirical data with the fit statistics of: χ^2= 375.591, df = 75, p = 0.000, χ^2/df = 5.008, RMSEA = 0.099, GFI = 0.885 and AGFI = 0.839.

4.2.7 The Modification of Structural Equation Modeling of Safety Culture Influencing the Likelihood of Near-miss Accident the Likelihood of Actual

The result from part 4.2.6 suggested that the initial model of safety culture influencing the likelihood of near-miss accident and the likelihood of accident was not congruent between the conceptual model and the empirical data. The constructed model showed that safety culture (CULTUR) had no significant effect to the likelihood of accident (ACTUL) and the model was considered as poor fit. The modified structural equation modeling of safety culture influencing the likelihood of near-miss accident and the likelihood of accident was performed by adding one more path between the likelihood of near-miss accident and the likelihood of accident according to literature reviews.

The result in table 4.46 presented the path coefficients, direct effects, indirect effects and total effect from the exogenous variables to the endogenous variables and the effect from endogenous variables to endogenous variables.

Table 4.46 Path Coefficients of Modified Model

Cause Variables	**Effect Variables**					
	Near-miss accident involvement			**Actual accident involvement**		
	DE	**IE**	**TE**	**DE**	**IE**	**TE**
Safety Culture	0.157*	-	0.157*	0.094*	0.092*	0.186*
Near-miss accident involvement				0.582*	-	0.582*
Squared Multiple Correlations for Structural Equations	**0.225**			**0.365**		

Note: * Significant at the 0.05 level

From table 4.46, the modified structural equation modeling of safety culture influencing the likelihood of near-miss accidents and the likelihood of accidents showed that, an effect from safety culture (CULTUR) was significantly direct to likelihood of near-miss accident (NEAR) at 0.05 level with path coefficient 0.157 and there was the effect from safety culture (CULTUR) significantly direct to likelihood of accident (ACTU) at 0.05 level with path coefficient 0.186.

Squared Multiple Correlations for Structural Equations or Coefficient of Determination of the endogenous latent variables can be explained as:

1) Likelihood of near-miss accident (NEAR): SMC = 0.225 indicated that safety culture could predict the likelihood of near-miss accident (NEAR) as 22.5%.

2) Likelihood of accident (ACTU): SMC = 0.365 indicated that safety culture (CULTUR) and likelihood of near-miss accident (NEAR) could jointly predict the likelihood of accident (ACTU) as 36.5%.

Table 4.47 Factor Loading of the Exogenous Observed Variables (Modified Model)

Exogenous Latent variables	**Exogenous observed variables**	**Factor loading (λ_x)**	**Standard Error (*SE* λ_x)**	**Significant test (*t*)**	**SMC**
Safety Culture	ORGAN	0.652*	0.120	5.422	0.425
	SOCIAL	0.737*	0.132	5.581	0.543
	PRECON	0.869*	0.152	5.705	0.755
	BEHAV	0.612*	0.119	5.137	0.375

Note: * Significant at the 0.05 level

The table 4.47 indicated that all factors loading of exogenous variable had four observed variables and were significant at the 0.05 level. Ranged of factor loading 0.612 - 0.869, Standard error 0.120 - 0.152 and square multiple correlations (SMC) ranged between 0.375 – 0.755.

The endogenous observed variables contained tow latent variables as the likelihood of near-miss accident (NEAR) with five observed variables and the likelihood of accident (ACTU) with five observed variables. The data analysis was performed to examine the factor loading (λ_y) in standardize form, standard error (*SE* λ_y), significant test (*t*) and Square multiple correlation (*SMC*) of the endogenous observed variables.

Table 4.48 Factor Loading of the Endogenous Observed Variables (Modified Model)

Endogenous Latent variables	**Endogenous observed variables**	**Factor loading (λ_x)**	**Standard Error ($SE\,\lambda_x$)**	**Significant test (*t*)**	**SMC**
NEAR	NEAR1	0.459*			0.211
	NEAR2	0.622*	0.120	5.176	0.387
	NEAR3	0.468*	0.127	3.687	0.219
	NEAR4	0.733*	0.181	4.059	0.537
	NEAR5	0.458*	0.122	3.746	0.210
ACTU	ACTU1	0.376*			0.141
	ACTU2	0.574*	0.155	3.703	0.329
	ACTU3	0.354*	0.130	2.725	0.125
	ACTU4	0.507*	0.160	3.164	0.257
	ACTU5	0.564*	0.178	3.168	0.318

Note: * Significant at the 0.05 level

The result from table 4.48 showed that all factors loading was significant at the 0.05 level. Ranged of factor loading between 0.354 - 0.733, Standard error 0.120 - 0.181 and square multiple correlations (SMC) 0.125 - 0.537. The result of modified model was presented in the figure 4.9.

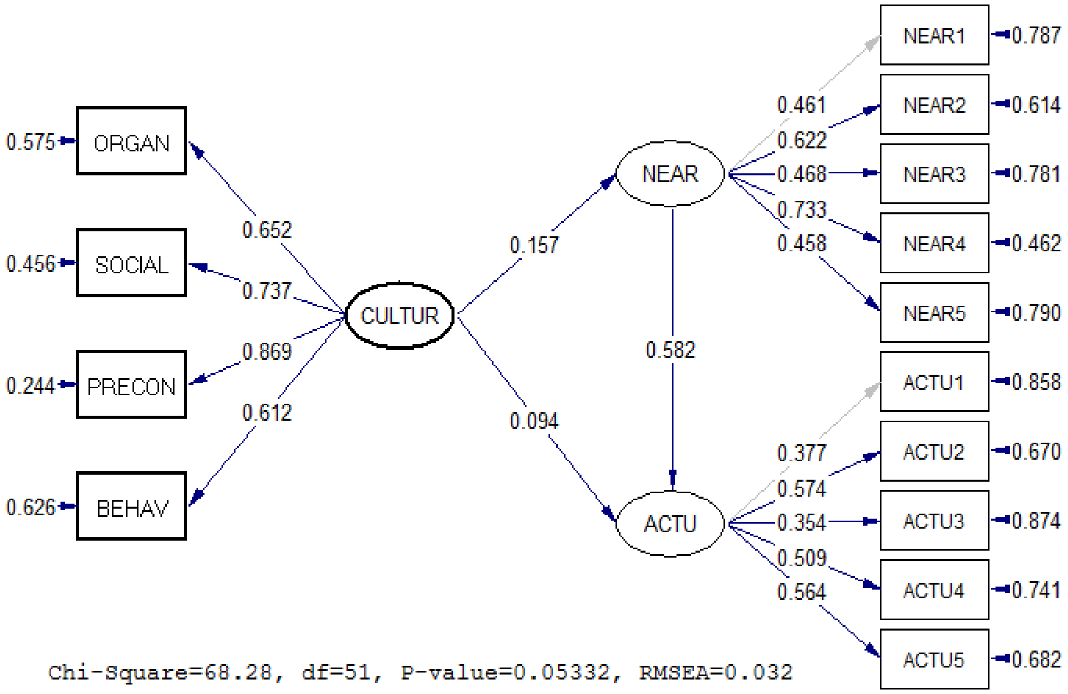

Figure 4.9 The Modified Structural Equation Modeling of Safety Culture Influencing the Likelihood of Near-miss Accident and the Likelihood of Accident

The validation of the modified SEM model was presented by goodness of fit indices according to table 4.49. Results of the modified structural equation modeling (SEM) for the model of safety culture influencing likelihood of near-miss accident and likelihood of accident indicated the good fit according to fit statistics of: χ^2= 68.284, df = 51, p = 0.053, χ^2/df = 1.339, RMSEA = 0.032, NFI = 0.960, NNFI = 0.981, CFI = 0.989, RMR = 0.036, SRMR = 0.036, GFI = 0.971 and AGFI = 0.941.

Table 4.49 Goodness of Fit Indices of Modified SEM Model

Fit indices	**Value**	**Criterion**	**Meaning**
1. χ^2	68.284	-	-
2. df	51	-	-
3. p	0.053	p> .050	Support

Table 4.49 (Continued)

Fit indices	Value	Criterion	Meaning
4. χ^2/df	1.339	χ^2/df < 2.000	Support
5. RMSEA	0.032	RMSEA < .050	Support
6. NFI	0.960	NFI >.900	Support
7. NNFI	0.981	NNFI > .900	Support
8. CFI	0.989	CFI > .900	Support
9. RMR	0.036	RMR < .050	Support
10. SRMR	0.036	SRMR < .050	Support
11. GFI	0.971	GFI > .900	Support
12. AGFI	0.941	AGFI > .900	Support

From the result, the modified structural equation modeling of safety culture influencing the likelihood of near-miss accident and the likelihood of accident suggested that there was congruency between the conceptual model and the empirical data.

4.2.8 Effect of Different Demographic Data on Safety Outcomes

Demographic data showed that the majority of respondents were male (99.758%). Most of them were found to be at the age between 31 to 50 years old (74.33%). Only few of the respondents held a bachelor degree (0.48%) as they mainly completed primary school (38.74%) and high school (48.67%). The main vehicles that the majority of the respondents used were the trucks that larger than six-wheel truck accounted for 83.37% (i.e. trailer truck (55.01%), tow-truck (19.56%) and 10-wheel truck (8.31%) respectively). Most of them held the driving license that allowed them to operate the large trucks (GE-3 license, 33.82%) and large truck that carried dangerous goods (GE-4 license, 44.04%). Report also showed that they had total work experiences in driving more than five years which is accounted for 81.68%. Approximately 80% of the respondents appeared to drive more than 6 hours a day with the distance more than 100 kms per day (83.54%). Mainly, the respondents were found to drive alone without co-driver (82.57%). Domestic short-haul driving style was the majority driving style for most of the respondents (54.72%), followed by the mix between short-haul and long-haul driving style (31.24%).

In this process, certain demographic variables were examined whether the safety outcomes occurance was different. Anova was performed to compare the effect of demographic variables (i.e. marital status, age, education, type of truck, experience, and number of working hour) on two safety outcomes (i.e. likelihood of near-miss accident and likelihood of accident).

Table 4.50 Variance of Truck Drivers' Age on Safety Outcomes

Safety Outcomes	Variance Source	Sum of Squares	df	Mean Square	F	Sig.
Likelihood of Near-miss Accident Involvement	Between Groups	2.10	3.00	0.70	8.58	0.00*
	Within Groups	33.35	409.00	0.08		
	Total	35.45	412.00			
Likelihood of accident Involvement	Between Groups	0.37	3.00	0.12	3.49	0.02*
	Within Groups	14.46	409.00	0.04		
	Total	14.83	412.00			

There was not a significant effect of marital status and type of truck on both safety outcomes at the p value < 0.05 level. However, there was a significant effect of truck driver's age group and driving experiences on both safety outcomes at the p < 0.05 level as presented in table 4.50.

Table 4.51 Variance of Truck Drivers' Driving Experience on Safety Outcomes

Safety Outcomes	**Variance Source**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Likelihood of Near-miss Accident Involvement	Between Groups	1.80	4.00	0.45	5.47	0.00*
	Within Groups	33.65	408.00	0.08		
	Total	35.45	412.00			
Likelihood of accident Involvement	Between Groups	0.45	4.00	0.11	3.16	0.01*
	Within Groups	14.38	408.00	0.04		
	Total	14.83	412.00			

Table 4.52 Variance of Truck Drivers' Education on Safety Outcomes

Safety Outcomes	**Variance Source**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Likelihood of Near-miss Accident Involvement	Between Groups	1.15	4.00	0.29	3.41	0.01*
	Within Groups	34.30	408.00	0.08		
	Total	35.45	412.00			
Likelihood of accident Involvement	Between Groups	0.22	4.00	0.05	1.51	0.20
	Within Groups	14.61	408.00	0.04		
	Total	14.83	412.00			

Table 4.53 Variance of Truck Drivers' Driving Time on Safety Outcomes

Safety Outcomes	**Variance Source**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Likelihood of Near-miss Accident Involvement	Between Groups	0.25	3.00	0.08	0.97	0.40
	Within Groups	35.20	409.00	0.09		
	Total	35.45	412.00			
Likelihood of accident Involvement	Between Groups	0.62	3.00	0.21	5.94	0.00*
	Within Groups	14.21	409.00	0.03		
	Total	14.83	412.00			

Taken this together, the results from table 4.50 – 4.53 suggested that different age group really did have an effect on both safety outcomes. Specifically, the older they are, the less likelihood of near-miss accident and actual accident. Similary, the work experiences of a truck driver also suggested an effect on both safety outcomes. Truck drivers who has work experience more than 20 years tend to have less likelihood of near-miss accident and actual accident compare to those truck drivers with 5-10 years and 10-15 years of experience in specific.

The results also determined that truck drivers' education level indicated an effect on the likelihood of near-miss accident. In this study, truck drivers who did not go to school or undertaken primary school have less likelihood of near-miss accident compare to those who graduated from vocational school and high school. In addition, number of driving hour per day also do have an effect on likelihood of accident. Specifically, driving time with 7-8 hours, 9-10 hours, and more than 10 hours per day tend to have less likelihood of accident compare to those who drive less than 6 hours a day. Further details were discussed in the next chapter.

CHAPTER 5

CONCLUSION AND DISCUSSION

In this chapter, the main findings regarding to the research questions were summarized. The conclusions based on the findings of the studies presented in this dissertation were described. Furthermore, the implication of this research as well as limitations were discussed and suggestions for further research were presented.

5.1 Summary of Findings

The findings discovered from chapter 4 were elaborated in this section with an attempt to answer the research questions as follow;

Research question 1: What are the key constructs and sub-constructs underlying of truck fleets safety culture in Thai context?

The result of this study is a classification of key aspects of safety culture in the context of Thai truck driver working in logistics organizations. The safety culture measurement model in this study was developed using Swiss Cheese Accident Causation Model as a framework for structuring key safety culture aspects. The composition of safety culture model in this study consists of four constructs which were identified as 1) organizational support for safety, 2) social support for safety, 3) preconditions for employee safety behavior, and 3) employee safety behavior. In addition, sub-constructs were developed under each of main constructs.

Item generation was carried on with in-depth interview with subject matter experts as well as the empirical studies of previous research. Pool of items were generated and grouped under each construct accordingly. Some of the items from previous studies were required to conduct back-translation. The draft safety culture measurement was developed and sent to two truck drivers for face validation, especially in term of the clarity of the language. The subject matter experts commented that the back-translation items were very difficult to understand, hense the unclear items were later rewritten. The revised questionnaire was sent to other five experts for content validation using IOC techniques (Indexes of Item-Objective Congruence). Suggestions and comments from expert were considered for another revision. As a consequence, the initial version of safety culture measurement was developed with total number of 60 items which was the version used in pilot test.

The pilot test was carried on with sample of 75 truck drivers who work for truck fleet companies that is a partner with company S – one of the large logistics company in Thailand. Pilot data was analyzed in SPSS to examine item-total correlation in order to eliminate the low quality of items as well as to examine internal consistency. As a consequence, 19 items with *r* value less than 0.30 were deleted, the Cronbach's alpha was 0.88 for the remaining 41-item safety culture scale which reflecting good reliability of the newly developed measurement. The 41-item of safety culture questionnaire was developed and distributed to 1,010 truck drivers.

413 completed questionaires were returned and put for further factor analysis. Prior to perform factor analysis, the suitability of data was tested 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. The finding suggested that set of data was was suitable enough for further factor analysis.

In order to determine sub-construct under each safety culture dimension, exploratory factor analysis (EFA) was performed. 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 results 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 (2017), 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 of 12 items, measured by 2 factors termed as ‘management commitment’ and ‘safety rules & training’. The social support for safety dimension was comprised of 7 items, measured by 2 factors termed as ‘supervisor support’ and ‘co-worker support’. The pre-conditions for employee safety behavior was comprised of 5 items, measured by 2 factors termed as ‘ work conditions’ and ‘ personal conditions. The last dimension, employee safety behavior was comprised of 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.

Next, confirmatory factor analysis (CFA) was used in this study to confirm the factor structure developed from previous EFA study. All 12 items of organizational support for safety construct, 7 items of social support for safety construct, 5 items of preconditions for employee safety behavior construct, and 6 items of employee safety behavior construct were entered into the factor analysis process.

The First-order factor analysis was conducted. The purpose of this level of analysis was to constructing observable variables that are supposed to measure the latent variables as well as to confirm the factor structure in order to identify adequate items for further analysis. The results revealed the goodness of fit indices of each model was adequate and acceptable, indicated the validity of each sub-scale. The findings suggested that organizational support for safety construct was measured by 2 latent variables (i.e. management commitment, safety rules and training). The second construct, social support for safety, was measured by 2 latent variables (i.e. supervisor support and co-worker support). The third construct, preconditions for employee safety behavior, was measured by 2 latent variables (i.e. working conditions and personal conditions). The last construct, employee safety behavior, was measured by 2 latent variables (i.e. attentive action to safety and supportive action to safety). Therefore, the CFA result confirmed that the factor structure with the results derived from EFA study was acceptable.

Table 5.1 Summary of the Results of the Finalized 30-item Safety Culture Instrument

Dimension	N of Items	CR	Factor Loading	Cronbach's Alpha
1. Organizational support for safety	12	0.94	0.65 – 0.84	0.91
2. Social support for safety	7	0.86	0.53 – 0.91	0.82
3. Preconditions for employee safety behavior	5	0.83	0.59 – 0.92	0.72
4. Employee safety behavior	6	0.78	0.24 – 0.77	0.72
Total items = 30 (α = 0.93), AVE = 0.53, CR = 0.90				

The safety culture measurement model in this study was multidimensional model based on four aspects applied from Swiss Cheese Accident Causation Model. The second order factor analysis was then conducted to confirm that the theorized construct in a study loads into certain number of underlying sub-constructs or components. The study of second order CFA found that all sub-factors were under one main factor and able to measure a construct model. Moreover, it validated a good fit between the conceptual model and the empirical data. The goodness of fit statistics for second order CFA was: 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 construct reliability (CR) of the safety culture scale were 0.53 and 0.90, which were higher than the recommended level of 0.50 and 0.70 (Fornell & Larcker, 1981; Hair et al., 1998), respectively, where it might be concluded that the convergent validity of the instrument was adequate, suggesting that this safety culture model was well constructed along with the theory against the empirical data.

In conclusion to this part, the findings of this study provided clear answer to the research question as it determined certain number of key constructs and sub-constructs of safety culture scale with acceptable validity and reliability. Therefore, the four-dimension safety culture assessment in this study was composed of:

1) Organizational support for safety with 2 sub-factors as
   (1) Management commitment
   (2) Safety rules and training
2) Social support for safety with 2 sub-factors as
   (1) Supervisor support
   (2) Co-worker support
3) Preconditions for employee safety behavior with 2 sub-factors as
   (1) Working conditions
   (2) Personal conditions
4) Employee safety behavior with 2 sub-factors as
   (1) Attentive action to safety
   (2) Supportive action to safety

Research question 2: What is the relationship between safety culture and safety outcomes?

The main purpose of this study was to examine the concurrent validity whether the newly developed safety culture scale produced any relationship with safety outcomes variables. First, partial correlation between each safety culture dimension and each safety outcomes was performedeach. Each sub-scale of safety culture (i.e. organizational support for safety, social support for safety, preconditions for employee safety behavior, and employee safety behavior) was considered as an independent variable in this analysis, however these four variables correlated to each one another and may have some effect on each other at certain level. Therefore, in order to avoid confounding variables that can misleading the information of analysis, the partial correlation was performed. The findings suggested that only employee safety behavior variable showed negative relationship with likelihood of near-miss accident, while organizational support for safety unexpectedly had positive relationship with likelihood of near-miss accident. In addition, none of them had relationship with likelihood of accident. However, the likelihood of near-miss accident showed positive relationship with likelihood of accident.

As a result, the findings provided that not all of safety culture sub-scales had relationship with safety outcomes, except for the pair of employee safety behavior and likelihood of near-miss accident which exhibited negative relationship to each other ($r = -0.157$, $p < 0.01$). The concurrent validity was partially found in this analysis. More explanation of this scenario will be further discussed in the discussion part.

Next, SEM analysis was used in order to examine structural equation modeling of safety culture influencing two safety outcomes that is: likelihood of near-miss accident and likelihood of accidents. The main purpose of this analysis was to validate the concurrent validity of safety culture measurement. The path coefficients result revealed that an effect from safety culture was significantly direct to the likelihood of near-miss accidents with path coefficient value at 0.20. However, an effect from safety culture to the likelihood of accidents had no significant. The result of hypothesized model of safety culture influencing safety outcomes indicated bad fit between conceptual model and empirical data, which suggested that the empirical data was not congruent with the hypothesized model.

The proposed modification of the structure equation modeling of safety culture influencing likelihood of near-miss accidents and likelihood of accident was introduced with additional path from near-miss accidents involvement to actual accidents involvement. The result showed that there was a significant direct effect from safety culture to both near-miss accidents involvement and actual accidents involvement at 0.05 level with path coefficient value at 0.157 and 0.186 respectively. The squared multiple correlations (SMC) for this model explained that safety culture could predict the likelihood of near-miss accidents as 22.5%. Moreover, the likelihood of accidents had SMC = 0.365, indicated that safety culture and likelihood of near-miss accident could jointly predict the likelihood of accidents as 36.5% . The modification model indicated the good fit with the fit statistics: $\chi^2 = 68.284$, $df = 51$, $p = 0.053$, $\chi^2/df = 1.339$, RMSEA = 0.032, NFI = 0.960, NNFI = 0.981, CFI = 0.989, RMR = 0.036, SRMR = 0.036, GFI = 0.971 and AGFI = 0.941.

The result of this modification model is aligned with several near-miss studies which explain that near-miss is the crucial incidents that may provide effect or lead to possible actual accidents (Gnoni & Lettera, 2012; Powell et al., 2007b; W. Wu et al., 2010). Many industries aim to focus the event classified as near-miss in order to manage the reduction of major accident rates (Muermann & Oktem, 2002). The study of Powell and colleagues (2007) revealed statistically significant between sleepy near-miss accidents and actual accident in which the finding suggested that sleepy near-miss might be dangerous precursors to an actual accident of drivers.

In conclusion to this part, the findings of adjusted structural equation model of safety culture influencing safety outcomes suggested that safety culture produced direct effect to both the likelihood of near-miss accident and the likelihood of accident with path coefficient at 0.157 and 0.092 respectively $(p < 0.05)$. In addition, safety culture exhibited indirect effect to the likelihood of accident transmitted through the likelihood of near-miss accident with total effect of 0.186 $(p < 0.05)$. The findings demonstrated the importance of the likelihood of near-miss accidents as a mediation between safety culture and the likelihood of accidents. Therefore, this level of analysis suggested that the newly developed safety culture instrument had concurrent validity.

Table 5.2 Summary of Hypothesis Testing

Hypothesis	Analysis	Results	Conclusion
Hypothesis 1: Safety culture consists of four construct: (1) organizational support to safety (2) social support to safety (3) preconditions for employee safety behavior (4) employee safety behavior	2^{nd} order CFA	χ^2/df = 1.782 RMSEA = 0.044 SRMR = 0.020 CFI = 0.997 NFI = 0.992 GFI = 0.989	Support
Hypothesis 2(a): safety culture has an effect on likelihood of near-miss accident	SEM (Path coefficient)	DE = 0.20* TE = 0.20* SMC = 0.04	Support

Table 5.2 (Continued)

Hypothesis	Analysis	Results	Conclusion
Hypothesis 2(b):			
safety culture has an effect on likelihood of accident	SEM (Path coefficient)	DE = 0.073 TE = 0.073 SMC = 0.005	Rejection
	SEM (Fit indices)	χ^2/df = 5.008 RMSEA = 0.099 SRMR = 0.110 CFI = 0.864 NFI = 0.835 GFI = 0.885	Rejection

5.2 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 researches addressed the possibility to conceptualize the research framework after SCM, especially in the area of safety culture. One of the previous researches 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, Oglen, & Kabban, 2018). Similar to Robert 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 safety 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, 2010) 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 & Ryan, 1985). In contrast, further discussion with Thai managers and truck fleet owners suggested that safety compliance was usually driven by punishments and rewards mechanism which central to the concept of extrinsic motivation or controlled motivation (Gagné & Forest, 2008). Thus, truck driver 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 et al. (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.

Apparetly, employee safety behavior was the only variable of safety culture that had negative relationship with the likelihood of near-miss accident. Consistent with this finding, Reason (1997) explained in the SCM model that latent errors (e.g. management failures, unsafe supervision and working conditions) were not the direct cause of accidents but these latent errors were the indicator of several risks in the organization which lead to certain unsafe act. The unsafe act, on the other hand, was considered as active errors that directly lead to certain accident. In accordance with SCM concept, organizational support for safety, social support for safety and preconditions for employee safety behavior variable were identified as latent factor, while employee safety behavior was identified as active factor. Consistent with the study of Fernández-Muñiz et al. (2007), they examined causal relations between key safety culture constructs and found that top management play a great role in reducing unsafe acts commited by employees which in turn, reducing the work-related accident rates. Their results provided strong confirmation to this present study that not all of the safety culture dimension will affect to safety outcomes. Therefore, it is reasonable to only witness the negative relationship between employee safety behavior variable with safety outcome in this study.

Several safety researches addressed that organizations with good safety culture are likely to associate with fewer accidents (Gordon, 2002). In coherent to this study, the adjusted SEM model also exhibited the influence of safety culture on safety outcomes. The path coefficients showed that safety culture had direct effect on the two safety outcomes. Such finding was supported by the study of Morrow and Coplen (2017) as they emphasized that accidents and incidents are less frequent and less severe when safety culture is strong, thus establishing and maintaining strong safety culture was recommended as a top priority across transportation industry in the United States.

The likelihood of near-miss accidents also had direct effect on the likelihood of accidents in the SEM analysis which consistent with the previous correlation analysis. The findings of partial correlation demonstrated the positive relationship between the likelihood of near-miss accident and the likelihood of accident. The finding of adjusted SEM model is coherent with several near-miss studies which explain that near-miss is the crucial incidents that may provide effect or lead to possible actual accidents (Gnoni & Lettera, 2012; Powell et al., 2007b; Wu et al., 2010). As such, many industries aim to focus the event classified as near-miss in order to manage the reduction of major accident rates (Muermann & Oktem, 2002). The study of Powell et al. (2007) revealed statistically significant between sleepy near-miss accidents and actual accident in which the finding suggested that sleepy near-miss might be dangerous precursors to an actual accident of truck drivers.

Moreover, indirect effect of safety culture on the likelihood of accident transmitted through the likelihood of near-miss accident was also found. From the result, it implied that the likelihood of near-miss accidents partially mediated the relationship between safety culture and the likelihood of accident. The findings with previously support literatures, suggested that the likelihood of near-miss accident may be a good indicator to predict the actual accident, so the organization should pay great attention on how to manage near-miss incidents in order to prevent accidents accordingly.

This current study also examined effect of different demographic data on safety outcomes. The findings suggested that different age group of Thai truck drivers really do have an effect on both safety outcomes. Specifically, the older they are, the less likelihood of getting near-miss accident and actual accident. Similary, the work experiences of a truck driver also do have an effect on both safety outcomes. Truck drivers who has work experience more than 20 years tend to have less likelihood of near-miss accident and actual accident compare to those truck drivers with 5-10 years and 10-15 years of experience in specific. Number of driving hour per day also do have an effect on likelihood of accident. While several studies suggested that the long driving hour will lead to driver's fatigue thus increase in accident. In contrast with many researches, the findings revealed that driving time with 7-8 hours, 9-10 hours, and more than 10 hours per day tend to have less likelihood of accident compare to those who drive less than 6 hours a day. This scenario can be explained in the linkage with Thai truck drivers' interview as they mentioned that many short-haul truck drivers usually get paid based on number of trips they drive each day. According to this payment scheme, the driver will not have a fixed salary but get paid by the cumulative amount of trips they can manage within particular period (Jeong et al., 2016), thus the more they drive, the more they earn.

However, the shorter work hours also mean the less time for rest break which may increase drivers' fatigue. While long-haul truck drivers are associated with specific driving schedule (i.e. 2 trips per day), they feel no rush as they can manage their own time and having sufficient rest break. Therefore, this could be the case why Thai truck drivers who work longer hour but having more rest are less likely to engage with accident than the other group. This assumption is aligned with many researches on the effect of fatigue and road accidents. Many studies evidenced that truck drivers' fatigue and drowsiness are appeared to be a critical major cause of traffic crashes among truck drivers. Inadequate sleep and rest time lead to physical fatigue of drivers, thus it is essential to ensure that drivers have sufficient sleep and rest opportunities prior to perform their duty on the road (Chen et al., 2016; Zhang, Yau, Zhang, & Li, 2016). However, the hours of service alone cannot be used to explain the likelihood of getting in an accident as there are still many factors that increase risk factors of accident.

Even though, social support for safety construct in this study was scored in high level ($\overline{X}$ = 4.03), however found to be the lowest ranking compare to the rest of 3 safety culture constructs. The lowest score was found in the item of 'my supervisor allows staffs to change the work schedule if sick or too fatigue to drive' ($\overline{X}$ = 3.89). Such finding implied that some Thai truck drivers feel uncomfortable to negotiate the work schedule with their supervisor. As a support to this context, the cultural aspect is drawn to explain this scenario. Thailand is a country that portray a high level of power distance which central to bureaucratic working style. The concept of this specific cultural context portrays that, in the society where low power distance is dominant, the communication is found to be more open for discussion. Whereas, in high power distance society, employee in higher rank is praised for superior (Biatas, 2009) which inhibits the drivers to refuse their boss from doing an extra hour driving, and/or to negotiate on work safety issues. In accordance with this context, Thai truck drivers tend to depend on their supervisor and have to accept the work schedule according to supervisor's assignment (Hank, 1962). In regard to this cultural context, it is understandable to witness why Thai truck drivers rated the low score under this item. Therefore, to effectively establish the good safety culture, it is essential to lower the power of distance level and create culture in which truck drivers can openly negotiate their work schedule in regard with their physical and mental readiness.

5.3 Implications for Practice

The organizations including logictics and land transports companies may conduct safety culture assessment for several reasons. The newly 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 instrument can be used to identify the key problematic areas and help the organization to quickly solve those safety issues. The survey results could be used to investigate which sub-constructs plays the largest role in influencing employee safety behavior (Robert et al., 2018) and whether how each safety culture dimension impact to safety outcomes. 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.

The modified structural equation modeling in this study was introduced by adding additional path from near-miss accidents involvement to actual accident involvement. The result of this modification model indicated good fit. The path coefficients showed that safety culture had direct effect on both near-miss accidents involvement and actual accident involvement. Near-miss accidents involvement also had direct effect on actual accidents involvement at 0.58. Moreover, there was an indirect effect of safety culture on actual accidents involvement transmitted through near-miss accident involvement. From the result, it implied that near-miss accidents involvement partially mediated the relationship between safety culture and actual accident involvement. The finding of modification model is consistent with several near-miss studies which explain that near-miss is the crucial incidents that may provide effect or lead to possible actual accidents (Gnoni & Lettera, 2012; Powell et al., 2007b; W. Wu et al., 2010). Many industries aim to focus the event classified as near-miss in order to manage the reduction of major accident rates (Muermann & Oktem, 2002). The study of Powell and colleagues (2007) revealed statistically significant between sleepy near-miss accidents and actual accident in which the finding suggested that sleepy near-miss might be dangerous precursors to an actual accident of drivers. Therefore, it is important for the organization to strongly pay attention to the near-miss accidents involvement when study the impact of safety culture on actual accidents as it is believed that less near-miss events, less accidents.

Previous research also recommends to use the safety culture assessment as a way to communicate what area is most important to the organization and what are the factors that the organization is lacking in order to successfully implementing organizational safety culture (Nieva & Sorra, 2003). 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. Human resource department or safety department may consider using this assessment in order to develop organizational safety culture, as well as the safety management system implementation.

In addition, the effectiveness of organizational safety programs and interventions may be assessed through the use of safety culture assessment. It is also can be used to track the progress in cultural transformation over time. A continuing measure of safety culture can be considered as part of a safety improvement program aiming for continuous improvement, which gradually can become part of organizational learning (Nieva & Sorra, 2003). This instrument can also be used to identify trends in an organization's safety performance as well as to establish benchmarks for the safety levels of different units within one organization or different organizations (Glendon & Litherland, 2001; Nieva & Sorra, 2003).

5.4 Limitation and Recommendation to 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.

Moreover, many Thai truck drivers associated in this study 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 negative single factor after EFA process which provided no clear meaning to the underlying construct and had to be removed from the questionnaire. 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" (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 as 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.

Moreover, this research only aimed to confirm the conceptual model constructs, but did not seek for causal relationship between each safety culture constructs. However, the result of concurrent validity in this study showed that safety outcomes were not directly impacted by all of the four safety culture dimensions, but only through the employee safety behavior, and some indirect effect were found. This demonstrated some kind of relationships between them. Next research may consider to investigate how one construct impact one another, for example, to examine how organizational support for safety influences social support for safety, preconditions for employee safety behavior and employee safety behavior.

5.5 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 of 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 also demonstrated the adequate model fit during the CFA process for the four-dimension safety culture which consisted of 1) organizational support for safety, 2) social support for safety, 3) preconditions for employee safety behavior, and 4) employee safety behavior. This implied that the obtained data fitted well with the hypothesis model. As a consequent, the results from this study initially provided evidence of the validity and reliability of the newly developed safety culture assessment scale. 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 various organizations to evaluate the level of safety culture that will create a safe workplace for employees.

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APPENDIX

APPENDIX

FINALIZED VERSION OF THE SAFETY CULTURE QUESTIONNAIRE

ชุดที่ 1 แบบสอบถามวัฒนธรรมด้านความปลอดภัย

คำชี้แจง ข้อความด้านล่างนี้บอกถึงความคิดเห็นที่ท่านมีต่อบริษัท **ในปัจจุบัน** โปรดพิจารณาแต่ละข้อความว่าท่านเห็นด้วยหรือไม่เห็นด้วยมากน้อยเพียงใด แล้วทำเครื่องหมาย ✓ ในช่องที่ตรงกับความคิดเห็นของท่านมากที่สุด โดยพิจารณาจากหลักเกณฑ์ดังต่อไปนี้

1 หมายถึง ไม่เห็นด้วยอย่างยิ่ง
2 หมายถึง ไม่เห็นด้วย
3 หมายถึง ไม่แน่ใจ
4 หมายถึง เห็นด้วย
5 หมายถึง เห็นด้วยอย่างยิ่ง

(คำตอบของท่านไม่มีถูกหรือผิด กรุณาแสดงความคิดเห็นตามความเป็นจริง)

คุณเห็นด้วยกับข้อความต่อไปนี้มากน้อยเพียงใด	**เห็นด้วยอย่างยิ่ง 5**	**เห็นด้วย 4**	**ไม่แน่ใจ 3**	**ไม่เห็นด้วย 2**	**ไม่เห็นด้วยอย่างยิ่ง 1**
1. บริษัทนี้แก้ไขปัญหาความปลอดภัยในการทำงานได้อย่างรวดเร็วและมีประสิทธิภาพ					
2. บริษัทนี้ให้ความสำคัญกับเรื่องความปลอดภัยของพนักงานขับรถมากกว่าบริษัทอื่นๆ ที่ฉันเคยร่วมงานด้วย					
3. บริษัทมีรางวัลจูงใจให้กับพนักงานที่ปฏิบัติตามกฎระเบียบความปลอดภัย					

คุณเห็นด้วยกับข้อความต่อไปนี้มากน้อยเพียงใด	เห็นด้วยอย่างยิ่ง 5	เห็นด้วย 4	ไม่แน่ใจ 3	ไม่เห็นด้วย 2	ไม่เห็นด้วยอย่างยิ่ง 1
4. บริษัทรับฟังข้อเสนอแนะ แนวทางการปรับปรุงความปลอดภัยในการทำงานจากพนักงาน และนำไปแก้ไขอย่างจริงจัง					
5. บริษัทมีการสื่อสารและให้ข้อมูลที่สนับสนุนความปลอดภัยในการทำงานอย่างสม่ำเสมอ					
6. บริษัทมีกฎระเบียบและขั้นตอนการทำงานอย่างปลอดภัย เพื่อให้พนักงานยึดถือเป็นแนวทางในการทำงาน					
7. ฉันเชื่อว่ากฎระเบียบและแนวทางการปฏิบัติงานอย่างปลอดภัยของบริษัทสามารถป้องกันความผิดพลาดในการทำงานได้ดี					
8. กฎระเบียบและแนวทางการปฏิบัติงานอย่างปลอดภัยของบริษัทสามารถปฏิบัติตามได้จริง					
9. บริษัทนี้สนับสนุนให้พนักงานขับรถได้เข้าฝึกอบรมเกี่ยวกับการขับขี่และการปฏิบัติงานอย่างปลอดภัยอยู่สม่ำเสมอ					
10. การฝึกอบรมทำให้ฉันได้เรียนรู้ถึงข้อจำกัดในการขับรถบรรทุกขนาดใหญ่อย่างที่ฉันไม่เคยรู้มาก่อน เช่นจุดบอดของรถบรรทุก					
11. ฉันสามารถทำงานได้อย่างมั่นใจและปลอดภัยมากขึ้น เมื่อได้รับการฝึกอบรมขับขี่อย่างปลอดภัย					

คุณเห็นด้วยกับข้อความต่อไปนี้มากน้อยเพียงใด	เห็นด้วยอย่างยิ่ง 5	เห็นด้วย 4	ไม่แน่ใจ 3	ไม่เห็นด้วย 2	ไม่เห็นด้วยอย่างยิ่ง 1
12. หลักสูตรการฝึกอบรมด้านการขับขี่อย่างปลอดภัยของบริษัทที่ฉันเข้าร่วม มีประโยชน์และสามารถนำมาประยุกต์ใช้กับการทำงานได้จริง					
13. หัวหน้า ยอมให้พนักงานปรับเปลี่ยนตารางการทำงานได้ หากพบว่าพนักงานไม่สบาย หรือเหนื่อยล้าเกินไปที่จะขับรถ					
14. หัวหน้า จัดเวลาการทำงานได้เหมาะสม ให้ลูกน้องมีเวลาเพียงพอต่อการจัดส่งสินค้าได้อย่างปลอดภัย					
15. ส่วนใหญ่แล้ว ฉันได้รับข้อมูลข่าวสารเกี่ยวกับความปลอดภัยในการทำงานมาจากหัวหน้า					
16. ฉันสามารถพูดคุยเกี่ยวกับปัญหาด้านความปลอดภัยในการทำงานกับหัวหน้างานได้อย่างเปิดเผย					
17. หัวหน้า คอยตรวจตราการทำงานของพนักงานให้เป็นไปตามกฎและนโยบายของบริษัท					
18. เพื่อนร่วมงาน คอยให้คำแนะนำกันเพื่อช่วยให้ฉันทำงานได้อย่างปลอดภัยมากขึ้น					
19. เพื่อนร่วมงาน คอยเตือนเวลาฉันพยายามฝ่าฝืนกฎระเบียบความปลอดภัยของบริษัท					
20. ที่บริษัทนี้มีพนักงานขับรถเพียงพอที่จะรองรับปริมาณงานของบริษัท ทำให้ฉันไม่ต้องเร่งรีบในการขับรถมากนัก					

คุณเห็นด้วยกับข้อความต่อไปนี้มากน้อยเพียงใด	เห็นด้วยอย่างยิ่ง 5	เห็นด้วย 4	ไม่แน่ใจ 3	ไม่เห็นด้วย 2	ไม่เห็นด้วยอย่างยิ่ง 1
21. รถบรรทุกของบริษัทที่ฉันขับอยู่นี้ มีสภาพดี ได้รับการบำรุงรักษาซ่อมแซมอยู่เสมอ					
22. โดยส่วนตัวแล้ว ความปลอดภัยในการทำงานเป็นเรื่องสำคัญที่สุดสำหรับฉัน					
23. การได้นอนหลับพักผ่อนอย่างเต็มที่ก่อนจะเริ่มปฏิบัติงานขับรถ เป็นสิ่งสำคัญมากสำหรับฉัน					
24. ฉันมีสภาพร่างกายและจิตใจที่แข็งแรงก่อนการขับรถทุกครั้ง					

พฤติกรรมที่ปลอดภัยของพนักงาน

คำชี้แจง กรุณาตอบคำถาม โดยทำเครื่องหมาย ✓ ในตัวเลือกที่ตรงกับความเป็นจริง ตามประสบการณ์ของท่านที่ได้ทำงานในบริษัทแห่งนี้ โดยตอบคำถามตามลำดับทีละข้อตามพฤติกรรมของท่าน ข้อละ 1 คำตอบ โดยพิจารณาจากหลักเกณฑ์ดังต่อไปนี้

1 หมายถึง ไม่เคยเลย หรือ 0 ครั้ง/ปี
2 หมายถึง นานๆ ครั้ง หรือ 1-2 ครั้ง/ปี
3 หมายถึง ไม่ค่อยบ่อย หรือ 2-3 เดือนครั้ง
4 หมายถึง บ่อยครั้ง หรือ ทุกสัปดาห์
5 หมายถึง ตลอดเวลา

พฤติกรรมต่อไปนี้เกิดขึ้นกับคุณบ่อยแค่ไหน	ตลอดเวลา 5	บ่อยครั้ง 4	ไม่ค่อยบ่อย 3	นานๆ ครั้ง 2	ไม่เคยเลย 1
25. ฉันยึดมั่นในกฎระเบียบ และปฏิบัติงานตามขั้นตอนความปลอดภัยของบริษัทอย่างเคร่งครัด					

พฤติกรรมต่อไปนี้เกิดขึ้นกับคุณบ่อยแค่ไหน	ตลอดเวลา 5	บ่อยครั้ง 4	ไม่ค่อยบ่อย 3	นานๆ ครั้ง 2	ไม่เคยเลย 1
26. ฉันมักจะรายงานปัญหาความปลอดภัยที่เกิดขึ้นให้หน่วยงานรับทราบ					
27. ฉันคอยช่วยเหลือ แนะนำ ให้เพื่อนร่วมงานทำงานอย่างปลอดภัย					
28. ฉันกล้าที่จะพูดหรือเสนอแนะแนวทางการแก้ปัญหาความปลอดภัยให้เถ้าแก่ หรือ ผู้บริหารของบริษัทฟัง					
29. ฉันขับรถอย่างระมัดระวัง และใส่ใจความปลอดภัยของเพื่อนร่วมทาง					
30. ถึงจะไม่มีกฎระเบียบควบคุม ฉันก็ยังใส่ใจในการขับรถโดยคำนึงถึงความปลอดภัยเป็นสำคัญ					

ชุดที่ 2: ผลลัพธ์ด้านความปลอดภัย

คำชี้แจง กรุณาตอบคำถาม โดยทำเครื่องหมาย ✓ ในตัวเลือกที่ตรงกับความเป็นจริง ตามประสบการณ์ของท่านที่ได้ทำงานในบริษัทแห่งนี้ โดยตอบคำถามตามลำดับทีละข้อ ข้อละ 1 คำตอบโดยพิจารณาจากหลักเกณฑ์ดังต่อไปนี้

1 หมายถึง ไม่เคยเลย หรือ 0 ครั้ง/ปี
2 หมายถึงนานๆ ครั้ง หรือ 1-2 ครั้ง/ปี
3 หมายถึงไม่ค่อยบ่อย หรือ 2-3 เดือนครั้ง
4 หมายถึงบ่อยครั้ง หรือ ทุกสัปดาห์
5 หมายถึงเคยประจำ หรือ ทุกวัน

ผลลัพธ์ด้านที่ 1 "การเกือบจะเกิดอุบัติเหตุ" เป็นเหตุการณ์ที่เกิดขึ้น แต่ยังไม่ก่อให้เกิดความเสียหาย หรือสูญเสีย ต่อตัวเอง ยานพาหนะ ตลอดจนผู้ที่เกี่ยวข้องในเหตุการณ์ (เช่น เกือบจะชน แต่ยังไม่ชน)

ระหว่างการขับรถบรรทุกในช่วง 1 ปีที่ผ่านมา คุณเคยประสบเหตุการณ์ หรือมีอาการใดๆ ดังต่อไปนี้ ที่ทำให้คุณ เกือบจะเกิดอุบัติเหตุ	**เคยประจำ 5**	**บ่อยครั้ง 4**	**ไม่ค่อยบ่อย 3**	**นานๆ ครั้ง 2**	**ไม่เคย 1**
31. เบรคหนักๆ กระทันหัน จนเกือบจะชน					
32. หักหลบกระทันหัน จนเกือบจะชน					
33. หลับใน จนเกือบจะเสียการควบคุมรถ					
34. ใจลอย ไม่มีสมาธิ จนเกือบจะเสียการควบคุมรถ					
35. เสียการทรงตัว จนเกือบตกจากที่สูง					

36. ปัจจัยสำคัญด้านใดที่คุณคิดว่า ช่วยให้คุณเอาตัวรอดจากเหตุการณ์ที่ทำให้คุณ <u>เกือบจะเกิดอุบัติเหตุ</u> มาได้ (เลือกตอบเพียง 1 ข้อ)

❒ 1) ทักษะและประสบการณ์การขับรถที่ดี ❒ 2) สติสัมปชัญญะ

ผลลัพธ์ด้านที่ 2 "การเกิดอุบัติเหตุ" เป็นเหตุการณ์ที่เกิดขึ้นแล้ว และก่อให้เกิดความเสียหาย หรือความสูญเสีย ต่อตัวเอง ยานพาหนะ ตลอดจนผู้ที่เกี่ยวข้องในเหตุการณ์

ระหว่างการขับรถบรรทุกในช่วง 1 ปีที่ผ่านมา คุณเคยประสบเหตุการณ์ใดๆ ดังต่อไปนี้ ที่ทำให้คุณ เกิดอุบัติเหตุ	**เคยประจำ 5**	**บ่อยครั้ง 4**	**ไม่ค่อยบ่อย 3**	**นานๆ ครั้ง 2**	**ไม่เคย 1**
37. Unable to break					
38. Unable to control the steering wheel					
39. Accident due to sleep driving					
40. Accident due to absentminded					
41. Accident due to fall from the height					

ชุดที่ 3 ข้อมูลทั่วไป

คำชี้แจง กรุณาทำเครื่องหมาย ✓ ในช่อง ❒ และ/หรือเติมข้อมูลลงในช่องว่างที่กำหนด

1. **เพศ** ❒ 1) ชาย ❒ 2) หญิง
2. **สถานภาพสมรส** ❒ 1) โสด ❒ 2) สมรส ❒ 3) อื่นๆ (หม้าย หรือ หย่า)
3. **อายุของท่านอยู่ในช่วงใด**
   ❒ 1) 20 – 30 ปี ❒ 2) 31 – 40 ปี
   ❒ 3) 41 – 50 ปี ❒ 4) มากกว่า 50 ปี
4. **ระดับการศึกษาสูงสุด**
   ❒ 1) ประถมศึกษา ❒ 2) มัธยมศึกษา ❒ 3) ปวช. - ปวส.
   ❒ 5) ปริญญาตรี ❒ 6) ไม่มีวุฒิการศึกษา ❒ 7) อื่นๆ....................
5. **ประเภทของรถที่ท่านใช้ในงานขนส่งเป็นประจำ**
   ❒ 1) รถ 6 ล้อ ❒ 2) รถ 10 ล้อ ❒ 3) รถพ่วง
   ❒ 4) รถเทรลเลอร์ ❒ 5) อื่นๆ (โปรดระบุ)..
6. **ประเภทใบอนุญาตขับขี่ของท่าน** ❒ 1) ทั่วไป ประเภท 2 (ท.2) ❒ 2) ทั่วไป ประเภท 3 (ท.3)
   ❒ 3) ทั่วไป ประเภท 4 (ท.4) ❒ 4) บุคคล ประเภท 3 (บ.3) ❒ 5) อื่นๆ (ระบุ)..................
7. **ท่านเป็นพนักงานขับรถที่บริษัทปัจจุบันนี้** เป็นระยะเวลานานเท่าไหร่...ปี
8. **ท่านมีประสบการณ์ขับรถบรรทุก** รวมทั้งสิ้นเป็นระยะเวลานานเท่าไหร่...ปี
9. **ใน 1 วัน ท่านใช้เวลาในการขับรถนานเท่าไหร่**..ชั่วโมง/วัน
10. **ใน 1 วัน ท่านขับรถเป็นระยะทางประมาณเท่าไหร่**..กิโลเมตร/วัน
11. **บริษัทของท่านมีรถบรรทุกทุกประเภทรวมประมาณกี่คัน**..คัน
12. **ลักษณะงานการขับรถบรรทุกของท่าน <u>ส่วนใหญ่</u> เป็นแบบใด (เลือกตอบมา 1 ข้อ)**
    ❒ 1) ขับระยะใกล้ ไป-กลับ ใน 1 วัน ❒ 2) ขับระยะไกล ภายในประเทศ พักค้างคืนระหว่างทาง
    ❒ 3) ขับระยะไกล ข้ามชายแดน พักค้างคืนระหว่างทาง ❒ 4) ขับระยะใกล้บ้าง ระยะไกลบ้าง สลับกันไป
13. **ปกติแล้ว รถที่ท่านขับเป็นประจำ มีจำนวน พขร. กี่คนต่อคัน**
    ❒ 1) 1 คน/คัน ❒ 2) 2 คน/คัน

<u>บทส่งท้าย</u>

ท่านต้องการให้บริษัททำอะไรเป็นพิเศษ เพื่อช่วยให้การทำงานของท่านมีความปลอดภัยมากยิ่งขึ้น (ถ้ามี)

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ข้อเสนอแนะเพิ่มเติม (ถ้ามี)

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ขอขอบพระคุณทุกท่านจากใจจริงที่เสียสละเวลาอันมีค่าเพื่อตอบแบบสอบถามนี้

BIOGRAPHY

NAME	Ms. Supavanee Thimthong
ACADEMIC BACKGROUND	Bachelor of Science (B.Sc.) with a major in Physics-Energy from Naresuan University, Phitsanulok, Thailand in 1998 Master of Technology Management (MTM) from University of New South Wales, Sydney, Australia in 2001.