THE UNIVERSITY OF HULL

THE EXPLORATION OF A SAFETY ATTITUDE MODEL FOR DEPARTMENTAL SAFETY REPRESENTATIVES TOWARDS THE IMPLEMENTATION OF A SAFETY MANAGEMENT SYSTEM IN AN INSTITUTE OF TERTIARY EDUCATION IN HONG KONG

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by

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DECLARATION OF ORIGINALITY

The following work has been completed by the author as coursework research project report in the PhD Education at The University of HULL under the supervision of Mr. Nigel Wright, Senior Lecturer of the University of Hull.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material that was previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a University or other institute of higher learning, except where due acknowledgement has been made in the text.

Chi-moon LI

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ABSTRACT

C.M.LI: THE EXPLORATION OF A SAFETY ATTITUDE MODEL FOR DEPARTMENTAL SAFETY REPRESENTATIVES TOWARDS THE IMPLEMENTATION OF A SAFETY MANAGEMENT SYSTEM IN AN INSTITUTE OF TERTIARY EDUCATION IN HONG KONG.

In this dissertation, an institute of tertiary education in Hong Kong "The University" represents a leading international research university dedicated to the pursuit of new knowledge in cutting-edge fields and the education of tomorrow's leaders. In the University, the success of an effective safety management system (SMS) depends on many factors, one of which could be safety attitudes of Departmental Safety Representatives "DSRs" who have a major role in implementing SMS at the departmental level. They are employees with additional safety duties to make sure the University's safety policy, in-house rules, procedures, Code of Practice and legal requirements are adhered to. Clearly, DSRs are different from each other. Attitude, behaviour, personal beliefs, culture, competence, personality and various co-factors of individual ultimately make a difference toward the implementation of SMS. A well-designed workplace with a well established SMS does not guarantee an injury-free workplace. The problem, however, is that some DSRs involved may have different safety attitudes in implementing the SMS at work. Then, what would happen? An

attempt has been made in this project to study the DSRs' safety attitudes by exploring the relationships of DSRs' introspection and various cognitive factors which may most likely influence the effectiveness of SMS implementation in the University.

A comprehensive review of literature has provided a substantial ground work for the design of research instrument and the theoretical framework to develop the hypothesized "DSRs Safety Attitude Model". A self-reported six points Likert type safety attitudes survey questionnaire was developed to measure responses of the targeted group 'DSRs' safety attitudes towards the implementation of SMS that probes into the possible relationships between various cognitive factors. Constructs measured by the survey included perceptions of safety management, perceived management commitment to safety, perceptions of safety communication, perceptions of safety training, personal beliefs in accident causation, perceptions of group safety norms, perceived safety responsibility and perceived efficacy in managing safety.

With respect to analyzing data, Statistical Package for the Social Sciences (SPSS) version 11.0 for Windows was employed to test validity and reliability of the survey questionnaire. Both were over recommended levels and so the survey instrument was deemed fit for use.

Structural equation modeling (SEM) was employed to analyze relationships among constructs of the hypothesized "DSRs Safety Attitude Model". Path analyses using AMOS 5.0 suggested some theoretically justifiable modifications to the model. The hypothesized "DSRs Safety Attitude Model" was tested by examining the goodness of fit of the model. Assessment of model fit was based on multiple criteria including model-fit indexes of Chi-square (p) value, Goodness-of-fit index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA) and PCLOSE. The results of five (5) selected model fit indexes fulfilled the criteria of model acceptance; as such the "DSRs Safety Attitude Model" fits the data and fails to be rejected. The excellent fit of the data from the questionnaire to the hypothesized "DSRs Safety Attitude Model" provided further evidence of the validity and reliability to the questionnaire. The significance of the research hypotheses between the model constructs was also tested and concurred with the hypothesized model structure. It is concluded that the hypothesized "DSRs Safety Attitude Model" falls within the criteria of a "Fit but Parsimonious" model in explaining DSRs' safety attitude towards the implementation of SMS at departmental level.

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INTRODUCTION AND PROBLEM STATEMENT

1. INTRODUCTION:

In this dissertation, the "University" represents "an institute of tertiary education in Hong Kong". The University officially admitted its first cohort of students in October 1991 and now has become one of the leading universities in Hong Kong. A leading university requires the infrastructure and facilities that contribute to the execution of its mission. It comprises of four schools: the School of Science, School of Engineering, School of Business & Management, and School of Humanities & Social Science. The University has 574 research laboratories on the campus, it is just like a 'microcosm' in that the risks involved are no less complicated than those experienced in the industrial or non-industrial sector in the local community. In order to strive for safety excellence, more resources such as management and employee effort, funding for safety improvement projects, personal protective equipment, training and support, as well as safety promotional activities are really needed. However, challenges arise in line with the demand for safety supports in academic and research activities, cost-cutting, downsizing in manpower and the need to fulfil new legislative requirements have been increasing. These challenges provide the safety impetus to the management of the University. This first chapter of the dissertation presents the problem statement, roles and challenges of Departmental Safety Representatives "DSRs" in implementing the safety management system (SMS) at the University. Research aims, objectives and project direction of this study also discussed.

2. PROBLEM STATEMENT:

In the University, DSRs are full time employees with part-time management responsibility in ensuring relevant policies, safety rules, operating procedures and legal requirements are adhered to. Clearly, DSRs personal characteristics are different from each other. Their attitudes and various co-factors ultimately make a difference toward the implementation of SMS. The effectiveness of SMS implementation could be affected by the personal characteristics of individuals such as personal experience, skills, knowledge, education and training, which influence personal beliefs when performing tasks.

A well-designed workplace with a well established SMS does not guarantee an injury-free workplace, if DSRs involved are not as proactive as they should be. As such, the overall safety performance in the University and the effectiveness of SMS implementation at departmental level are directly affected by DSRs safety attitudes. In order to understand more deeply DSRs safety attitudes towards the implementation of SMS, their roles and challenges will be discussed in Section 3.

3. ROLES AND CHALLENGES FOR DSRS:

The problem of running a safe job is complicated by the fact that the hazards present may derive from characteristics of the individuals involved, the physical workplace environment, the nature of the work and the interaction between these factors. In the University, activities such as research and experiments inside laboratories, industrial process inside workplaces and construction works around the campus comprise a wide range of risk exposures. The safety requirements can be totally different from one research project to another. Where strict procedural guidelines attempt to control unsafe behaviour, a human factors' perspective acknowledges individual differences that influence behaviour.

Today, safety management is a complex activity requiring the expertise of safety specialists. At the University's level, the mission of the Safety & Environmental Protection Office (SEPO) is to promote and help sustain health, safety and environmental protection in teaching, research, and other activities at the University by providing professional expertise, efficient support services and effective compliance assistance. To fulfil its mission effectively, a team of eighteen (18) SEPO's professional staff always provide necessary expert support through planning, organizing, controlling and monitoring the effectiveness of implementation of SMS at University level. They are not working alone in ensuring a safe working environment for all stakeholders (i.e. including staff members, students and contractors) in the University. To ensure proper execution of teaching and research projects and to ensure a safe workforce at the departmental level, it is a formal requirement that "DSRs" should be appointed in each department to assist the Head of Department "HOD" in implementing the departmental SMS.

DSRs including Departmental Safety Officers, Deputy Departmental Safety Officers and staff members with a duty of safety supervision (e.g. Fire Safety Ambassadors and front-line supervisors) are nominated from various departments and offices. In the academic year of 2005/2006, a total of 314 staff members were appointed as DSRs. They were recruited from the local community and from countries with varying cultural backgrounds, educational levels, working experiences and expertise. There exist differences in language, personal beliefs, norms, perceptions and attitudes towards occupational safety. As such, DSRs would be likely to produce differences in implementing SMS at departmental level. In recent years, DSRs are facing a more demanding situation in performing safety duty.

Major challenges for DSRs will be discussed in section 3.1; 3.2; 3.3 and 3.4.

3.1 CULTURAL DIFFERENCES:

The mission of the University is to advance learning, knowledge and contributing to the economic development of Hong Kong through teaching and research, particularly in the field of science, technology, engineering, management and business studies. In 2006, the student population stood at about 9,000, with 64% enrolled in undergraduate programs, 23% in taught masters programs and 13% in research postgraduate programs. About 1,500 students (16.7% of student population) were non-local students. The proposed change from a three-year to a four-year degree structure has brought new challenges to campus development. With the implementation of the four-year undergraduate degree program in 2012, it has been estimated that about 9,680 students will be educated in each academic year. In the University, about 2,000 staff members, including 400 faculty members from 24 countries have been employed to deliver educational services to students. More than half of the faculty members (52%) are recruited from outside Hong Kong and about one-third are from North America.

In recent years, connections with leading institutions in the world through academic partnerships make the composition of staff members and students increasingly diverse. New comers including staff members and students are continuously arriving on campus to perform various tasks in each academic year. They are vulnerable to accidents, until they become aware of hazards and learn how to cope with them. Thus, human factors, organizational culture and their interaction with research and technical aspects are concerns in safety management. Therefore, maintaining a positive safety culture with proper safety attitudes and behaviour on campus is not only important in ensuring a healthy and safe environment on campus, it is also important for our students and visiting scholars to experience how safety issues are integrated into every aspect of campus life. The main challenge for the DSRs will be to lead a cultural change at the departmental level.

3.2 COMPLEXITY OF FACILITIES AND EQUIPMENT:

In the University, there are more than 570 science and engineering research laboratories including Chemical Engineering, Chemistry, Biology, Biochemistry, Physics, Mechanical Engineering, Civil & Structural Engineering, Electrical & Electronic Engineering, Research Centre, Material Characterization & Preparation Facility, Microelectronics Fabrication Facility, Geotechnical Centrifuge Facility and Wind/Wave Tunnel Facility managed by various departments. A full range of campus services including a sports centre, student halls, staff quarters, restaurants, bookstore, supermarket, visitor lodgings and banks are also offered. In fact, activities such as research and experiments inside laboratories, industrial process inside workplaces and building construction works comprise a wide range of risk exposures. Occupational safety hazards may involve the use of potentially dangerous hardware and the handling of hazardous materials, such as chemical and radioactive substances, biological materials, toxic and harmful gases, high-power laser set-ups, high voltage electrical equipment, mechanical/ pneumatic/hydraulic power operated tools, machinery, robotic instruments and dangerous work processes.

In the local tertiary institutions, the undergraduate academic program structure will be re-engineered. A landmark decision has been made for the tertiary education sector to change from a 3-year undergraduate program to a 4-year one in 2012. To support student growth resulting from the conversion to the four-year degree program and expanding non-local admissions in coming years, it is not difficult to foresee that the services will have to undergo some substantial enhancement in order to cope with changes. It is therefore crucial that campus infrastructures are extended to support the new demands placed upon them. Upcoming works include the construction of student halls and amenities, faculty apartments, library extension, lecture theatres, teaching and research laboratories, classrooms and offices will also be increased through the development of the main academic complex.

An effective SMS should ensure that all the necessary safety procedures and practices are being properly implemented. As Kletz (1990, p.151) asserts "*Accidents* *often occur because someone does something which does not break any code of practice or set of instructions but is not good engineering or operating practice".* Substantial efforts should be made by HOD and DSRs to ensure the SMS is in place, facilities and equipment are properly provided for safe operation.

3.3 <u>DUTY OF CARE AND COMPLIANCE WITH LEGAL REQUIREMENTS:</u>

The ultimate goal of control over safety is to reduce accidents. In recent years, occupational safety has become a paramount issue in Hong Kong. The Occupational Safety and Health Branch (OSHB) of the Labour Department, Hong Kong Special Administrative Region (HKSAR) should be responsible for overseeing the formulation and implementation of policies, strategies and legislative requirements regarding occupational safety, health and welfare. To further enhance safety culture in Hong Kong, the legislative requirements of occupational safety and health at work have shifted the focus from the concept of prescriptive standards to a self-regulatory approach.

Besides the Chapter 59 Factories and Industrial Undertakings Ordinance (FIUO) and their 30 sets of subsidiary legislation; the Chapter 509 Occupational Safety and Health Ordinance "OSHO" and subsidiary regulations was enacted in May 1997.

The OSHO has extended the coverage of employees' safety and health at work of all economic activities in industrial and non-industrial establishments including the offices, commercial premises, educational institutions, hospitals, clinics, laboratories and other workplaces. It imposes a general duty of care on employers, occupiers of premises and employees. This ordinance made it obligatory for the employer at each workplace to take a reasonable, practicable and a more systematic approach to the management of occupational health and safety in workplaces. Employers have to set basic requirements in accident prevention, fire prevention, working environment, workplace hygiene, first aid, manual handling operation and use of display screen equipment. Further more, implementation of SMS was made mandatory with introduction of the Chapter 59AF Factories and Industrial Undertakings (F&IU) (Safety Management) Regulation which was enacted in 2000. All these regulations set the direction for the organization to comply with as a mininum safety standard.

All tertiary institutions in Hong Kong including the University have been bought under the jurisdiction of the ordinance and regulations. No exemption has been granted to the University! To fulfil legal responsibility and obligation to ensure a safe working environment, at the university level, top management are responsible for ensuring that they meet their obligations under legislation. At the departmental level, the HOD is regarded as the occupier who is legally bound to ensure, so far as reasonably practicable, the health and safety at work for their stakeholders. In other words, he or she should bear additional management responsibilities in ensuring healthy and safe workplaces for their stakeholders by providing adequate safety information; instruction; training, supervision and proper personal protective equipment "PPE". HOD should also provide leadership, resources and take the management responsibility for bringing the vision to implementation in their areas of control. Failure to provide a safe working environment may jeopardize the safety of stakeholders.

All stakeholders in the University also have general duty of care. They should know how to comply with legislative requirements and fulfil legal responsibilities including exercising duty of care to other people and to fully cooperate with their employers. They have to cooperate with their supervisors and DSRs to ensure safe working practices are implemented at all times. Going to jail would not be fun as non-compliance with the legislative requirement is a prosecutable offence; it could be prosecuted by the Labour Department of HKSAR. The Chapter 509 Occupational Safety and Health Ordinance "OSHO" and subsidiary regulations, an employer or an occupier who fails to comply with relevant regulations intentionally, knowingly or recklessly commits an offence and is liable on conviction to a fine of Hong Kong dollars $200,000 and to imprisonment for 6 months. An employee who fails to comply with relevant regulations intentionally, knowingly or recklessly commits an offence and is liable on conviction to a fine of Hong Kong dollars $50,000 and to imprisonment for 6 months. The concerted efforts made by all parties concerned through legislation, enforcement, education, training, promotion and administration have significantly improved the safety performance at the University with a remarkable reduction in its accident rate. Some department heads, front line supervisors and contractor's workers are still unaware of the general duty of care and as a result don't treat "Safety" as equally important as other operational parameters.

3.4 COST-CUTTING, RESTRUCTURING AND DOWNSIZING:

Maintaining a healthy and safe environment is fundamental to achieving excellence in teaching and research. The University has invested a great deal of resources and adopted a reasonable, practicable and proactive approach in ensuring that a safe and healthy environment is being provided to all stakeholders on campus. Unfortunately, along with other Asian countries, after encountering the worst economic crisis in recent years, the Hong Kong region entered into a period of organizational downsizing, restructuring and cost-cutting toward the end of 2005.

To meet these challenges, all universities in Hong Kong have to change corporate strategies, downsizing, restructuring and cost-cutting to reduce the total costs for their organizations. Kletz (1990, p.274) points out that "*Reorganization can result,* *and has resulted, in safety procedures being discontinued, not because someone took a considered decision to stop them but because they were overlooked when the new organization was set up and no one was made responsible for them*".

After trimming payrolls and reducing manpower in recent years, curricula and teaching methodologies will have to be enhanced because of the upcoming transition to four-year degrees scheme in tertiary institutions in Hong Kong. In order to maintain the same level of quality and services, the University has to be more focused on the better utilization of all the available resources they already have. Some staff members left the University through the voluntary retirement scheme. Those who remain fear being laid off and working under stress with "to do more with less manpower". It is becoming one of our safety concerns, as cost-cutting, restructuring and downsizing may create a situation in which necessary safety measures overstress or exceed the capacity of the reduced workforce that is retained.

As the University operations continue to grow in coming years, challenges and responsibility for DSRs in implementing SMS at the departmental level have also increased. DSRs need to maintain the correct level of skills, knowledge, experience, training and attitudes to meet these new challenges including safety. To ensure a safe place of work, it is important that the DSRs in this tough situation will get all possible support to gain self confidence in implementing SMS.

4. RESEARCH AIM AND OBJECTIVES:

It is now widely recognized that the human factor is a significant contributory factor in a large proportion of accidents and incidents. Investigation of the human factors has become a contemporary study. The following are examples of attitude researches:

1. *"EFFECTS OF SAFETY INSTRUCTION UPON SAFETY ATTITUDES AND KNOWLEDGE OF UNIVERSITY STUDENTS ENROLLED IN SELECTED AGRICULTURAL ENGINEERING COURSES"* (SEABOCH, 1994);

2. *THE EXPLORATION OF A MULTI-DIMENSIONAL SAFE BEHAVIOUR MODEL FOR CONSTRUCTION WORKERS IN HONG KONG – A STRUCTURAL EQUATION MODELLING APPROACH.* (KAM, 2002);

3. *"ATTITUDES OF STAFF TOWARDS FEMALE MANAGERS AT A TERTIARY INSTITUTION"* (VAN HOEK, 2004); and

4. *"GENDER-BASED ISSUES IN AVAITION, ATTITUDES TOWARDS FEMALE PILOTS: A CROSS-CULTURAL ANALYSIS"* (WILSON, J., 2005).

In the University's environment, the success of an effective SMS depends on several factors, one of which could be influenced by DSRs attitudes. However, DSRs with different background characteristics and perceptions imposed different attitudes towards the implementation of SMS at departmental level. So, it is important that the University should able to identify factors that could influence DSRs safety attitude towards the implementation of SMS. In this study, research on safety attitudes sheds light on the reasons DSRs hold the attitudes they do and the degree to which attitudes predict behaviour in implementing the SMS at the departmental level.

The aim of present study is the exploration of DSRs introspection and various cognitive factors which may most likely influence the effectiveness of SMS implementation. The main objectives of the study were:-

- To examine critically the possible relationships between DSRs safety attitude towards the implementation of SMS at departmental level.
- To provide a clear picture regarding the problems of implementation of SMS at departmental level reflected in the DSRs safety attitudes survey.

Results of the survey were used to identify what personal factors of DSRs associated with and most likely to influence the effectiveness of SMS.

- To examine the use of DSRs safety attitudes survey as an alternative measure of an effective and successful SMS.
- The results of the research should be able to provide practical recommendations for the enhancement of current SMS at the University.

The study of DSRs attitudes towards the implementation of SMS at departmental level mainly refers to the literature review in Chapter Two (2), Three (3) and Four (4).

The literature review of theories and models helps researchers focus on what is changeable and the most suitable areas or targets for change. *"A theory presents a systematic way of understanding events or situations. It is a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables. Concepts are the building blocks of the primary elements or a theory. Constructs are concepts developed or adopted for use in a particular theory. The key concepts of a given theory are its constructs. Variables are the operational forms of constructs. They define the way a construct is* *to be measured in a specific situation. Match variables to constructs when identifying what needs to be assessed during evaluation of a theory-driven program. Finally, models may draw on a number of theories to help understand a particular problem in a certain setting or context. They are not always as specified as theory."*

(U.S. Department of Health and Human Services, National Institutes of Health, 2005, p.4)

In this study, the theories and models approach helps to explain DSRs attitudes from different dimensions and to provide the basic structure of the hypothesized "DSRs Safety Attitude Model". It is assumed that the more favourable the DSRs attitudes towards safety, the stronger the DSRs intention to implement SMS in a positive way. An attitude survey would be developed to measure responses of DSRs safety attitudes towards the implementation of SMS that probes into the possible relationships of the DSRs attitudes and various co-factors such as personal beliefs, perception, behaviour and safety culture. The proposed theoretical model with hypothetical constructs and observed variables would be developed through the literature review. With respect to analyzing data in the pilot tests, the statistical package SPSS 11.0 for Windows was employed for conducting factor analysis and calculating Cronbach's Alpha. Structural equation modelling (SEM) was then employed to analyze relationships among constructs of the structural "DSRs Safety Attitude Model". The final model will demonstrate that no better-fitting models exist.

The outcomes of this study constitute an initial step in identifying personal and contextual variables that impact on DSRs attitudes towards the implementation of SMS at departmental level. It also provided useful information into the formulation of the University's safety policy and the appointment of DSRs.

5. PROJECT DIRECTION:

Structural Equation Modelling "SEM" software can test traditional models, but it also permits examination of more complex relationships and models, such as confirmatory factor analysis. In this study, the modelling process is followed through "The basic approach to performing a SEM analysis" (Figure 1) as recommended by the "Statistical Support, a division of Research Consulting at Information Technology Services" (ITS) at The University of Texas at Austin, USA.

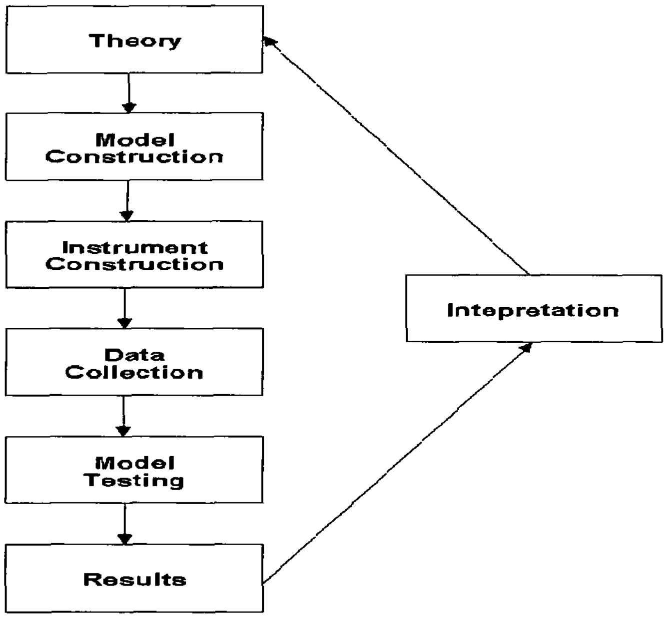


FIGURE 1: THE BASIC APPROACH TO PERFORMING A SEM ANALYSIS

STRUCTURAL EQUATION MODELLING USING AMOS: SECTION 2: SEM BASICS [ONLINE]. AVAILABLE FROM: HTTP://WWW.UTEXAS.EDU/ITS/RC/TUTORIALS/STAT/AMOS/ [ACCESSED 11 MAY 2007]

The "Step one – Theory":

The literature review of theories and models in Chapter Two (2), Three (3) and Four (4) would draw attention on the basic structure of the hypothesized "DSRs Safety Attitude Model". Kam (2002, p.103) states that *"It is visualized that a proficient application of theories can thus help safety professionals to identify the most suitable targets for safety programmes, the methods for accomplishing change, and the outcomes for evaluation. A suitable choice of appropriate theory and model can assist the explanation why people behave, suggest ways to achieve changes and aid in all stages of the behavioural intervention programmes."* The HIV/AIDS Program Office of State of Nevada Health Division also writes that *"An effective health promotion programme must be grounded in theory. There are many reasons why theory is important. One of the major reasons is that theory explains human behaviour and suggests ways to achieve behavioural change. A good theory is applicable across a wide variety of populations and settings. If carefully selected and applied, it can help predict what consequences various programmes and interventions are likely to have, even in situations never before encountered. Because of this, a good theory can save a lot of wasted time, effort, and resources."* Available from: *Comprehensive HIV Prevention Plan - Chapter 6: paragraph 1, Potential Strategies and Intervention.* The HIV/AIDS Program Office, State of Nevada Health Division. http:/health2k.state.nv.us/hiv/prevention/chap6.htm [Accessed 15 August 2008]

The literature review of theories and models provides the writer insight to identify and to explain the interactions among these variables (both hypothetical constructs and observed variables) with the aim of constructing the hypothesized model.

The "Step two - Model Construction": Considerations regarding construction of the hypothesized "DSRs Safety Attitude Model" will be discussed in Chapter Five (5). Model specification is based on the review of literature to decide which variables to be included for construction of the hypothesized "DSRs Safety Attitude Model" and how these variables are related. After going through the process of literature review, a list of ten (10) variables were identified from eleven (11) psychological theories and models. The hypothesized "DSRs Safety Attitude Model" will be constructed by exploring the relationship between ten (10) identified variables that could potentially influence DSRs safety attitude towards the implementation of SMS.

The "Step three - Instrument Construction" and the "Step four – Data Collection": In Chapter Six (6) "Research Methodology and Statistical Analysis", major steps in developing the research instrument "questionnaire" will be discussed. Collection of data from the pilot study, tests of validity and reliability of the survey questionnaire will be discussed in details.

The "Step five – Model Testing" and the "Step six – Results": Chapter Seven (7) presents "Model Testing of the hypothesized "DSRs Safety Attitude Model"; the tests would be conducted using Structural Equation Modelling "SEM" for analyzing a series of dependence relationships among latent and observed variables simultaneously. All structural equation modelling and confirmatory factor analysis would be performed using AMOS. Goodness-of-fit tests would be conducted to determine the adequacy of the model and variations on the model. Results of model testing will be discussed. Recommendations, conclusion and contribution of the study will be discussed in Chapter Eight (8).

6. WHAT GOES NEXT?

Up to this point, major roles and challenges of DSRs in implementing SMS at the University have been discussed. Problem statement, research aims, objectives and project direction of the study were also presented. Chapter Two will focus on the discussion of the current general situation of the safety management system (SMS) at the University and its implication to DSRs. A literature review on safety management, relevant legislative requirements and the University's safety manual will help to identify factors that could affect the effectiveness of SMS.

CHAPTER TWO

MANAGING SAFETY AT THE UNIVERSITY

1. INTRODUCTION:

This chapter is focused on the discussion of the SMS at the University and its implications for DSRs. A literature review on safety management, relevant local legislation and regulations, Codes of Practice, guidance notes, the University's safety manual helped to identify factors that could affect the effectiveness of SMS.

2. THE CHANGING PARADIGM IN MANAGING SAFETY AT WORK:

Under the traditional safety management program, the concept of "directive command and control", "compliance oriented", "procedural dominated", "punishment reinforced" and "accident driven" have become deeply rooted inside the reasoning logic of managerial staff in organizations.

Traditional safety management is heavily reliant on the use of authority. *"Traditionally, safety management meant complying with the governing safety standards as promulgated by the state or federal jurisdiction. From this flows safety programs, processes, and procedures designed to meet the requirements of these regulations".* Available from: Furst, G. (2006) *Safety Excellence by Design - Integrated Risk*

Management Safety Excellence by Design - Integrated Risk Management. http://www.irmi.com/Expert/Articles/2006/Furst05.aspx [Accessed 28 March 2008]

These approaches also emphasize the use of punishment to discourage unsafe behaviour and safety rules are seemingly an inevitable part of risk control. The organization only acts when accidents or injuries happen. Each time after accidents or incidents happened, management will attempt to impose new rules and regulations to forbid any unsafe behaviour that led to it. Kelly (1996, pp.14-17) criticized "*the belief in tightening control over workers is the effective means in ensuring compliance of safety regulations and prevents accidents*". Veltri (1991, p.149) reported that "*77% of companies focused on regulatory compliance, and that investment and resources allocated for safety were very minimal*".

Up to this end, the shortfalls of traditional safety management program are summarized as follows:-

- Near misses and at-risk behaviours are not tracked.
- Remedial action for safety is more reactive rather than proactive. Management only paid attention on serious accidents, rather than taking proactive action in preventing the occurrence.
- Safety was considered an independent function rather than a part of

management function within the organization.

- ✧ Solutions to safety problems often focus on "hard wares" and legal compliances rather than healing root causes.
- ✧ Use in a top-down management approach, employees were either rewarded or punished.
- ✧ A strong emphasis was placed on rules, regulations and supervision of employees.

Nevertheless, these approaches have been responsible for some significant improvements in safety over the years. However, it is evident that the traditional approach of "command-and-control" to safety is being questioned with respect to its fairness and effectiveness. This approach does not focus on the human factors such as attitude and behaviour, as well as the organizational safety culture.

In fact the greatest driver of accidents, incidents and losses is human factor issues. The importance of the self-regulatory approach for accident prevention is gradually being recognized by The Hong Kong SAR Government. Implementation of SMS was made mandatory with introduction of the Chapter 59AF Factories and Industrial Undertakings (F&IU) (Safety Management) Regulation which was passed on 24 November 1999 and came into operation in 2000. This regulation requires construction sites and other designated industrial undertakings to develop, maintain and implement SMS at their workplaces.

What is a safety management system (SMS) under the law? According to "A Guide to the Factories and Industrial Undertakings (Safety Management) Regulation, 1st Edition October 1999" prepared by the Occupational Safety and Health Branch Labour Department of HKSAR, the following are interpretations of "safety management" and "safety management system" in this guidebook:-

- "S*afety Management*" means the management functions connected with the carrying on of an enterprise that relates to the safety of personnel in the enterprise, including:-
  - (a) The planning, developing, organizing and implementing of a safety policy.
  - (b) The measuring or auditing of the performance of those functions.

- "S*afety Management System*" means a system which provides safety management in an enterprise.

Hurst (1998, p.23) also describes safety management is *"management applied to achieving safety, where safety is taken to be freedom from unacceptable risks that are* *harmful to people either local to the hazard or elsewhere".*

The paradigm in managing safety shifts from a traditional safety approach to a self regulatory approach. *"A paradigm is commonly considered to be a personal perception or mindset we use to interpret our experiences. In other words, our paradigm represents our attitude or expectancy in a particular situation and biases the way we view that situation. It also influences what we take from a situation."* (Geller. 1998, p.2) The implementation of the safety management regulation is moved away from the concept of prescriptive standards and a law enforcement approach or "hardware approach" towards a new way of self-regulatory approach "software approach". This change is in line with some thoughts from Mr. Y.L Yip, the former Chief Factory Inspector of the Labour Department and the former Executive Director of the Occupational Safety & Health Council in Hong Kong. Yip (1991, pp.27-30) observed that there has been a change in the ideology of occupational safety from a "hardware approach" to a "software approach". This means more focus on management and human factors including safe systems of work, safety cultures and tactics for changing attitudes toward safety. Under the regulation, certain workplaces are required to develop, implement and maintain an effective SMS to administer safety; and to appoint a registered safety auditor to conduct regular audits of the system.

3. CURRENT GENERAL SITUATION OF THE SAFETY MANAGEMENT SYSTEM (SMS) AT THE UNIVERSITY:

The SMS do not only aim to fulfill regulatory requirements, professional standards and moral obligations, it should also minimize losses due to accidents and impacts to the company's goodwill. *"The best Safety and Health Programs involve every level of the organization, instilling a safety culture that reduces accidents for workers and improves the bottom line for managers. When Safety and Health are part of the organization and a way of life, everyone wins."* Available from: U.S. Department of Labour, OSHA. *Does a safety and health program really make a difference?* http://www.osha.gov/SLTC/etools/safetyhealth/index.html [Accessed 14 September 2004]

SMS is an integral part of the management function. To protect the environment and stakeholders, the University established a practicable SMS for all hazardous operations in ensuring operational safety to ensure the compliance with legal requirements. The framework of the University's SMS was modeled alongside the schema (Figure 2) proposed in the Health and Safety Executive (HSE) publication (1991) "Successful Health and Safety Management HS (G) 65".

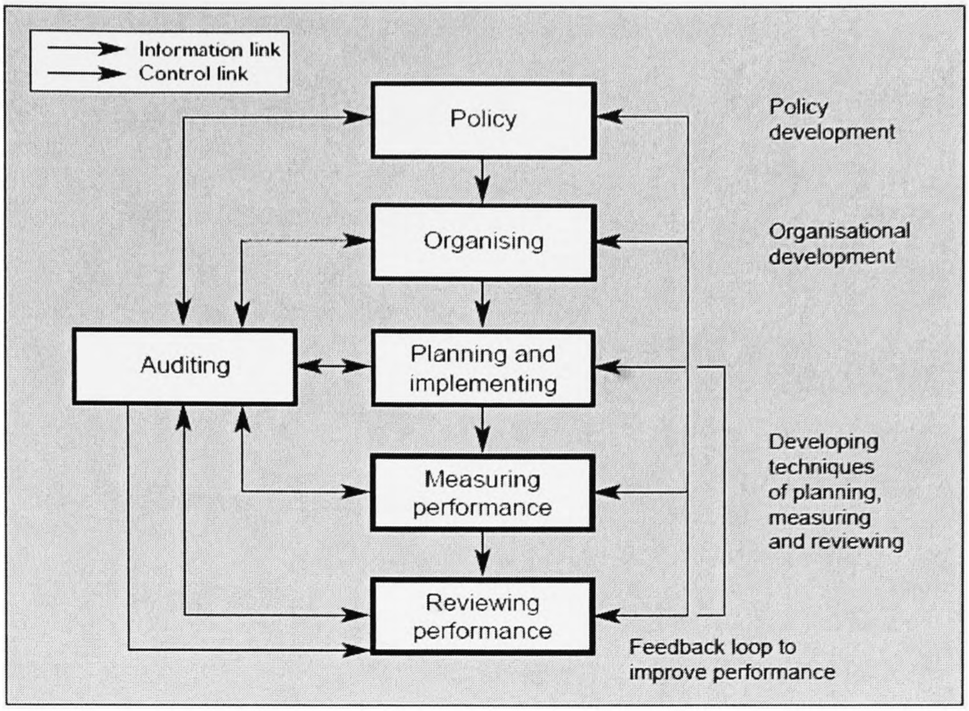


Figure 2: Key Elements of Successful Health and Safety Management HS (G) 65

In 2006, The University received an award of merit from the National Safety Council, USA, recognising the University's outstanding organization and performance in safety management. The goal of this scheme is to measure the performance of a particular campus against a set of international best practices.

A SMS used as a framework by the University contains the following elements:

3.1 Initial Status & Periodic Review

3.2 Policy

3.3 Organizing

3.3.1 Responsibilities and Accountability

3.3.2 Employee Involvement and Commitment

3.1 INITIAL STATUS & PERIODIC REVIEW:

There are many research projects, laboratory experiments, plant maintenance and building construction activities in the University's environment. All these activities have to be conducted in accordance with the University's policy, strategic plan and local legislative requirements. To further strengthen the effectiveness of the SMS, the first and most important step is to carry out an initial review of the existing arrangements and procedures for managing safety. It provides baseline information that will influence decisions and resources to sustain the implementation of the SMS. This is known as an initial status review. In 1991, an initial status review of the SMS at various departments was internally conducted by the safety professionals of SEPO.

Periodic review provides an opportunity for senior management to revisit the status of the implementation of SMS at departmental level and at the University level; since safety management strategy can be adjusted to cope with changes. Two periodic reviews of the SMS were conducted by the external reviewers in 2002 and 2005. These reviews were focused on comparing performance against various established criteria including:-

- Requirements of relevant legislation and regulations, Codes of Practice issued by the Labour Department in Hong Kong in dealing with SMS;
- In-house guidance on SMS;
- Bench marking with other tertiary institutions' safety performance and best practices; especially with those in Hong Kong;
- Effectiveness of current resources devoted to the University's SMS.

With so many sets of legislative regulations relevant to the University, good compliance is unlikely if tasks were tackled in a non-systematic manner. It is only by recognizing that safety is a legitimate management function that it can be addressed logically and successfully. External reviewers were pleased to see the existence of a positive safety culture and the acceptance of safety responsibility amongst departments. In achieving continuous improvement, the University needs to regularly review the effectiveness of the SMS at departmental level, as well as at the University's level.

3.2 POLICY:

A key feature of an effective safety policy is a commitment to give full support in managing safety issues. In the University, the top management developed the safety policy and asserts its firm commitment to safety. A formal statement of safety policy was developed by the University's Environment, Health and Safety (EH&S) Committee and was endorsed by the President. The policy reflects an absolute commitment to achieving a safe, healthy and environmentally friendly working environment in the University. The safety policy makes it clear that safety is one of the core values at the University. It is clearly expounded in the Statement of Health and Safety Policy in the University's Safety & Environmental Protection Manual issued in 1997. If there is any conflict with another goal, then safety should not be sacrificed. The policy provides adequate protection to all stakeholders, as well as the environment through the implementation of a comprehensive SMS. Having a clearly stated safety policy, all HODs have an obligation to set up in-house safety rules, guidelines and procedures, to appoint DSRs in ensuring OHS issues at departmental level.

3.3 ORGANIZING:

Organizing is a management structure which identifies who is responsible and who does what. In the University, the management is accountable for and has a duty to establish and maintain management control of safety in the campus. To ensure the safety of all stakeholders, implementing SMS should be treated with the same priority as other business and operations. The following paragraphs provide a practical approach to organizing and managing safety in the University.

3.3.1 ACCOUNTABILITY AND RESPONSIBILITY:

Line management should be accountable for safety at work and safety is a shared responsibility for each individual. Without a clear line of accountability and responsibility for safety, possibly, there may be reluctance in implementing safety rules and procedures. The current safety legislation specifies the responsibilities of employers, occupiers and employees with regard to safe working practices. These suppositions are more likely to be fulfilled if a positive cultural attitude toward safety exists. Chapter 59 F&IU (Amendment) Ordinance 1989, the Laws of Hong Kong; imposes General Duties on proprietors and persons employed with regard to safety and health at work. It clearly states that *"It shall be the duty of every proprietor of an industrial undertaking to ensure, so far as is reasonably practicable, the health and safety at work of all persons employed by him at the industrial undertaking"*. For persons employed in industrial undertakings:- *"it shall be the duty of every person employed at an industrial undertaking while at work- (a) to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or* *omissions at work; and (b) as regards any duty or requirement imposed on a proprietor of the industrial undertaking or on any other person by this Ordinance for securing the health and safety of persons employed at the industrial undertaking, to co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with."*

In addition, the Chapter 509 Occupational Safety and Health Ordinance (OSHO), the Laws of Hong Kong; also imposes responsibility for safety of employers and employees at work. *"Every employer must, so far as reasonably practicable, ensure the safety and health at work of all the employer's employees."* .... *"An employee while at work- (a) must, so far as reasonably practicable, take care for the safety and health of persons (including the employee) who are at the employee's workplace and who may be affected by the employee's acts or omissions at work; and (b) as regards any requirement imposed in the interests of safety or health on the employee's employer or any other person by this or any other Ordinance, must, so far as reasonably practicable, co-operate with the employer or other person so far as may be necessary to enable the requirement to be complied with."*

Under the laws, the University has a legal duty of care towards all stakeholders in the campus. In ensuring that the commitments in safety policy are being implemented, the accountability and responsibility for safety starts with the President, HODs and flows through the management chain to staff members at all levels.

In the University, the HOD of at school or departmental level is required to have a tailor-made SMS structure to cope with operations, with assigned responsibilities for ensuring the safety of all stakeholders. Indeed, the success of SMS not only depends upon the departmental management being held accountable for performing their tasks, it should be shared amongst stakeholders in the University. Therefore, job descriptions should list appropriate safety responsibilities of all staff. Everyone in the University should recognize that "Safety is everyone's business" and "Safety is a shared responsibility". As Wells Jr. (2003, p.26) states *"the accountability is one of the hardest mindsets to break or build. When it comes to enforcement of the law, society takes the attitude of 'I saw nothing!' or 'Leave me alone and I'll leave you alone'. Attitudes such as these can be extremely dangerous when allowed to exist in the workplace. When a program is incorporated where employees want to participate and* *are rewarded for finding hazards or identifying problems, you are building a positive mindset."*

A positive safety culture would be well developed, when the individuals really hold themselves accountable for their areas of responsibility. It is only through the joint effort of management and all stakeholders that a win-win situation can be created. Once safety is recognized as an equally important element in the overall success of the University, the SMS used to accomplish the goals will be more uniformly applied. Safety is not an option. No one in the University can afford not to be safe. Fortunately, there are clear signs that many departments are practising greater responsibility and accountability in managing safety.

3.3.2 COMMITMENT AND INVOLVEMENT:

Management commitment and involvement leads to the development of positive safety cultures right through an organization. Smith et al. (1978, pp.5-15) found that "*low accident companies to have higher levels of management commitment and involvement than high accident plants*". Employee involvement supports a positive safety culture where safety is everyone's business. Management and employees at all levels of the organization should always work safely, in order to achieve the same safety target. As the Health and Safety Executive (1997) states, "*Employee co-operation and management commitment are promoted as key factors for achieving effective safety management.*"

Thoresen et al. (2003, pp.914-945) indicated that "*Some individuals like their jobs and experience a sense of connection or commitment to their work and the organization, whereas others dislike their jobs and experience a sense of disdain for their organizations and their working lives.*" In the University's environment, it is recognized that people with different educational background, personality, interests, aptitudes, culture and prior work practices are working together. People's attitude toward safety work may not the same, DSRs are no exception.

Managerial staff should have a prime influence on the organization's safety culture. In ensuring safety at work in the University, the HOD needs to demonstrate continuously their commitments to safety and working closely with stakeholders. For example, the allocation of sufficient resources for the proper functioning of SMS; the establishment of organizational structures whereby departmental management and employees at all levels are supported in their safety duty; attend safety meetings, participate in safety inspections and the appointment of DSRs for overseeing the proper functioning of the SMS at departmental level.

Total involvement of the workforce in safety is the most effective way to make safety improvements in the organization. Making use of workforce's knowledge and experience to ensure safe work practices is regarded as the best way, as they are the people who know the specific tasks, procedures and working conditions best. They will have insights into how it impacts on safety. The mechanisms for involving the workforce are optional and all depend on the nature of business, such as nomination of DSRs and the setting up of departmental safety committee. A commitment to stakeholders' involvement should be clearly specified in the general safety policy. The University enjoys good collaboration and excellent support from staff members for developing, maintaining and implementing SMS. The challenge here is to continue to build on this foundation despite changes in personnel and operations which are usually encountered in academic institutions. Without their commitment and involvement to safety, it is unlikely that the University will meet the target of safety performance.

3.3.3 ENSURING COMPETENCE THROUGH EFFECTIVE SAFETY TRAINING:

It is often the case that experienced staff members do have accidents or incidents because of complacency. Desired safety attitudes and behaviour need continual reinforcement to overcome the strong desire to take risks at work. Therefore, management should believe that training is vital in managing safety. Wells Jr. (2003, p.26) considers "*There are four main areas of a safety program that, when implemented correctly, can help create and maintain a safety culture. Heavy focus has to be placed on training, participation, accident prevention, and accountability when evaluating any existing safety program.*"

It is important that everyone in the workplace should be properly trained, as training can help to develop the knowledge and skills needed to understand workplace hazards and safe procedures. In any workplace, only properly trained and authorized persons should be allowed to do the job. The Occupational Safety and Health Ordinance (OSHO) underlined the importance of training in ensuring that people handle risk properly and behave safely at work. Under the OSHO, employers have legal duties to provide both a safe place of work and training for their employees. On the other hand, employees have to fully cooperate with their employers in ensuring the safety at work.

In Hong Kong, tertiary institutions are too often only providing knowledge and skill in particular subjects. As a result, many graduates will enter the job market without the mindset of safety awareness to recognize workplace hazards. To provide safety information on the variety of physical, chemical and biological hazards encountered, the HOD must be aware that staff members and students should be trained to recognize potentially hazardous conditions, materials and equipment which may pose risks. The University provides safety training to students in the School of Engineering as a mandatory part of the engineering curriculum since 1996. It is hoped that through safety training, students should learn to observe the procedures, rules and regulations that govern industrial operations and to develop safe work habits.

3.3.4 COMMUNICATION:

Communication is an essential tool used to share information, knowledge, beliefs and values so that people will change attitudes to act in a safe or unsafe manner. Effective communication brings the safety policy, updated information on safety goals and standards to the attention of stakeholders. HOD needs to be involved in safety and foster open communication, while ensuring compliance with SMS at departmental level. They should allow DSRs a degree of autonomy for safety initiatives. In the University, the safety organization consists of the Environment, Health and Safety Committee (EHSC), the Safety and Environmental Protection Office (SEPO) and a network of DSRs to assist HODs. The EHSC is chaired by the Vice President of Administration and Business and has several senior administrators, academic members and safety professionals from SEPO. Members of the committee should meet regularly to establish safety policy, to provide overall strategies and direct the safety management programs. Safety communication meetings also organized by SEPO on a regular basis with aims to assist HOD in developing appropriate safety procedures, preventive measures and to disseminate safety information. In the meetings, members are encouraged to share their safety concerns and freely discuss safety matters.

Ineffective communication can lead to misjudgment and misinterpretation of work-related instructions. One of the challenges among departments is bridging the communication gap amongst the multicultural workforce. In recent years, English, Cantonese and Mandarin are popular languages spoken at the University, because of the increase of staff members and students from Mainland China and overseas. In an attempt to minimize the languages barriers, the University has set up some on-line safety training programs with a Chinese version which can be found from the University's intranet.

In providing a wider communication channel to interested parties for information dissemination in the world, safety related information such as safety manual, safety bulletin, MSDS, safety rules, statutory requirements, safety practices and professional standards can be easily accessed through a search in the intranet or internet. Communication of the various components of the SMS must be continuous and available to all faculty, staff and students. To enhance further the communication channel, there should be some systems for reminding people of the lessons of past accidents. In the University, both formal and informal communication channels between HOD, DSRs, front-line supervisors and colleagues at departmental level are crucial for safety information to be disseminated. HODs should model desired safety behaviours, communicate safety expectations to their subordinates and other stakeholders, recognize good performers and seriously deal with poor performers. They should hold meetings on a regular basis to not only emphasize safety, but the importance of employee participation in meeting safety objectives. The bottom line in any form of communication is to get the message across so that all concerned parties receive it, understand it and take the appropriate preventive measures to prevent accident.

3.3.5 DOCUMENTATION:

Proper documentation is an indicator of good management. A systematically documented system is needed to ensure that the management can identify safety tasks, assign competent personnel to perform the SMS effectively, and have the practices documented for consistency. Under the Chapter 59AF Factories and Industrial Undertakings (Safety Management) Regulation, records of all relevant documents concerning the fourteen (14) elements of SMS, where appropriate, are required to be kept in departments for future audits. These 14 elements are:-

1. Safety policy.

2. Safety organization.
3. Safety training.
4. In-house safety rules and regulations.
5. Safety committee
6. Program for inspection of hazardous conditions.
7. Job hazard analysis.
8. Accident / incident investigation.
9. Safety promotion.
10. Process control program.
11. Personnel protection program.
12. Health assurance program.
13. Evaluation, selection and control of sub-contractor.
14. Emergency preparedness.

3.4 PLANNING AND IMPLEMENTATION:

Various operations at the University may involve the use of new technologies, dangerous equipment, hazardous materials, dangerous work procedures to be carried out by staff members and students. In any change of operations, technologies, processes and equipment, error may occur that has the potential to impose additional hazards. HSG (65) of Health and Safety Executive (1991) describes an effective plan as "*concerned with prevention through identifying, eliminating, and controlling hazards and risks*". In fact, devising workplace precautions is part of the planning process and a primary outcome of risk assessment. Safety planning is to identify how best to deploy resources to control risk including identification of risks, probability of occurrence and their potential impact, followed by the implementation of control measures to reduce risks to an acceptable level.

All safety programs in the University's operations need to be developed and implemented effectively. Departments have adopted the "Hazard Control Plan" approach to address safety concerns of new operations. These include identification of suitable control programs and safe technologies to do the job, review of research proposals with relevant operating rules and procedures. Personnel engaging in hazardous operations must first compile a safety work plan to identify all such agents and operations. Through careful planning, organizing and close monitoring, SMS would be implemented effectively and in-line with the established standards.

3.4.1 RISK ASSESSMENT:

The inter-relationships amongst workers, workplace environment, equipment, and material involved in the work process might create hazards. Risk assessment is a careful examination of what could harm people, how high the risk level and the associated risk control measures. Only when we understand the risks involved in our activities, then we could derive appropriate control measures, so as to control risks, to protect the workforce and the properties before risk exposure occurs. From the safety point of view, risk assessment provide a systematic means by which the potential risks can be assessed and managed to ensure that they are minimized accordingly. Current legislation in Hong Kong also makes explicit what employers are required to do to ensure health and safety at work and to carry out risk assessment for some of specified operations. When conducting a risk assessment, the assessor should not only focus on physical hazards, it is important to take the human attitudes and behaviour towards to safety into consideration. Depending on risk level, systems to control particular risks associated with high hazards have to be monitored at more frequent intervals. If additional hazards are identified after the work has started, the responsible party should stop the work until new hazards have been assessed and properly controlled to an acceptable level.

An educational establishment should provide a safe workplace and learning environment in the campus. The University emphasizes identifying hazards and collecting relevant information at an early stage before the commencement of a research project. As research work involves innovative ideas, new technologies and work protocols, definitely, the risk assessment program is needed. A risk assessment program has been established to anticipate, recognize, evaluate and control the variety of health, safety and environmental risks associated with the variety of activities on campus. For the success of implementation of a risk assessment program, it very much depends on the commitment and support of the HOD! They have to ensure that appropriate arrangements to control health and safety risks are in place at departmental level. Faculty members should play significant roles in ensuring research safety by taking part in reviewing risk assessments and project safety proposals for various research proposals prior to undertaking any hazardous activity. SEPO always works with all concerned parties such as Principal Investigators, supervisors and lab users in safety review of research proposals.

Good safety practices are vital in any kind of work. Each of the individuals working at the University should bear a safety responsibility to perform tasks and to comply with safety procedures for controlling hazards. They should bring to the attention of their superiors, if deficiencies are found. An ultimate goal of risk assessment is to enable staff members and students to perform their tasks in a safe manner.

3.5 MEASURING SAFETY PERFORMANCE:

Stranks (1994, p.82) states that *"The basis of successful safety management is* *the installation and maintenance of effective systems aimed principally at the prevention of accidents, ill-health and other forms of incident which result in loss to an organization. Such systems should identify the standards to be maintained and the systems for monitoring and measuring in the achievement on these standards."* Safety performance is just like a mirror to reflect the effectiveness of SMS and the implementation against predetermined safety plans, procedures and standards used to control hazards.

To ensure the effectiveness of the SMS, measuring safety performance is needed in order to provide feed back to management and staff members the information regarding lost-time injury accidents, incidents and near-misses in an organization. Fitzgerald (2006, p.42) points out that "*we need to be clear on the aspects of safety performance we are seeking to influence, and implement the right mix of indicators to monitor our performance.* Accident statistics such as lost time injury frequency rate, accident frequency rate, severity rate have been regarded as the most common quantifiable indicators used in measuring the overall safety performance of an organization. Obviously we do need accident statistics to show us whether or not the accident record is improving and how it compares with other organizations of similar nature. By reviewing and monitoring past accident records and analyzing trends over time, patterns with common causes can be identified. It provides the top management a yardstick in measuring the effectiveness of SMS and reviews of safety problems involved.

In reality, the significance of accident statistics as a measure of safety performance is in question. The accident figures themselves are not reliable safety performance indicators, because they are only based on the summary of all reportable accidents. Obviously, if accidents, incidents and near-misses are under-reported or unreported, then the measurement of safety performance system would break down totally and thus preventive lessons will never be learned from mistakes. Pransky et al. (1999, pp.171-183) point out that "*Under-reporting is sometimes the consequence of safety incentive programs that reward managers and employees for achieving good safety records*". It can lead to such accident, incident or near-miss case not being reported so as to maintain a good safety performance. There were many near-misses that often go unreported especially if a blame culture exists in an organization. At the University, this potential problem is minimized by a comprehensive accident reporting system managed by SEPO with full support from the campus medical clinic, Security Control Centre and Personnel Office.

When there have been no accidents for sometime, people become complacent, careless and relaxed in implementing safety procedures and then there would be a sudden jump to one or more serious accidents. In ensuring a safe environment at the University, there is no room for complacency. Staff at management level have always been committed and stayed vigilant in maintaining a healthy and safe environment for all stakeholders in the campus. It is believed that our concerted efforts will pay good dividends!

3.6 SAFETY AUDITS:

Safety audit is a way to understand how the HOD and DSRs are ensuring the compliance with the University's policy, set standards, legal requirements, operating procedures and in-house safety rules at departmental level. "*A health and safety audit is a systematic examination to determine whether activities and related results conform to planned arrangements, whether these arrangements are implemented effectively, and are suitable for achieving the organization's policy and objectives. A health and safety audit system provides a framework for the examination of managerial and operational procedures and practices. It thus provides verification of, and a degree of reassurance about, the overall adequacy of protective plans and actions. Auditing supports health and safety management at all levels because it is an independent measure of health and safety performance.*" (University Health and Safety Management: Code of Best Practice, 2001)

The University assembled a comprehensive, systematic and user- friendly audit program to evaluate the strengths, weaknesses and effectiveness of SMS from various departments. This in-house safety audit program could be downloaded from the University's website and DSRs have the choice to select relevant audit contents for self-monitoring the effectiveness of departmental SMS.

4. CHAPTER SUMMARY:

Many expectations are built into the current occupational safety legislation that specifies the responsibilities of managers and employees with regard to safe working environment and practices. These suppositions are more likely to be fulfilled if a positive attitude toward safety exists. To cope with legislative requirements, ever-changing technologies and research projects, the whole SMS should be reviewed. At the University, a strong sense of safety culture gives the necessary impetus for continuous improvement and the mechanism of self-regulating. Attitude towards safety at work appears to be more pro-active. The adoption of SMS, codes of practice and in-house safety rules by these departments are all strong indicators of a good safety culture.

It is evident that the traditional "command-and-control" safety management approach is being questioned with respect to its fairness and effectiveness. An effective SMS is the sum of a good safety culture, shared responsibilities, effective procedures and adequate resources in ensuring the health and safety of all stakeholders. The departmental SMS will only be effective, if fully implemented and embraced by HOD, DSRs and everyone in the department. An important element of successful and effective SMS should address the issues of human factors - because accidents often result from unsafe acts due to human errors. From the safety management point of view, accidents can be reduced by controlling unsafe behaviour. It appears that currently in the University there is evidence of a strong move towards management system based approaches in safety. The top management in the University has provided the campus community with reasonable resources and embedded accountability to occupational safety, health and environmental protection as into organizational culture. HOD and DSRs should always make safety equally important to teaching, research and experiments. They should be able to understand attitudes and behaviour of their colleagues and students. There is no room for complacency for safety! Continuing effort is to needed to operate an effective SMS to help ensure a safe and environmentally sound study and work environment at the University.

In Chapter Three, discussion will focus on accident causation and human factors. A comprehensive review of relevant literature could highlight the importance of human factors in accident causation and lead to the identification of variables for the construction of hypothesized model in this research project.

CHAPTER THREE

HUMAN FACTORS AND ACCIDENT CAUSATION

1. INTRODUCTION:

An injury-free workplace requires attention to the workplace environment, tools, equipment, work processes and the person (such as knowledge, experience, competence, attitudes, beliefs, and behaviour). These factors are interactive. Influencing one factor eventually has impact on others. Risk situations could be caused by improper design, inadequate instructions, unsafe conditions (such as temperature extremes, poor lighting, too wet or too noisy) and unintentional/intentional actions of operators.

Human error is a significant contributory factor in a large proportion of accidents. It is now widely recognized that human error such as lapses of attention, mistaken actions, misperceptions, mistaken priorities and willful violations are frequently reported as one of the causal factors in accidents across a range of industrial and non-industrial sectors. Some people are inherently risk-takers, because of their perception of risk. They tend to trade off a slight increase in risk to their safety, in order to complete the job faster. Stranks (1994, p.32) suggested that *"personal factors, such as attitude, motivation, perception, personality, training and the potential for* *human error, are significant elements in any consideration of human factors and safety".* It is important that organizations should be able to identify the link between the errors people made and the accidents that result.

Many organizations are striving for the improvement of safety performance. An understanding of human and organizational factors such as safety culture in the workplace and knowing how to tackle human error is therefore of key importance for accident prevention. The development of proper safety habits, attitudes, knowledge, and skills represents the best opportunity for making significant inroads into resolving accident problems. Reviews of selective literature on relevant theories and models are conducted which lay the theoretical background of the research. These reviews will cover the key areas of, the 'Concept of an iceberg', 'Heinrich's and Bird's accident triangles', 'Accident proneness theory', the 'Domino theory', the 'Multiple causality (causation) theory', 'Human factors theory of accident causation', the 'Accident/incident theory', the 'Systems theory of causation' and the 'Synoptic accident model'.

2. SAFETY PHILOSOPHY: "ACCIDENTS ARE UNAVOIDABLE" VS "ACCIDENTS ARE PREVENTABLE":

In ancient times, most people deeply believed that "Life is unpredictable" and

"Accident is unavoidable!" "Acts of God" will make it happen when time's come for punishment! Kletz (1990, p.88) points out that "*In many eastern countries there is a more fatalistic attitude to death than in the West. One dies when one's time comes not before and not after, so why bothers to take precautions?* " The thinking was similar to that in the situation just like the natural disaster like "Tsunami" that devastated coastal areas in countries around the Indian Ocean on 26 December 2004. As a result, hundreds of thousands of people were killed, lost their families and many buildings, infrastructure in the region were damaged. In this respect, before the disaster, people in the region never realized the natural disaster "Tsunami" could occur at their places. They were quite reluctant to take precautionary measures to alert people to the danger. Many people in this modern world still have the same beliefs and attitudes just as Murphy's Law describes that "*If anything can go wrong, it will*". Available from: *Murphy's Laws Site* [Online]. http://www.murphys-laws.com/murphy/murphy-true.html [Accessed 21 February 2005] This kind of people tends to blame their injuries on accidents.

It is indeed, human life is invaluable! In modern safety management, the basic assumption of safety philosophy is that "Accidents are preventable". Within the philosophy, prevention of accidents can be achieved through the development of an effective SMS that incorporates hazard identification, risk assessment, implementation of prevention measures, performance monitoring and review. Actually, when we examine the accident causation in the following paragraphs, we will find that most accidents are preventable by changed of people's attitudes towards safety in a positive way!

3. WHAT IS AN ACCIDENT?

The term "accident" has been defined thus:

- ✧ Accident as *"unplanned event giving rise to death, injury, damage or other loss"*. (British Standard BS8800, 1996)
- ✧ Accident as *"something that happens by chance and is beyond control"*. (Kletz. 1990, p.4)
- ✧ Accident as *"event that happens unexpectedly and causes damage, injury, etc"*. (Oxford Advanced Learner's English-Chinese Dictionary, 4th edition,1994)

Numerous definitions of the term 'accident' are given in the literature. There is a reasonable degree of consensus that an accident is some kind of unexpected or unplanned event, which results in injury, fatality, loss of property and damage to the company's goodwill.

4. COSTS OF AN ACCIDENT:

"The magnitude of the global impact of occupational accidents and diseases, as well as major industrial disasters, in terms of human suffering and related economic costs, has been a long-standing source of concern at the workplace, national and international levels. Significant efforts have been made at all levels to come to terms with this problem, but nevertheless ILO estimates are that over 2 million workers die each year from work-related accidents and diseases, and that globally this figure is on the increase." (ILO, 2003, p.1)

Accident are costly, as Kletz (1990, p.85) describes that *"Accidents cost money; they also cost lives and injuries!"* An examination of a serious accident can give you a better understanding of what makes up total accident costs. To calculate total costs of an accident, Health and Safety professionals often use the concept of an iceberg (Figure 3) to explain the relationship between direct and indirect costs.

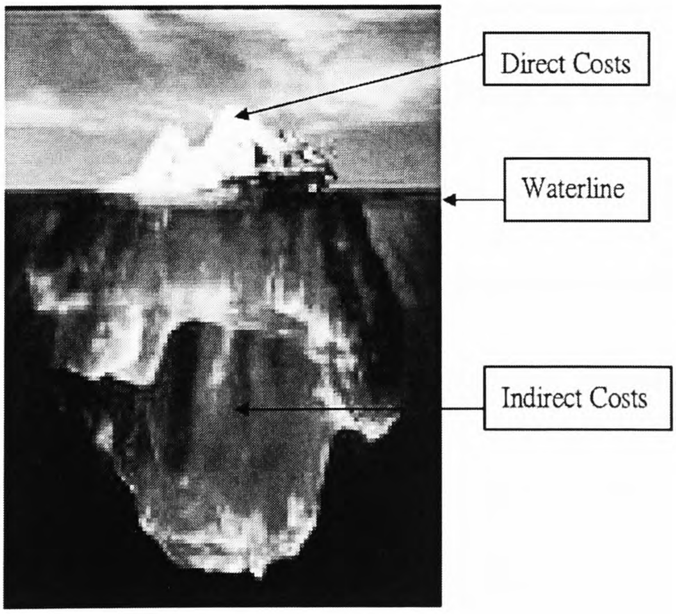


FIGURE 3: THE CONCEPT OF AN ICEBERG

Picture available: http://www.dailygalaxy.com/.../2007/10/21/iceberg_3.jpg. [Accessed 30 March 2008]

The visible part of an iceberg is represents direct costs which are always above the water-line. Direct costs includes the damage to equipment, loss of products, legal claims plus an injured person's sick pay, medical costs, compensation payments and insurance premium. These are tangible costs generally paid by the insurance company using premium dollars. In recent years, the effects of legal claims practices have already been seen in the insurance companies. Legal claims have increased, because some injured employees tend to take advantages of the "No win, No fee" package offered by solicitors or some of labor unions in the local community.

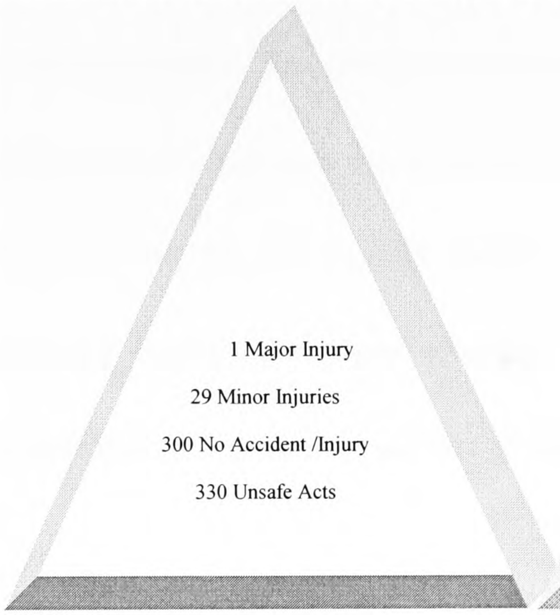
Indirect costs are the largest expenses and are usually undervalued in many organizations. It just looks like a hidden part of an iceberg below the water-line that is not easy to estimate, but are still present nonetheless. It can be a thousand times greater than the value of the direct costs. Examples of such hidden costs including compensation to injured persons, training new workers, repairing damaged property, delay of production and paid high insurance premiums to maintain insurance coverage. Further more, lower morale and poorer customer relations will produce negative impacts on the company's goodwill.

To reduce the financial burden (both direct and indirect costs) from accidents, management in organizations have to be more focused on all safety aspects. Building a positive safety culture, further enhance management commitment and communication with employees at all level are required. The HOD is encouraged to integrate the departmental SMS into a business plan that educates employees, students and other stakeholders in accident prevention. Only through a combination of successful SMS and sustained organizational safety culture among each other, will safety performance continue to improve.

5. IMPLICATIONS OF THE ACCIDENT TRIANGLE:

In 1959, H. W. Heinrich reported that *"300 out of 330 unsafe acts or dangerous occurrences do not result in an accident or injury. Of the 30 that do result in injuries, 29 cause only minor injuries, and only one causes a major injury".* Therefore, every time we avoid 330 unsafe acts we prevent a serious injury. Implication of accident ratios is illustrated in Figure 4 with a triangle indicating a single serious incident at the peak and a broad base of non-injury incidents. However, Geller (2005, p.41) points out that *"The number of at-risk behaviours per injury is much larger 300, as verified empirically by Frank Bird in 1966, who also found property damage to be a reliable predictor or leading indicator of personal injury".* The accident ratio of Frank Bird's studies produced a well known Bird's Triangle (Figure 5), i.e. 600

Near-misses: 30 property damage accidents: 10 minor injury: 1 serious or disabling injury. (Bird et al., 1990) It is visualized that the base of Bird's Triangle of Accident "Near-misses" is behaviourally related. Near misses are something we tend to ignore.



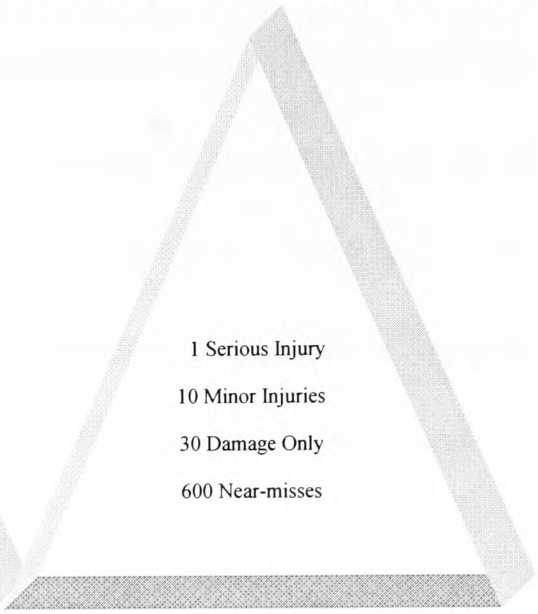


FIGURE 4: HEINRICH'S TRIANGLE OF ACCIDENT **FIGURE 5: BIRD'S TRIANGLE OF ACCIDENT**

What is a "near-miss" in safety management perspective? Stranks (1994, p.91) defined a "near-miss" as "*an unplanned and unforeseeable event that could have resulted, but did not result in human injury, property damage or other form of loss*". A "near-miss", though it bears no immediate grave consequences, does have the same potential to develop into a major disaster resulting in serious fatalities. Sometimes, it's just a fraction of an inch or a split second that separates the near miss from a fatal accident. The upper parts of the accident triangles in figure 4 & 5 demonstrate that the severity of the accidents and the lower parts show a significant percentage of accidents can be linked directly to unsafe behaviour. The metaphor of the accident triangle offers a graphic representation which people can be encouraged to accept that serious injuries are built on numerous unsafe acts or near misses.

The relationship between accidents of different consequences depicted by the "Accident Triangle" has prompted safety professionals to focus on people's at-risk behaviours, as unsafe acts are the common pathway to accidents. From the safety point of view, the two accident triangles also implied that unsafe acts or at-risk behaviour doesn't always cause accidents. Therefore, people often behave unsafely because they have never been hurt before while doing their job in an unsafe way.

Johnson et al. (2004, p.148) points out that *"The role of human factors has been recognised as one of the most important factors contributing to avalanche accidents"*. Krause (1995, p.166) also describes that *"In most cases employee behaviour is the final common pathway of an incident, the workers know that for some time those at-risk behaviours have been part of the way work is conducted at their site. In other words, the at-risk behaviours that are the common pathway of incidents at a facility are part of the plant culture, the work system at the site"*. Taking a short cut, starting up equipment without proper warning signal, removal of machine guarding, defeating the purpose of safety devices, failure to use personal protective equipment (PPE), etc. are common at-risk behaviours at work.

HSE (1993a) substantiates that to eliminate the underlying causes of accidents at the base of the accident triangle "at-risk behaviour" is crucial. Although at-risk behaviour contributes to 95 percent or more of most injuries, this does not mean an individual's at-risk behaviour is the only root cause of the injury. In any organization, targeting responses on reportable accidents/incidents only is a reactive approach which removes the management from the opportunity of visualizing the pattern of all types of accidents/incidents including near misses in totality. There were many "near-miss" cases involving unsafe acts and or unsafe conditions not being reported!

In fact that the numeric discrepancy of different accident ratios is immaterial; but the philosophy behind these accident ratios brings out a very important message that most accidents do not lead to personal injury but represent failures in management control. The relationships in the ratio indicate quite clearly that management direct most of efforts and resources at the relatively few events resulting in serious injury. Management who focus too much on the reportable lost time injury figures alone are narrow-minded, and they may fail to notice the root causes of accidents and learn the lesson from accidents. In order to identify the root cause, management should take action to investigate, examine and record all these accidents, incidents and "near-miss" cases. Safety improvements must be made by bringing safety to the hearts and minds of individuals.

6. COMPLEXITY OF ACCIDENT CAUSATION:

Why do accidents happen? Causation of accidents is very complex and inextricably linked to human factors. People must understand the root causes adequately in order to prevent accidents. In fact, root causes of accidents can be classified as "immediate" and "contributing". The immediate causes could be unsafe acts of the operator (for example: emergency responder performing emergency rescue in a poorly ventilated confined space without wearing proper self-contained compressed air breathing apparatus) or unsafe working conditions (for example: perform gas welding in a confined space with presence of flammable vapor). The contributing causes could be management-related factors, the physical environment and mental condition of the operator. A combination of causes must converge in order to result in an accident. The above description is in-line with Stranks (1994, p.85) *"the indirect causes (personal factors and source causes) contribute to the direct causes (unsafe acts and unsafe conditions) that result in an accident".*

Many attempts have been made to develop a predictive theory of accident causation, but people should understand that there is probably no single best model of accident causation that has been universally accepted. Staff at management level can only help to reduce the incidence of workplace accidents if they have an understanding of the principles of accident causation and human factors. The following sections aim to clarify accident phenomena and help to explain the causation of accidents in relation to human factors.

6.1 ACCIDENT PRONENESS THEORY:

One of the most controversial theories of accident causation is the accident proneness theory. Accident-prone is used to describe *"people who, as a result of their personal failings, have more than fair share of accidents*". (Kletz 1990, p.7)

In an organization, within a given set of workers, there exists a subset of workers who are more liable to be involved in accidents and are classified as accident-prone. *"In everyday experience it is commonly observed that certain individuals have repeated accidents whereas others rarely if ever meet with any mishap. From such observations as these it has been proposed by many different sources that certain people are accident-prone. In other words, accidents don't just "happen"; they occur because certain people have a tendency to make them."* Available from: Rawson A. J. *Accident Proneness.* http://www.psychosomaticmedicine.org/cgi/reprint/6/1/88.pdf [Accessed 16 April 2008] However, because susceptibility to accidents varies from person to person, there is no profile of characteristics that can positively identify accident-prone employees.

It assumes that through the nature of a worker's carelessness, they are making bad choices and are thus hurting themselves due to a poor sense of safety at work. Accidents were blamed solely on accident-prone people rather than the work process. It is unfair to blame accident-prone people only, if poor work systems contain traps for them. Kletz (1990, p.7) points out that "*accident-prone people are responsible for only a small proportion of the total number of accidents*". From the management point of view, in some cases, people who are labeled as "accident-prone" may be unsuitable for their occupation.

6.2 THE DOMINO THEORY:

According to W.H. Heinrich (1931), who developed the domino theory, 88% of industrial accidents are caused by unsafe acts committed by fellow workers, 10 % of industrial accidents are caused by unsafe conditions of physical or social environment and 2% of industrial accidents by "acts of God" that are not controllable!

The domino theory was developed in the form of five standing dominoes (Figure 6) showing a linear series of five inter-connected causal factors in the sequence of events leading up to an accident and its consequences. A five-step accident sequence occurred in which the first domino falls over; the remaining dominoes will also fall in a particular sequence.

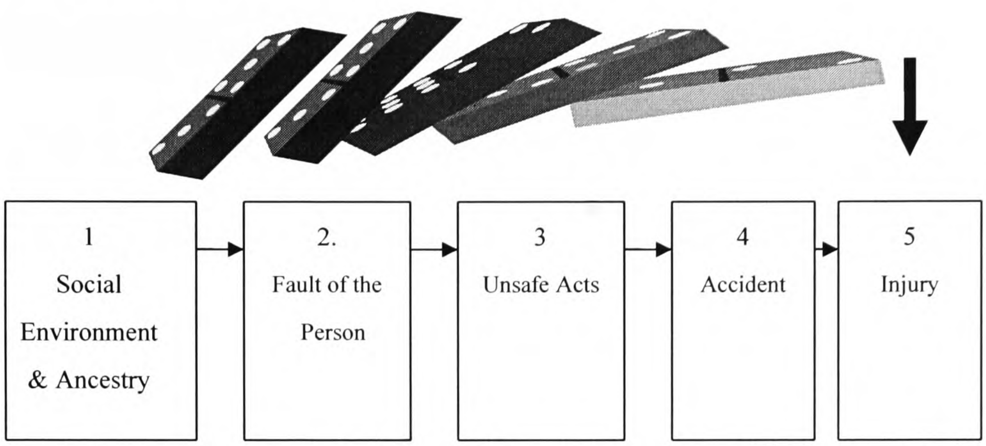


FIGURE 6 DOMINO THEORY – ACCIDENT CAUSATION

Goetsch (1993, p.31) points out that "*This is how Heinrich's theory of accident causation works*"... "*Heinrich's theory has two central points: (1) Injuries are caused by the action of preceding factors; and (2) removal of the central factor negates the action of the preceding factors and, in so doing, prevents accidents and injuries.*" The removal of a single domino in the row would interrupt the sequence of toppling and the end result, the falling of the last domino cannot take place. "*The accident is avoided, according to Heinrich, by removing one of the dominoes, normally the middle one or unsafe act. This theory provided the foundation for accident prevention measures aimed at preventing unsafe acts or unsafe conditions.*" Available from: Health and Safety Executive, *Lecture Notes 'Accident Aetiology'*, http://www.hse.gov.uk/quarries/education/documents/topic3.doc [Assessed 18 September 2008]

Heinrich suggested that unsafe acts by people had a direct causal relationship to accidents. Accident prevention should aim to eliminate the unsafe acts represented by the third domino so that the chain can be broken. Unsafe acts could result from a lack of training, lack of communication, lack of technical knowledge about machine operation, lack of work experience, being inattentive, having alcohol, smoking and overriding safety procedures. Based on this logic, every endeavor should be made to identify and remove a single domino “Unsafe acts” in the row before the accident and as a consequence break the sequence.

The Domino theory is a more advanced concept when compared to the Accident Proneness theory. When taking a closer look at the sequence, it is not difficult to visualize that they have encompassed the element of “Personal Liability to Accident” as suggested by the Accident Proneness Theory. Although now discredited by many, its underlying principle is still valid. However, the Domino theory can be criticized as it assumes an accident results in injury, has narrowness of focus on behaviour and a mechanistic philosophy. The theory is less focused on physical and technical factors. Goetsch (1999, pp.35-37) argues that the key to accident prevention would be the elimination of the third domino. This implies that the “person” is largely responsible for "carrying" the sequence of events to its conclusion in the accident.

Generally, people would carry out different processes using of different tools, equipment, machinery and materials in the workplace to generate products or services. These factors are interactive when a process is undertaken. Changes in any one may lead to subsequent adjustment of the others. In real life, the chances for an accident resulting from a series of events happening immediately one after the other are very rare. In most cases it requires a chain of root causes that reaches from top management to the lowest level of the work process.

Goetsch (1993, p.30) also points out that *"Heinrich's theory has been discounted by more contemporary research that it is now considered outdated. However, since some of today's more widely accepted theories can be traced back to Heinrich's theory, students of industrial safety should be familiar with his work".* Heinrich's theory has been gradually outdated, because the theory is lacking the concept of continual improvement and workers are excluded from participation in safety management. There was a feeling that sound controls and management of the physical causes of risk could override human incompetence.

6.3 THE MULTIPLE CAUSALITY (CAUSATION) THEORY:

Petersen (2000, pp.37-40) presented his theories of Multiple Causation in 1971. The Multiple Causation theory (Figure7) has the merit over the Domino theory in that it postulates that for a single accident there may be many contributory factors, causes and sub-causes. These factors combine together in a random style, causing accidents. The theory provides a multi-dimensional space for an objective evaluation of the possible events and their intersection that led to an accident. He has illustrated how the narrow interpretation of the Domino theory has severely limited us in diagnosing the underlying causes of an accident in relation to the socio-personal-environment interfaces.

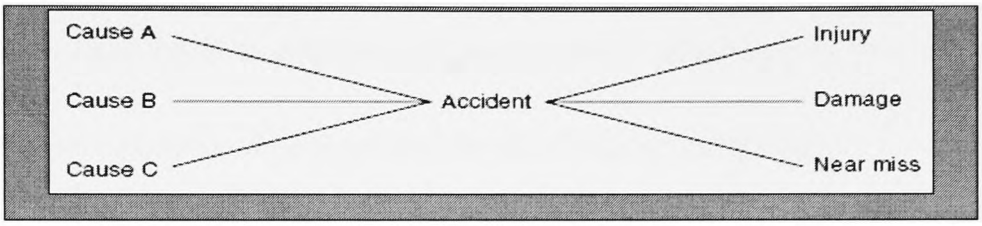


FIGURE 7: MULTIPLE CAUSALITY THEORY (SOURCE: STRANKS, 2002, P.117)

Professor Dan Petersen extended the causation theory from the unsafe acts and/or unsafe conditions to the management system. Petersen (2000, pp.37-40) points out that "*Safety has moved from the Domino Theory which stated that accidents are caused by unsafe acts and/or unsafe conditions, to newer theories which suggest that accidents are caused by a combination of management system failure and human error; furthermore, human error is often caused by a management-created environment that rewards risk-taking*". He recognized that it is the responsibility of top management to develop and maintain the SMS so that hazards associated with the organization's operation can be effectively controlled.

Evans (1983, pp.21-23) also agreed that very rarely does an accident arise from a single case, but, results from the combined effects of physical circumstances or human factors. He stresses that both the physical and psychological factors must be considered in recognizing that accidents result from unsafe systems of work either by error in design or by default. It is therefore vital to identify root causes and remove them to prevent a recurrence. These factors include safe systems of work, human behaviour, man-machine interface and many others. According to this theory, the contributory factors can be grouped into the following two categories:-

1. Behavioural: This category includes factors pertaining to the worker, such as improper attitude, lack of knowledge, lack of skills and inadequate physical and mental condition.
2. Environmental: This category includes improper guarding of other hazardous work elements and degradation of equipment through use and unsafe procedures.

6.4 <u>HUMAN FACTORS THEORY OF ACCIDENT CAUSATION:</u>

It is clear from the literature view that the major factors in most accidents are human factors. Stranks (1994, p.32) states that *"personal factors, such as attitude, motivation, perception, personality, training, and the potential for human error, are* *significant in any consideration of human factors and safety".* Human factors can impact on safety issues regardless of how well educated, trained and experienced people are. Its implication in accident causation has been spelled out in accident causation theories described in previous sections. Whatever the causation of accident is, the message is very clear that managing the safety at work requires an understanding of human factors. Careful consideration of human factors can improve safety by reducing the number of accidents/incidents and near-miss cases at work.

HSE has defined human factors as *"the environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work"*. Available from: Health and Safety Executive, *Human Factors Homepage.* http://www.hse.gov.uk/humanfactors/index.htm [Accessed 17 Nov 2006]

Human factors can be regarded as a multidisciplinary activity concerned with peoples' characteristics and capabilities in relation to the following:-

- Organizational factors such as poor safety culture, poor management of safety at work and poor communication.
- Environmental factors such as an unfamiliar workplace environment, uneven floor and inadequtae lighting.

- Job factors such as poor maintenance of equipment, heavy workload, unclear procedures in operation, and
- Personal factors such as attitude, competence levels, individual medical problems.

Stranks (1994, p.2) further points out that in considering the relationship of human factors to accident prevention, it is important to identify the basic features of the typical pre-accident situation. These are:-

- The *objective danger* at this point in time, that is, the shortcomings or deficiencies in the physical conditions - the badly fenced machine, slippery floor, unfenced floor opening, etc.
- The *subjective perception of risk* on the part of the individual or potential "accident victim".

Human factors may help to avoid accidents at work. Referring to the Human Factors Theory of Accident Causation that accidents are attributed to a chain of events which might be ultimately caused by human error. Goetsch (1999, p.145) states that "*The theory proposes that the nature of interaction between the worker, the machinery in operation, and the worksite environment is important*". The key is to analyze how the human interacted with the machine and the equipment; and what effect the environment had on the accident. Having these components interact optimally reduces the frequency of accidents.

6.5 THE ACCIDENT/INCIDENT THEORY:

"The accident/incident theory is an extension of the human factors theory. It was developed by Dan Petersen and is sometimes referred to as the Petersen accident/incident theory". (Goetsch, 1993, p.32) It introduces such as new elements as ergonomic traps, the decision to err, and systems failures. Based on Petersen's theory, factors of overload (i.e. pressure, fatigue, motivation, drugs, alcohol, worry etc.); ergonomic traps (i.e. incompatible workstation, incompatible expectations); and / or a decision to err (i.e. misjudgment of the risk, unconscious desire to err, logical decision based on the situation) may lead to human error and accident.

There are many different potential safety management problems in organizations, such as management's failure to establish a comprehensive safety policy, roles and safety responsibility are not clearly defined; safety procedures are ignored and employees do not receive proper safety training. Goetsch (1993, pp. 32-33) pointed out that the system failure component is an important contribution of Petersen's theory in a number of ways; *"Firstly, it shows the potential for a causal relationship between* *management decisions/management behaviour and safety. Secondly, it establishes management's role in accident prevention as well as the broader concepts of health and safety in the workplace."*

6.6 THE SYSTEMS THEORY OF CAUSATION:

The Systems Theory of Causation was developed by R. J. Firenzie. *"This theory views that a situation in which an accident might occur as a system comprised of the following components: person (host), machine (agency), and environment. The likelihood of an accident occurring is determined by how these components interact. Changes in the patterns of interaction can increase or reduce the probability of an accident occurring."* (Goetsch, 1993, p.35) When a person interacts with a machine within workplace environment, each of the components has a bearing on the probability that an accident will occur.

Rasmussen et al. (1987, p.24) pointed out that *"for the improvement of safety, an often fruitful point of view is to describe human errors as instances of man-machine or man-task misfits"*. The Systems Theory of Causation views the workstation as a system comprised of various components that must interact harmoniously. People who had developed safe work practice always show more sensitivity to the changing workplace environment in terms of lighting, smell, noise, heat, air quality, slippery floors, machinery, dangerous moving parts, housekeeping and other irregularities.

6.7 THE SYNOPTIC ACCIDENT MODEL:

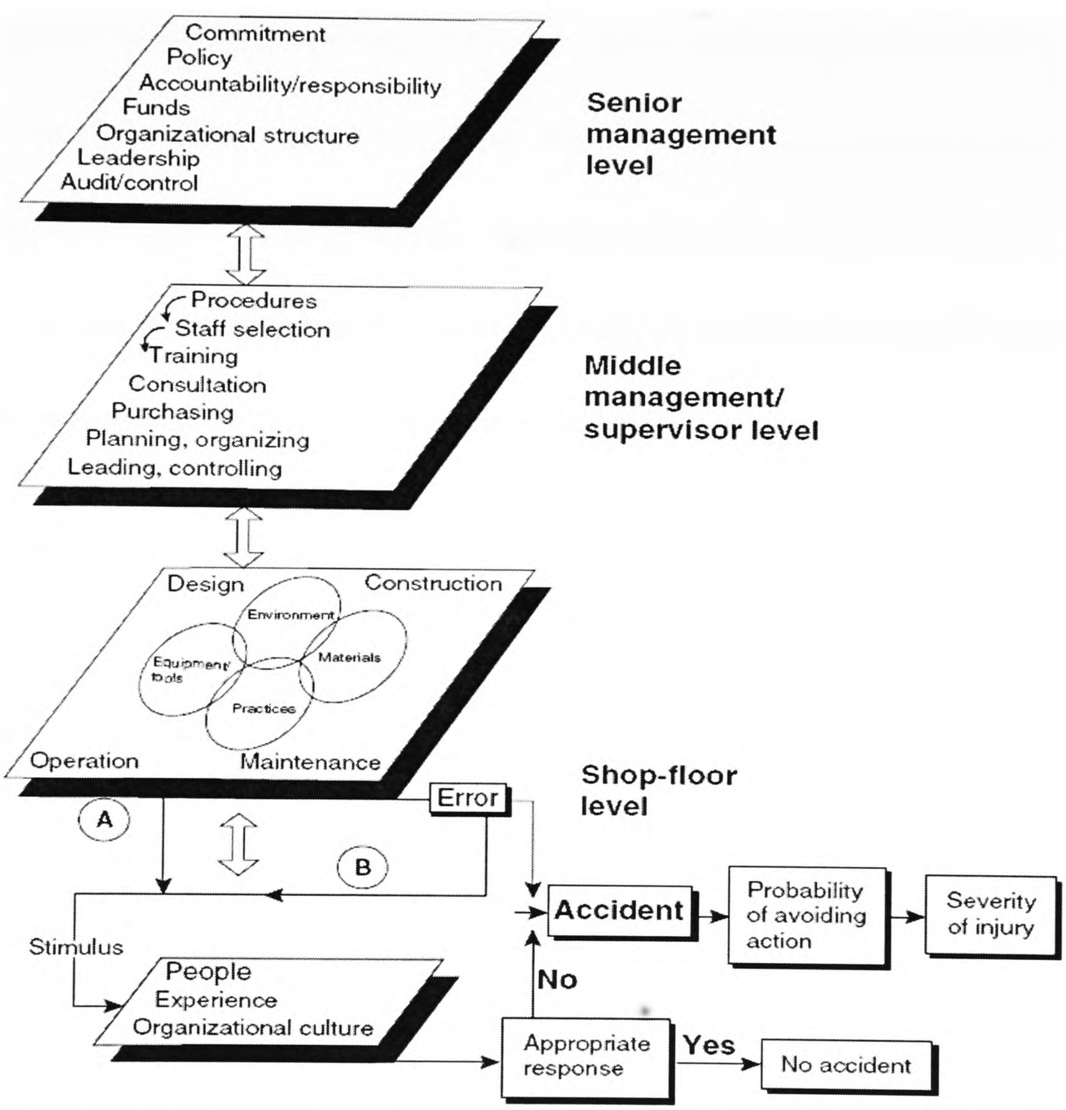
Management and employees at all levels should always cooperate to strive for the betterment of safety performance. Toward this end, the accident causation models and theories discussed in previous sections indicated that most accidents are related to human factors such as individual risk-taking behaviour, personal beliefs and perceptions, judgment and competence.

Now, we use the Synoptic Accident Model (Figure 8) to scrutinize key components contributing to accident causation from senior management level (e.g. commitment and responsibility), middle management level (e.g. training), shop-floor level (e.g. practices) and the organization culture.

According to the Synoptic Accident Model (Taylor et al., 2004, pp.197-198), looks at the accident process in two ways:-

- *Vertically through a series of transparent 'screens' where individual elements in a lower screen derive from 'macro' issues in a higher screen, and where the effects of macro issues are seen in a lower screen.*
- *Horizontally at the 'shop-floor' level, where the interaction between*

people and four other elements of the work system occurs. The sixth element, management, is projected from above, even though participative management may be used. The term 'shop floor' is used to indicate that all management is part of the workplace.



<u>FIGURE 8: "THE SYNOPTIC ACCIDENT MODEL" AVAILABLE FROM: TAYLOR, ET AL. (2004, P.198)</u>

If there is an error in the work process and no appropriate response at the right time; the interaction of individuals with the work environment, equipment, tools, materials, work practices and other contributing factors such as management supervision leads to adverse effects on work systems. These trigger a sequence of events ending in an accident.

7. HUMAN ERROR IN ACCIDENT CAUSATION:

Error could occur when someone forgets to do something, which is usually caused by a distraction or a lack of training. This is reflected in the persistence of the division of accident causes known as the "80:20 rule" (80% of accidents being due to human and 20% to technical causes). Since errors of people at work can in turn trigger a sequence of events ending in an accident, a study of human errors may shed light on the implication of human factors in accident causation.

What is the meaning of "Error"? Reason (1990, p.9) states that *"Slips and lapses are errors which result from some failure in the execution and/or storage stage of an action sequence, regardless of whether or not the plan which guided them was adequate to achieve its objective".* Human error can be regarded as the failure to achieve the desired outcomes in the way that was planned, due to unintentional or intentional behaviour. Kletz (2001, pp.4-5) classified human errors as follows:-

- *Errors due to a slip or a momentary lapse of attention. The intention is correct but the wrong action or no action is taken.*
- *Errors due to poor training or instructions. Some one does not know*

what to do or, worse, think he knows but does not. These are called mistakes. The intention is carried out but is wrong. We need to improve the training or instruction or simplify the jobs.

- *Errors which occur because a task is beyond the physical or mental ability of the person asked to do it, perhaps beyond anyone's ability. There is a mismatch between the ability of the person and the requirements of the task. We need to change the work situation.*
- *Errors due to a deliberate decision not to follow instruction or accepted practices. These are often called violations but non-compliance is a better term, as people often believe that the rule is wrong or that circumstances justify an exception. We should ask why the rules were not followed.*

Goetsch (1993, pp.31-32) blames "human error factors", which he describes as "overload, inappropriate activities, and inappropriate responses". They are detailed as follows:-

- *Overload:* Means imbalance between a person's capacity at any given time and the load that person is carrying in a given state. Undue stress caused by overload might make unsafe acts and errors. Due to economic down trends in today's environment, no matter in commercial firms, industrial sectors, hospitals or universities, employees have to encounter problems of budget cuts and manpower reduction in organizations such as downsizing, outsourcing, increase in span of control, salary cuts, frequent re-engineering of structure and high performance expectation. All these factors can refer to the task to perform physically, physiologically and psychologically.

- ✧ *Inappropriate response:* Means a person who detects a hazardous condition but does nothing to correct it; he or she has responded inappropriately.
- ✧ *Inappropriate activities:* Means a person who undertakes a task he or she doesn't know how to do.

The concept of human error was broadened through the literature review and detailed discussion. Upon a close scrutiny of Kletz's and Goetsch's suggestions, it is not difficult for us to comprehend that human errors are a result of various cognitive dimensions. For accident prevention, management needs to understand the human factors and the other factors which tend to make errors.

8. INSPIRATIONS GAINED FROM THE REVIEW OF THEORIES AND MODELS IN HUMAN FACTORS AND ACCIDENT CAUSATION:

In this chapter, the relevant accident causation theories and models have been reviewed and summarized in Table 1.

TABLE 1: INSPIRATIONS GAINED FROM THE REVIEW OF THEORIES AND MODELS IN CHAPTER THREE

THEORY AND MODEL REVIEWED IN CHAPTER THREE	INSPIRATIONS GAINED
The Concept of an Iceberg	Have a better understanding of what makes up total accident costs.
Heinrich's Triangle of Accident and Bird's Triangle of Accident	"Accident Triangle" has prompted safety professionals to focus on people's at-risk behaviours.
Accident Proneness Theory	This theory suggests that "within a given set of workers, there exists a subset of workers who repeatedly have accidents and are classified as accident prone".
The Domino Theory	This theory suggests that the key to accident prevention would be the elimination of the third domino "unsafe acts". This implies that the "person" is largely responsible for "carrying" the sequence of events to its conclusion in the accident.
The Multiple Causality (Causation) Theory	It postulates that for a single accident there may be many contributory factors, causes and sub-causes. The theory suggests that accidents are caused by a combination of management system failure and human error; furthermore, human error is often caused by a management-created environment that rewards risk-taking".
Human Factors Theory of Accident Causation	This theory suggests that accidents are attributed to a chain of events which might be ultimately caused by human error. It is noted that *"personal factors, such as attitude, motivation, perception, personality, training, and the potential for human error, are significant in any consideration of human factors and safety".*
The Accident/Incident	This theory suggests that factors of overload;

Theory	ergonomic traps; and / or a decision to err may lead to human error and accident.
The Systems Theory of Causation	This theory suggests that a situation in which an accident might occur could be considered as a system comprising the following components: person (host), machine (agency), and environment.
The Synoptic Accident Model	This model scrutinized key components contributing to accident causation from senior management level (e.g. commitment and responsibility), middle management level (e.g. training) and shop-floor level (e.g. practices). If there is an error in the work process and no appropriate response at the right time; the interaction of individuals with the work environment, equipment, tools, materials, work practices and other contributing factors such as management supervision leads to adverse effects on work systems. These trigger a sequence of events ending in an accident. Culture in the organization also affects the overall safety performance.

The review of relevant theories and models listed in Table 1 could help to develop survey questionnaire items and construct the hypothesized "DSRs Safety Attitude Model" in this study. It is widely recognized that "Human Factor" is a significant contributory factor in a large proportion of accidents and incidents.

9. CHAPTER SUMMARY:

This chapter tends to emphasize the crucial role of human factors in accidents. A well-designed workplace with a well established SMS does not guarantee an injury-free workplace, if human factors are not properly addressed. Accidents continue to occur and most of these cases were triggered by deeply ingrained unsafe behaviours or poor safety attitudes at work. Today, some people still have the wrong perception in mind that "safety is not their business". If so, the whole SMS in the organization is doomed. Safety management will only be effective where a positive safety culture exists throughout all stakeholders in the organization. Reviews of literature on relevant theories and models in this chapter provided a substantial, theoretical background to develop the research instrument in this study.

DSRs are full time employees with added safety management responsibility in ensuring relevant policies, safety rules, operating procedures and legal requirements are adhered to. Clearly, DSRs are different from each other. In Chapter Four, a comprehensive review of literature on human attitudes, behaviour, safety culture and other behavioural aspects of safety would be conducted. Available information would provide an in-depth understanding of the importance of individual differences of DSRs and lay the theoretical background of the research. A list of latent and observed variables would be identified for construction of the hypothesized "DSRs Safety Attitude Model".

CHAPTER FOUR

ATTITUDE, BEHAVIOUR AND SAFETY CULTURE

1. INTRODUCTION:

The relationship between attitude and behaviour has long been of interest to social psychologists. There is some degree of consensus that organizational factors such as safety culture influence an individual's safety attitude, which in turn influence an individual's intention to perform safety behaviour. Attitude towards behaviour is interpreted as a person's overall evaluation of performing the behaviour as either positive or negative. In any organization, individual's negative safety attitude, unsafe behaviour, poor safety culture interaction with other contributing factors could possibly trigger a sequence of events ending in an accident. This chapter aims to examine relationships between attitude, behaviour and safety culture through the literature review of various psychological theories and models. A total of eleven (11) psychological theories and models regarding attitude, behaviour and safety culture listed in Table 2 would be reviewed. Variables for construction of the hypothesized "DSRs Safety Attitude Model" would be identified.

TABLE 2: A LIST OF 11 THEORIES AND MODELS – ATTITUDE, BEHAVIOUR AND SAFETY CULTURE

THEORY AND MODEL – ATTITUDE, BEHAVIOUR AND SAFETY CULTURE
A MODEL OF "SEPARATE ENTITIES VIEW"
THE "SELF-PERCEPTION THEORY"
THE MODEL OF THEORY OF REASONED ACTION (TRA)
THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB)
THE HEALTH BELIEF MODEL
THE COGNITIVE-DISSONANCE THEORY
THE SOCIAL COGNITIVE THEORY (SCT)
BANDURA'S MODEL OF RECIPROCAL DETERMINISM
THE RECIPROCAL MODEL OF SAFETY CULTURE
THE PERFORMANCE MAP
SAFETY CULTURE MATURITY MODEL

2. WHAT IS AN ATTITUDE?

Attitudes studies have been accompanied by a long history of research, the definition of attitude is voluminous, but a universally agreed definition is not yet available. The following are some of the definitions viewing attitude from different perspectives:-

- Attitude as *"an enduring organizational, motivational, emotional, perceptual, and cognitive process with respect to some aspect of an individual's world"*. (Krech and Crutchfield, 1948, p.152)
- Attitude as a *"tendency or disposition to evaluate an object or the symbol of that object in a certain way"*. (Katz and Stotland, 1959, p.428)
- Attitude as *"a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's*

response to all objects and situations with which it is related". (Fishbein, 1967, p.8)

- Attitude is *"a disposition to respond favorably or unfavorably to an object, person, institution, or event".* (Ajzen, 1988, p.4)

After examining the above cited definitions, attitude can be regarded as a person's feelings, evaluations, or an expression of how people would like to feel, think, with important motivational consequences in a more or less favourable or unfavourable way. Many modern social psychologists describe the term 'attitude' as a fairly persistent and enduring disposition to evaluate an object, place and person either positively or negatively.

Attitude is a useful indicator of a safety culture. Cox and Cox (1991, pp.93-106) point out that "*constructive attitudes are probably the most important single index of the effectiveness of a safety culture as they result from all other contributory features*". Indeed, one negative attitude towards safety by an individual can infect an entire group and create an epidemic in the workplace, so as to impose an adverse effect on overall safety performance in the organization. One of the aspects that this study will examine is whether attitudes, and specifically attitude functions, influence DSRs attitudes towards the implementation of SMS in the University.

2.1 FORMATION AND CHANGE OF ATTITUDE:

How do people acquire attitudes? "*Attitudes are formed as a result of continuing experience of situations during a lifetime*". (Stranks, 1994, p.36) and "*The most effective way of creating a strong sense of efficacy is through mastery experiences*". (Bandura, 1994, pp.71-81) For the formation of attitudes, it is a continuous interaction with different people and different situations. They are directly associated with:-

- *"Self-image - the image that an individual wishes to project to the outside world, for example, affluent, stern, well-mannered, fair-minded".*
- *"The influence of groups and group norms – that is the standards upheld by a particular group".*
- *"Individual opinions – including superstitions, such as "All accidents are 'Acts of God', implying that nothing can be done in terms of preventing accidents".*

A model of "separate entities view" (Figure 9) was developed by Fishbein and Ajzen regarding components of attitudes which links the cognitive component embodies the person's "beliefs" and the affective component "attitudes" to the behavioural intention.

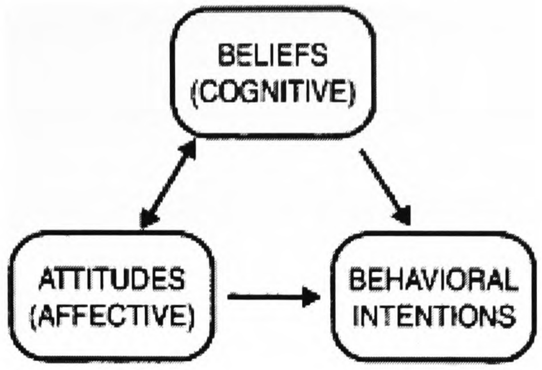


FIGURE 9: SEPARATE ENTITIES VIEW DEVELOPED BY FISHBEIN AND AJZEN

Oskamp et al. (2005, pp.10-11) states that "*In Fishbein and Ajzen's theory, the term attitude is reserved solely for the affective dimension, indicating evaluation or favorability toward an object. The cognitive dimension they label as beliefs is defined as indicating a person's subjective probability that an object has a particular characteristic. The behavioural dimension they refer to as behavioural intentions is defined as indicating a person's subjective probability that he or she will perform a particular behaviour toward an object.*"

Change of attitude is rather difficult, but is possible. What produces attitude change? Stranks (1994, p.36) suggests that change of attitudes must take place in a series of well-controlled stages: - *1) by attracting the attention of the individual to the fact that a change of attitude is needed; and 2) by convincing this person that their current attitude is inappropriate or wrong.* Traindis et al. (1971, p.142) also states that attitudes change when:-

- A person receives new info from others or media- *Cognitive change.*
- Through direct experience with the attitude object- *Affective change.*
- Force a person to behave in a way different from normal- *Behavioural change.*

It is important to keep in mind these three dimensions of an attitude including cognitive, affective and behavioural especially when considering a change in attitude.

Formation and change of attitude are interrelated. Acceptance of new attitudes very much depends on how the person is perceived and the credibility of the communicator. In reality, people are always adopting, modifying and relinquishing attitudes and decisions to fit the ever-changing environment, situation and needs. It is because present attitudes interfere with an important outcome, such as performance, organizational culture, job requirement, communication, information and partnering with others. The "Self-perception Theory" is developed by psychologist Daryl Bem. Bem (1972, p.2) defines the self-perception theory as "*Individuals come to know their own attitudes, emotions, and other internal states partially by inferring them from observations of their own overt behaviour and/or the circumstances in which this behaviour occurs.*"

As far as we know perception is an important feature of human behaviour in that people behave in accordance with the way they perceive work situations, processes and fellow workers in the organization. People infer their own attitudes and other internal states such as feelings from watching themselves behave in various situations. This is particularly true when internal cues are so weak.

An employee's attitude and behaviour could be influenced by the perception they have of the priority given to occupational safety by their superiors. Clarke (1999, pp.185-198) considers the "*Perceptions of senior managers' attitudes and behaviours in relation to the safety and well-being of the workforce, will form the basis for the safety behaviour of workers, and therefore, the safety performance of the company.*" Rundmo (2000, pp.47-59) clearly points out that "*Management attitudes towards safety have the potential to affect not only decision-making at top and middle management level, but also those decisions made by employees*".

Misperception is one of the causes of human error and frequently results in accident at work. It is obviously dangerous at the "man-machine-environment" interface in the workplace. People may differ in their safety perceptions, depending on their roles, hierarchical level and many other factors within the organization. For example, a professor may estimate the level of risk in laboratories quite differently from the students. At this point, human error such as taking shortcuts in order to get the job done faster - the "Hurry-Hurry Culture" is a common causation of accident. The at-risk behaviour allows people to under estimate the level of risks involved.

In any organization, people understand that the reasons for attitude formation and change could possibly lead to better attitudes and greater commitment to safety. Thus, there is a need to regulate how these perceptions, positive attitudes and safe behaviours are transmitted to subordinates to ensure that management commitment to safety is accurately perceived. SMS can provide an effective safety framework that the organization and its employees place at the centre of creating safe working practices.

Based on theoretical consideration in sections 2.1 and 2.2, identified variables "attitude", Belief" and "Perception" are consolidated in Table 3.

TABLE 3: KEY VARIABLES IDENTIFIED FROM A MODEL OF "SEPARATE ENTITIES VIEW" AND THE "SELF-PERCEPTION THEORY"

IDENTIFIED VARIABLES	THEORY AND MODEL
ATTITUDE, BELIEFS	A MODEL OF "SEPARATE ENTITIES VIEW"
ATTITUDE, PERCEPTION	THE "SELF-PERCEPTION THEORY"

3. RELATIONSHIP BETWEEN ATTITUDE AND BEHAVIOUR:

Individuals instinctively seek comfort! They may behave in a way that unintentionally threatens their own life and endangers others while at work.

"Accidents can be caused by any one (or combination) of the following behaviour. First, a lapse of attention. Second, a genuine mistake. Third, deliberately cutting corners in an effort to maximize productivity. Fourth, simple rule-breaking. Fifth, environment factors such as poor maintenance, housekeeping or the failure of systems and equipment." Available from: *The Psychology of Industrial Safety,* Article 12 "Behavioural Safety - An Overview". http://www.rydermarsh.co.uk/BehaviouralSafet.html [Accessed 17 August 2004]

When someone takes a risk or behaves unsafely at work, they will often have a good reason for doing so. An understanding of individual attitude and behaviour is an essential prerequisite to the exploration of how individuals work safely in the organization. The definition of attitude has already been explained in details in Section 2. The following are some of the definitions viewing behaviour from different perspectives:-

- ✧ *Behaviour as the total response a person makes to any situation with which they are faced.* (Stranks, 1994, p.61)
- ✧ *Behaviour is simply anything someone does or says.* (McSween, 1995, p.227)
- ✧ *Behaviour to acts or actions by individuals that can be observed by others.* (Geller, 1996, p.115)

The first generation of researchers to examine the link between attitude and behaviour departed from the assumption that attitude had a "*directive or dynamic influence on individual response to all objects and situations*". (Allport, 1935, pp.798-844) A first landmark study that looked at the relationship between attitudes and behaviour was done by LaPiere. In 1934, LaPiere found that virtually all businesses served Chinese couples courteously, yet most owners held negative attitudes. Owner's attitudes as verbally expressed (intentions) were inconsistent with their actual behaviour (action), i.e., between what people say they would do and what they actually do.

Ajzen & Fishbein (1980, p.18) summarized the case of LaPiere (1934) investigation of racial prejudice against Orientals: - "*In the early 1930s, LaPiere accompanied a young Chinese couple in their travels through the United States. Calling upon 251 restaurants, hotels, and other establishments, they were refused service only once. About 6 months later, LaPiere sent a letter to each establishment visited, asking the same question: Will you accept members of the Chinese race as guests in your establishment? Of the 128 establishments that replied, over 90% answered "NO".*

LaPiere has given an account of this “weak attitude-behaviour consistency” in this study. As he had expected, there was no consistency between the symbolic attitudes (responses to the letter) and actual behaviour. Inconsistent support for attitudes as predictors of behaviour was found. The Chinese couple received courteous service in virtually every establishment, but responses to the letter were almost universally negative. In general, the attitude-behaviour relationship is important in all aspects of society. We have so far understood the characteristics of attitudes and behaviour. The next logical question is "What are the relationships between attitudes and behaviour?" Glendon et al. (2006, pp.195-198) articulated four possible types of relationship between attitudes and behaviour, they are:-

- *Attitudes influencing behaviour;*
- *Behaviour influencing attitude;*
- *Attitudes and behaviour influencing each other;*
- *Other factors.*

The following sections will focus on the discussion regarding relationships between attitudes and behaviour.

3.1 DOES ATTITUDE INFLUENCE BEHAVIOUR?

Attitude is regarded as an important influence on human behaviour and is a strong predictor of future behaviour. It is assumed that if you can change someone's attitude, then a change to their behaviour will follow. Tye (1994, p.36) considers that "*changing workers safety attitudes is the pre-requisite in changing their behaviour*". Everley (1995, pp.19-22) also reports that "*there exist divided opinions among safety practitioners in that some believe employees' behaviour can be modified through discipline and reward, while others believe that it is necessary to change employees' attitudes through empowerment and involvement, in order for a long-term behavioural change to occur*". Louw (1998, p.818) agrees that "*it is generally accepted that attitudes must change, before behaviour can change*". How do attitudes guide behaviour? Ajzen and Fishbein introduced the models of Theory of Reasoned Action (TRA) and Theory of Planned behaviour (TPB) to explain how and why attitudes guide people's behaviour.

Ajzen and Fishbein first introduced the Theory of Reasoned Action (TRA) in 1967 which provides a framework of "Reasoned Action Model" (Figure 10) to explain how and why attitudes guide people's behaviour.

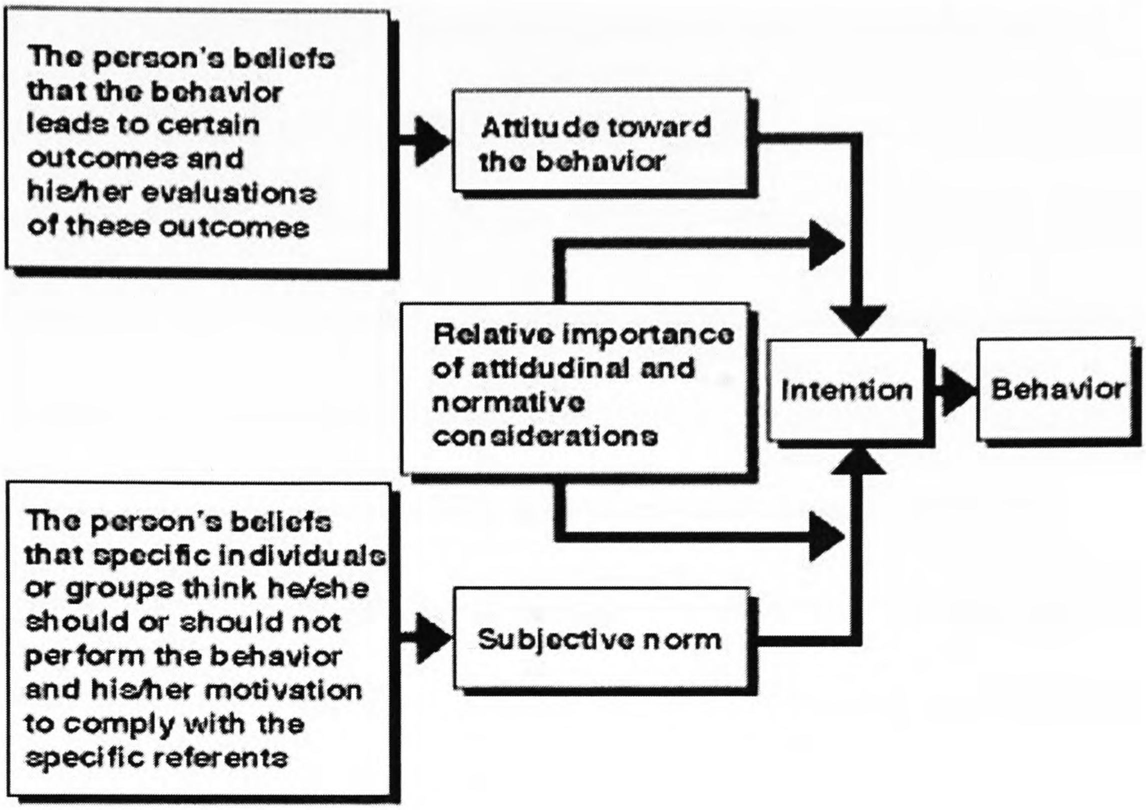


FIGURE 10: REASONED ACTION MODEL –FISHBEIN & AZJEN, 1975

TRA is a widely validated intention model that has proven successful in predicting behaviours that are under a person's volitional control. Ajzen & Fishbein (1980, p.7) points out that *"It is possible to predict and gain some understanding of a person's intention by measuring his attitude toward performing the behaviour, his subjective norm, and their relative weights".* It is hypothesized that a person's behaviour is predicted reasonably by his/her behavioural intention, which in turn, is predicted by his/her attitude toward the behaviour and subjective norm. The personal beliefs (behavioural and normative) are referred to as cognitive structures which will influence individual attitude and subjective norms, respectively. Personal beliefs of the action towards a target are learned through past experiences, perception, level of educational background, work stress and social influences. Changes in an individual's behavioural and normative beliefs will ultimately affect the individual's actual behaviour. TRA is concerned with rational, volitional, and systematic behaviour. Fishbein et al. (1994, pp.61-78) stated that "*Based on the premise that humans are rational and that the behaviours being explored are under volitional control, the theory provides a construct that links individual beliefs, attitudes, intentions, and behaviour*". When making a decision, rational people are rationally thinking about all their actions and the possible outcome.

TRA explains the constructs affecting human behaviour. In order to understand the concept of TRA, we should examine the links between key components in detail:-

- **"Intention" to "Behaviour":**

  A person's intention to perform a given behaviour is the immediate determinant that behaviour. In TRA, Ajzen & Fishbein introduced the concept of intention links between attitude, subjective norm and behaviour to strengthen the relationship. "*We found that intention to perform a given behaviour is related to particular kinds of attitudes and beliefs,* *namely, attitudes toward the behaviour and subjective norms concerning performance of the behaviour."* (Fishbein & Ajzen, 1975, p.511) *"We have agreed that a person's intention to perform a behaviour is determined by her attitude toward the behaviour and by her subjective norm".* (Ajzen & Fishbein, 1980, p.59) It has provided a conceptual explanation of human actions.

✧ **"Personal Beliefs" to "Attitude toward the Behaviour" and "Subjective Norm":-**

"A person's intention is a function of two basic determinants, one personal in nature and the other reflecting social influence. The personal factor is the individual's positive or negative evaluation of performing the behaviour; this factor is termed 'Attitude toward the Behaviour'. The second determinant of intention is the person's perception of the social pressures put on him to perform or not perform the behaviour in question. Since it deals with perceived prescriptions, this factor is termed 'Subjective Norm'." (Ajzen & Fishbein, 1980, p.6)

Beliefs are viewed as underlying a person's attitudes and subjective norms, and they ultimately determine intentions and behaviour.

Schermerhorn et al. (1955, p.141) indicate in a diagram how the collective components of attitudes are related to each other as depicted in Figure 11.

Beliefs and values create → **attitudes** **that predispose** → **behaviour**

FIGURE 11: COMPONENTS OF ATTITUDES (SCHERMERHORN ET AL, 1955, P.141)

- The first antecedent of behavioural intention is "Attitude toward the Behaviour" which is formed on the basis of "behavioural beliefs" about consequences. Ajzen & Fishbein (1980, p.6) described attitude toward the behaviour as "*a person's judgment that performing the behaviour is good or bad, that he is in favor of or against performing the behaviour*". It is assumed that favorable attitudes predispose positive responses to the object and unfavorable attitudes predispose negative responses. "*The beliefs that underlie a person's attitude toward the behaviour are termed behavioural beliefs.* (Ajzen & Fishbein, 1980, p.7). Attitude does not determine behaviour directly; it is an individual's positive or negative behavioural belief (salient beliefs) about performing a specific behaviour.

"*When employees' attitudes are favorable, employees follow safe* *procedures, report and fix (when possible) safety hazards, participate in safety initiatives, warn coworkers about safety hazards and risky behaviours, and teach and model safe work practices for newer employees. When employees are scared, angry, and/or apathetic on the job, they hide injuries, take shortcuts, resist safety improvement efforts and quit providing safety feedback to others*". (Williams, 2003, p.32)

- The second antecedent of behavioural intention is "Subjective Norm" which is formed on the basis of "normative beliefs". A subjective norm is the person's perception of the social pressures (e.g. peer pressure) put on him/her to perform or not to perform a behaviour. Ajzen & Fishbein (1980, p.6) say that "*the person's perception of the social pressures put on him to perform or not perform the behaviour in question. Since it deals with perceived prescriptions, this factor is termed subjective norm.*" Subjective Norm is a main influencer of a person's intentions which come from the person's belief.

"*The person's beliefs that specific individuals or groups think he should or should not perform the behaviour. These beliefs underlying a person's subjective norm are termed normative beliefs*". (Ajzen &

Fishbein, 1980, p.7) Normative beliefs are a combination of a person's beliefs regarding other people's views of a behaviour and the person's willingness to conform to those views. The evaluation of those opinions will vary from population to population. For example, if an individual employee does not believe that colleagues are concerned with safety, then he/she is less likely to consider safety as important. It is a common practice that people will consult others before making any decisions, for example, to accept a new employment in other organization.

"It is reasonable to feel positively about performing a behaviour if you believe that its performance will lead to more good than bad outcomes. It is also reasonable to feel social pressure to not perform a behaviour if you believe that people with whom you are motivated to comply think you should not perform it. Finally, it is reasonable to weigh your personal feelings (attitude) and the perceived social pressure (subjective norm) in arriving at and carrying out your intention. Taken together, the processes involved in this sequence comprise a theory of reasoned action." (Ajzen & Fishbein, 1980, p.244)

In real life, many day-to-day decisions are not taken in this manner. Some criticism has been leveled against this conception of how the link between attitudes and behaviour works since it only accounts for the rational decision-making. If behaviours are not fully under volitional control (i.e. not entirely under his/her control), even though a person may be highly motivated by his/her own attitudes and subjective norm, he/she may not actually perform the behaviour due to intervening environmental conditions.

To address the inadequacies and overcome limitation of TRA on volitional control, the Theory of Planned Behaviour (TPB) was developed by Azjen in 1988. The TPB extends this idea and takes into account performance of behaviours which are not entirely under the individual's control, by including the concept of perceived behavioural control. Azjen modified the TRA by adding a third antecedent of intention to the original model of TRA which is called "Perceived Behavioural Control" (PBC) to predict behaviours in which individuals have incomplete volitional control.

"The concept of perceived behavioural control is similar to the concept of self-efficacy -- person's perception of his or her ability to perform the behaviour. Perceived behavioural control over opportunities, resources, and skills necessary to perform a behaviour is believed to be a critical aspect of behaviour change processes."

Available from: Grizzell, J. (2003), *Theory of Reasoned Action and Theory of Planned Behaviour.*

http://www.csupomona.edu/~jvgrizzell/best_practices/bctheory.html#Reasoned_Action [Accessed 15 September 2007]

Ajzen described this concept as the individual's perception of control over the behaviour, an estimate based on past experiences and on the anticipation of obstacles that may prevent the behaviour. PBC is included in TPB that has both a direct effect on actual behaviour and an indirect effect on actual behaviour through intentions. The framework and the relations among variables of TPB are depicted in Figure12.

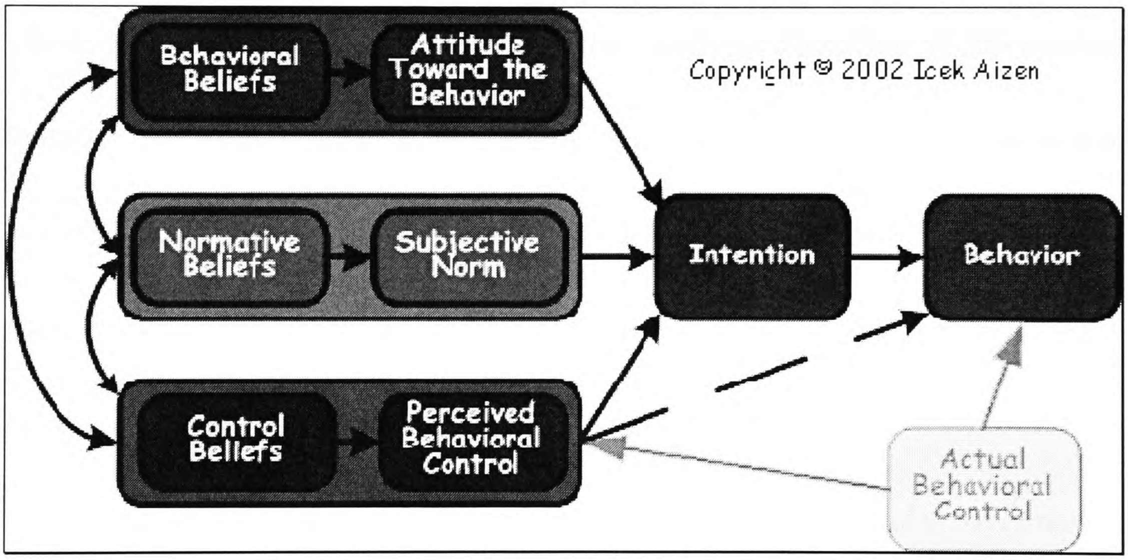


FIGURE 12: CONCEPTUAL MODEL OF THEORY OF PLANNED BEHAVIOUR - ICEK AJZEN (2002, P.1)

The TPB offers an account of the proximal determinants of behaviour and has become the dominant social-psychological model for relating attitudes to behaviour. The TPB would argue that behaviour results from an individual's intention to perform a particular behaviour, and that intention itself is a function of three determinants including "Attitude toward the Behaviour" i.e. whether he/she is in favor of performing the behaviour, "Subjective Norm" i.e. how much social pressure that he/she perceives and "Perceived Behavioural Control" i.e. whether he/she perceives ease or difficulty in control of performing the behaviour. Ajzen (1988, pp.132-133) points out that "*the more favorable the attitude and subjective norm with respect to a behaviour, and the greater the perceived behavioural control, the stronger should be the individual's intention to perform the behaviour under consideration*".

Beliefs play a central role in the TPB and both "Outcome Beliefs", "Normative Beliefs" and "Control Beliefs" may indirectly contribute to "Behavioural Intention". Ajzen (2002, p.1) explains that "*In their respective aggregates, behavioural beliefs produce a favorable or unfavorable attitude toward the behaviour; normative beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioural control. In combination, attitude toward the behaviour, subjective norm, and perception of behavioural control lead to the formation of a behavioural intention*". It is important to realize that these beliefs are influenced by a wide variety of cultural, personal, and situational factors. If a person holds strong control beliefs about the existence of factors that will facilitate a behaviour, then the individual will have high PBC.

"*Clearly, a multitude of variables could potentially influence the beliefs people* *hold: age, gender, ethnicity, socio-economic status, education, nationality, religious affiliation, personality, mood, emotion, general attitudes and values, intelligence, group membership, past experiences, exposure to information, social support, coping skills, and so forth.*" (Ajzen & Fishbein, 2005, p.54)

Note that the theories of reasoned action and planned behaviour depicted in Figure 13 is a causal chain of effects starting with the formation of behavioural, normative, and control beliefs. *"The solid arrow pointing from actual control to the intention-behaviour link indicates that volitional control is expected to moderate the intention-behaviour relation such that the effect of intention on behaviour is stronger when actual control is high rather than low".* (p.49) *and "the dotted arrows in the diagram indicate that, although a given background factor may in fact influence behavioural, normative, or control beliefs, there is no necessary connection between background factors and beliefs."* (Ajzen & Fishbein, 2005, p.55) In the meantime researchers and academia are using these models as the backbone for trying to understand the attitude-to-behaviour relationships.

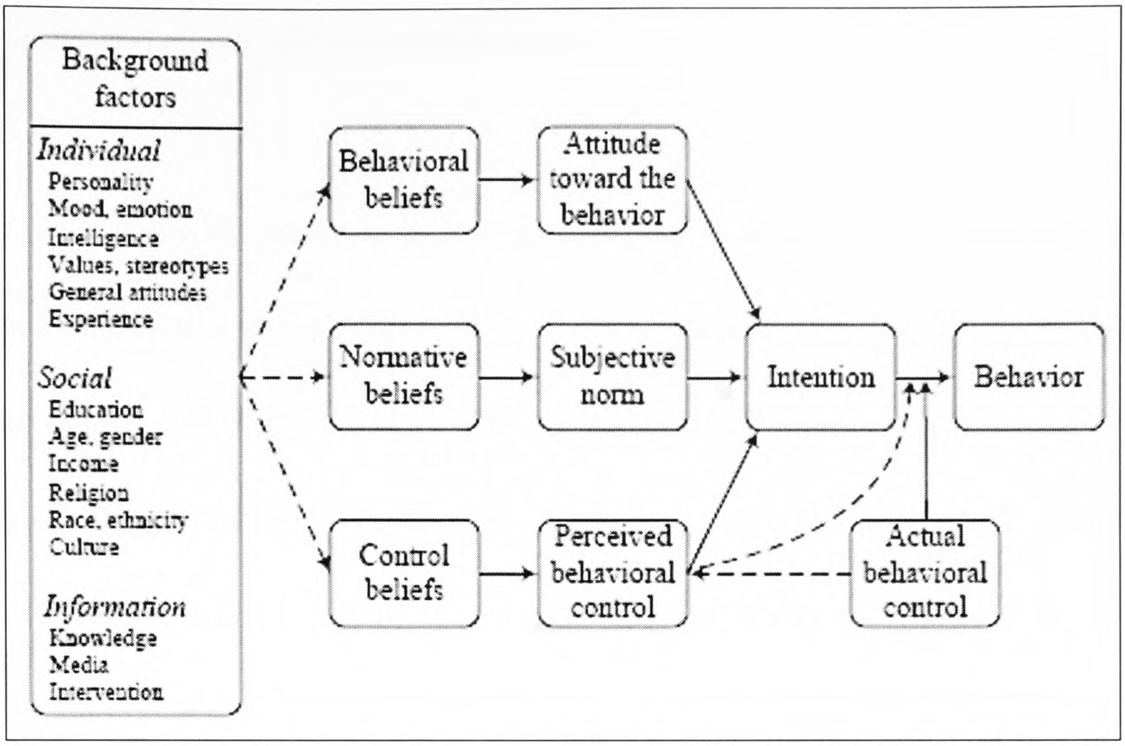


FIGURE 13 THE THEORIES OF REASONED ACTION AND PLANNED BEHAVIOUR, AJZEN ET AL. (2005, P.49)

Based on the literature review, both Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) offer rich insights into attitude–behaviour relations. They assume that human beings are basically rational and make systematic use of information available to them when making decisions.

The major difference of TPB is the addition of a third determinant "PBC". The TPB seeks to explain the underlying forces to why a planned behaviour is or is not performed by implementing the behavioural beliefs, normative beliefs, and control beliefs. Consequently, Ajzen introduced the concept of intention as a link between attitude and behaviour to strengthen the relationship. In this way, attitudes can be used to predict an individual's intention to perform a behaviour, which in turn can be used to predict the occurrence of the actual behaviour.

From the literature review, personal beliefs are viewed as underlying a person's attitudes and subjective norms, and they ultimately determine intentions and behaviour. The effectiveness of SMS implementation at departmental level will be guided by the attitudes that DSRs hold, by their assessment of social norms and by perceived behavioural control (e.g. barriers to implementation). Change of DSRs personal beliefs can change of their attitudes, so as to change their behaviour. The concept of the Health Belief Model (HBM) could help to explain how person's perception or self-efficacy to influence his or her ability to perform the behaviour. The Health Belief Model (HBM) was first developed in the 1950s by social psychologists Hochbaum, Rosenstock and Kegels working in the U.S. Public Health Services.

"The health belief model stipulates that a person's health-related behaviour depends on the person's perception of four critical areas: the severity of a potential illness, the person's susceptibility to that illness, the benefits of taking a preventive action, and the barriers to taking that action. The model also incorporates cues to action (e.g., leaving a written reminder to oneself to walk) as important elements in eliciting or maintaining patterns of behaviour. The construct of self-efficacy, or a person's confidence in his or her ability to successfully perform an action, has been

added to the model, perhaps allowing it to better account for habitual behaviours, such as a physically active lifestyle." Available from: Grizzell J. *Health Belief Model,* http://www.csupomona.edu/~jvgrizzell/best_practices/bctheory.html#Health_Belief_Mode [Accessed 15 September 2007].

The HBM is a psychological model that uses conceptual frameworks to explain and predict a given health-related behaviour from certain patterns of belief about the recommended health behaviour and the health problems that the behaviour was intended to prevent or control. In this study, DSRs personal beliefs and perceptions would be investigated through an attitude survey.

Based on the theoretical consideration in section 3.1, identified variables "Attitude", Beliefs", "Perception", "Norm" and Self-efficacy" are consolidated in Table 4.

TABLE 4: KEY VARIABLES IDENTIFIED FROM THE MODEL OF THEORY OF REASONED ACTION (TRA), THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB) AND THE HEALTH BELIEF MODEL

IDENTIFIED VARIABLES	THEORY AND MODEL
ATTITUDE, BELIEFS, NORM	THE MODEL OF THEORY OF REASONED ACTION (TRA) AND THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB)
PERCEPTION, SELF-EFFICACY	THE HEALTH BELIEF MODEL

3.2 DOES BEHAVIOUR INFLUENCE ATTITUDE?

It's now widely accepted that 80-95% of all accidents are triggered by the unsafe behaviour of employees. *"The reason to focus on behaviour is that when an incident occurs, behaviour is the crucial final common pathway that brings other factors together in an adverse outcome. Therefore, ongoing, upstream measurement of the sheer mass of these critical at-risk behaviours provides the most significant indicator of workplace safety. And the only satisfactory mechanism to drive this activity is employee involvement".* (Krause, 1995, p.6) Hence it is important to identify unsafe behaviours that cause accidents.

Krause (1995, p.34) also opines that in a business or industrial setting there are two powerful reasons to focus on behaviour first:-

- *Behaviour can be measured and therefore managed, whereas attitude presents measurement problems.*
- *Changes in behaviour can lead to changes in attitude.*

Based on Krause's opinion, behaviour has the power to change attitude. Although people are not usually aware that changed behaviour can change attitude and personal beliefs, this effect of behaviour on attitude is also a common fact of life.

The Cognitive-dissonance Theory first proposed by social psychologist Leon Festinger in 1956 is an example of how the perspective of social cognition has been applied to explain the effect of behaviour on influencing attitudes. What is cognitive dissonance? *"Cognitive dissonance can be seen as an antecedent condition which leads to activity oriented toward dissonance reduction just as hunger leads to activity oriented toward hunger reduction."* (Festinger, 1962, p.3) When an unpleasant state resulting from inconsistency between attitudes and behaviour occurs, this state is knows as Cognitive Dissonance. Suedfeld (1971, p.17) offers an example – "*if one studies hard for a test, he expects to do well. But if he studies hard and fails, dissonance is aroused.*"

Robbins (1996, p.190) states that "*people seek consistency amongst their attitudes and behaviour. However, inconsistency occurs, if people's behaviour changes but attitudes don't, then people feel uncomfortable. It is the uncomfortable tension that comes from holding two conflicting thoughts at the same time. Individuals will be motivated to engage in various kinds of cognitive restructuring to remove such feelings of tension and uncertainty.*"

"Thus, our self-directed behaviour informs our self-perception and our core values. And our self-perception and personal values influence our behaviour. We

strive for our behaviour to be consistent with our values, and vice versa. When we perceive an inconsistency between behaviour and the values that define us, we experience tension or "cognitive dissonance" (the academic label used by the many social psychologists who researched this phenomenon). We direct our self-talk to reduce this negative state." Available from: Geller S. (2005). *Psychology of Safety: What's on your mind?* http://www.ishn.com/CDA/Archives/f3b0dbf7161c7010VgnVCM100000f932a8c0 [Accessed 1 September, 2005]

The Cognitive Dissonance Theory focuses on consequences of incompatibility between two related cognitions. The easiest way to remove these unpleasant tensions and to reduce cognitive dissonance is change their attitude.

Explanations on the major difference between the "Cognitive Dissonance Theory" and "Self-perception Theory" were given by Eiser et al. "*The dissonance theory suggests that there is an underlying state of psychological tension that pressurizes the individual into changing an attitude, whereas the self-perception theory suggests a more passive process whereby people simply change their perceptions of their attitudes.* (Eiser et al., 1988, p.36)

Based on theoretical considerations from section 3.2, identified variable

"Perception" is consolidated in Table 5.

TABLE 5: KEY VARIABLE IDENTIFIED FROM THE COGNITIVE-DISSONANCE THEORY

IDENTIFIED VARIABLE	THEORY AND MODEL
PERCEPTION	THE COGNITIVE-DISSONANCE THEORY

3.3 DO ATTITUDE AND BEHAVIOUR INFLUENCE EACH OTHER?

Social Cognitive theory favors a model of causation involving triadic reciprocal determinism. *"In this model of reciprocal causation, behaviour, cognition and other personal factors, and environmental influences all operate as interacting determinants that influence each other bidirectionally.* (Bandura, 1989, p.2) *"In the social cognitive view people are neither driven by inner forces nor automatically shaped and controlled by external stimuli. Rather, human functioning is explained in terms of a model of triadic reciprocality in which behaviour, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other."* (Bandura, 1986, p.18)

Bandura's model of Reciprocal Determinism is shown in Figure 14 to explain the interaction between the three domains in the development of the social self: Personal, Behavioural, and Environmental. *"This model of reciprocal determinism involves "personal factors in the form of cognitive, affective, and biological events, behavioural patterns, and environmental events that all operate as interacting determinants that* *influence each other bidirectionally"* (Bandura, 2001, p.266).

Through feedback and reciprocity, individual's cognitions might change over time as results of maturation and experience. Bandura points out that that behaviour, environmental influences, and internal personal factors (including beliefs, thoughts, preferences, expectations, and self-perceptions) all causes are interactive, dynamic, and reciprocal. Influencing one factor eventually has impact on the other two when under the situation where peoples' behaviours influence both their attitudes and the situation, and that people attitudes will influence their behaviours and the situations.

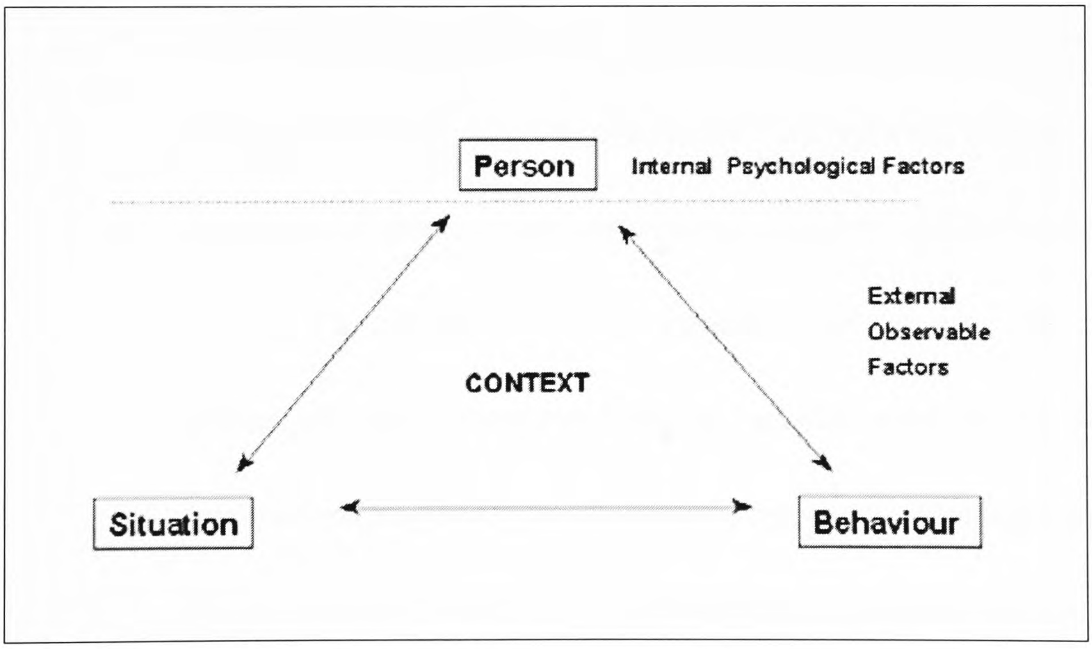


FIGURE 14: BANDURA'S MODEL OF RECIPROCAL DETERMINISM (1977, 1986)

The relationships between person, behaviour and environment (situation) are:-

- A bi-directional interaction occurs between the person and behaviour characteristics. *"The person-behaviour of reciprocal causation reflects the interaction between thought, affect and action. Expectations, beliefs, self- perceptions, goals and intentions give shape and direction to behaviour. What people think, believe, and feel, affects how they behave."* (Bandura, 1989, p.3) It is concerned with what people think and believe affects how they behave and vice-versa.

- A bi-directional interaction also occurs between the environment and personal characteristics. *"The environment and personal segment of reciprocal causation is concerned with the interactive relation between personal characteristics and environmental influences. Human expectations, beliefs, emotional bents and cognitive competencies are developed and modified by social influences that convey information and activate emotional reactions through modeling, instruction and social persuasion."* (Bandura, 1989, p.3) It is concerned with "the interactive relation between personal characteristics and environmental influences. Environment refers to social and physical environment. Social environment such as classmates, family members, friends, superiors and subordinates. Physical environment such as ambient temperature, humidity or lighting at the workplace.

- A bi-directional interaction also occurs between the behaviour and environment. *"The behaviour and environment segment of reciprocal causation in the triadic system represents the two-way influence between behaviour and the environment. In the transactions of everyday life, behaviour alters environmental conditions and is, in turn, altered by the very conditions it creates."*(Bandura, 1989, p.3) The link between "behaviour and environment" is concerned with the aspect of the potential environment that becomes the actual environment for given individuals and thus depends on how they behave.

Behaviour change usually results in attitude change and some change in the environment. The stronger the situational pressures, the less likely an individual's attitude will predict behaviour. To conclude that some external factors, such as work stress, financial constraints, company rules, organization culture and peer pressure may prevent people from behaving in conformity with his/her attitudes and situation.

Geller (1996, pp.11-12) also explains that "*the internal (unobserved) states of mind continually influence observable behaviours, while changes in observable behaviours continually affect changes in person states of attitudes*"... "*This spiraling of behaviour feeding attitude, attitude feeding behaviour, behaviour feeding attitudes and so on can lead to employees becoming totally committed to safety achievement, as reflected in their daily behaviour*". Numerous studies have shown that individual's unsafe behaviour is the most common cause of accidents at work. Change individual's unsafe behaviour by enhancing individual's attitude towards safety may possible to prevent accidents in any type of work. To assure employees' commitment to safety at work, management should understand the link between employees' safety attitudes and safety culture in the organization.

Based on the theoretical consideration in section 3.3, identified variable "Beliefs" and "Perception" are consolidated in Table 6.

TABLE 6: KEY VARIABLES IDENTIFIED FROM THE SOCIAL COGNITIVE THEORY (SCT) AND BANDURA'S MODEL OF RECIPROCAL DETERMINISM

IDENTIFIED VARIABLES	THEORY AND MODEL
BELIEFS, PERCEPTION	THE SOCIAL COGNITIVE THEORY (SCT)
BELIEFS, PERCEPTION	BANDURA'S MODEL OF RECIPROCAL DETERMINISM

4 WHAT IS SAFETY CULTURE?

In recent years, there is a much stronger argument for considering the human dimension of accident causation at organizational level, rather than the individual worker level. The interaction of individuals with the work environment, tools, equipment, material, process and other contributing factors will possibly trigger a sequence of events ending in an accident. Employees recruited from different countries will have a different culture. They may have different risk perceptions and attitudes towards safety at work because of individuals' differences arising from different tasks, family backgrounds, educational qualifications, working experiences, training, seniority of position held and social contexts. Therefore, fostering safety culture is a must! To understand safety culture, we should know what the culture is? Culture is a shared phenomenon with a complex construct which has many definitions, for example:-

- Culture is *"a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems."* (Schein, 1992, p.12)
- Culture is *"the relatively stable set of inner values and beliefs generally held by groups of people in countries or regions and the noticeable impact those values and beliefs have on the peoples' outward behaviours and environment"*. (Peterson, 2004, p.17)

- Culture is *"a combination of an organization's attitudes, behaviours, beliefs, values, ways of doing things, and other shared characteristics of a particular group of people"*. Available from: Occupational Safety and Health Administration, *Safety and Health Management Systems eTool.* http://www.osha.gov/SLTC/etools/safetyhealth/index.html [Accessed 14 September, 2004]

Each organization has its own unique culture as Kletz (1990, p.87) describes that *"companies and nations both have cultures (beliefs, values and forms of behaviour) that have an influences on safety"*. Culture in the organization will differ from different groups of people and vary from department to department. Different subculture is formed around functional groups and departments. In reality, *"People who share the same culture play the social game by the same rules. People from different cultures, however, play by different rules."* (Hofstede et al., 2002, p.169)

Organizational culture may be expressed through shared practices amongst people within the organization. In simple terms, it is the common perceptions and modes of action that characterize one organization against others. Schein (1992, p.10) provides a useful summary on organizational culture, i.e. *"...the accumulated shared learning of a given group, covering behavioural, emotional, and cognitive elements of the group members' total psychological functioning. For shared learning to occur,* *there must be a history of shared experience, which in turn implies some stability of membership in the group. Given such stability and a shared history, the human need for parsimony, consistency, and meaning will cause the various shared elements to form into patterns that eventually can be called a culture".* From the safety management perspective, the foundation of culture is just as important as the bridge metaphor for the architecture of safety (see Figure 15). Eckenfelder (2003, p.34) describes that "*the bridge metaphor shows that while all safety areas are important, culture is the foundation and should be dealt with directly.*"

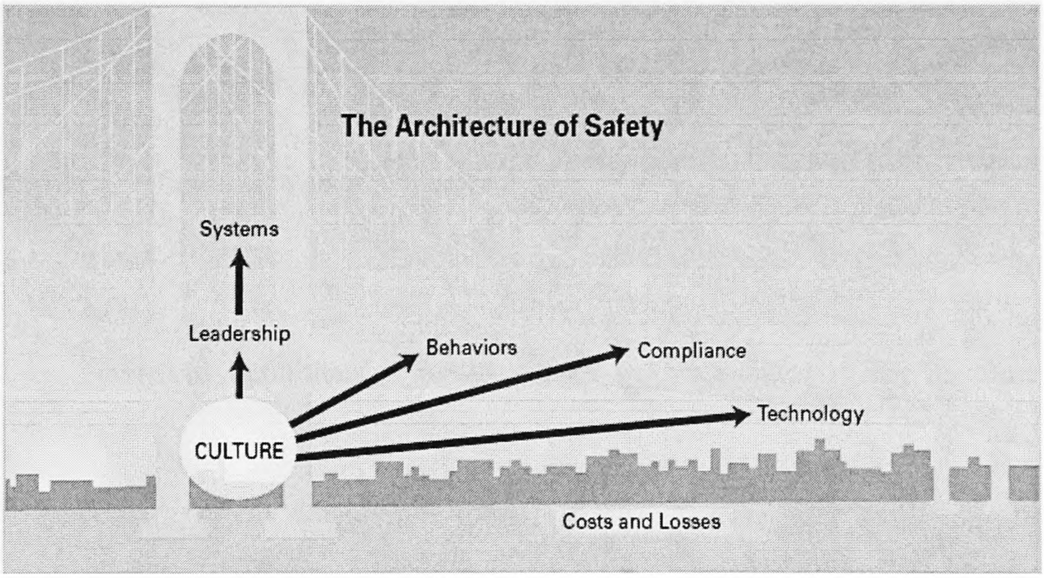


FIGURE 15: BRIDGE METAPHOR FOR THE ARCHITECTURE OF SAFETY (ECKENFELDER, 2003, P.34)

Many researchers in the field consider the concept of safety culture is however, equally applicable to major accident hazards where most of accidents were caused by human error. The term "Safety Culture" first appeared in the 1987 OECD Nuclear

Agency report on the 1986 Chernobyl disaster and drew the attention of government agencies. Kletz (1990, p.63) describes that *"the world's worst nuclear accident occurred at Chernobyl in the Ukraine in 1986 when a water-cooled reactor overheated and radioactive material was discharged to atmosphere. Although only about 30 people were killed immediately several thousand more may die during the next 30 years, a one-millionth increase in the death rate from cancer in Europe."* As a consequence of the enquiry into the Chernobyl nuclear disaster where errors and violations of the operating procedures at the plant were the major causes of the accident. A poor safety culture in that organization was identified. Since then, the term "safety culture" is increasingly being used to describe the overall safety performance, attitudes and behaviour to safety within an organization.

Numerous definitions of safety culture have abounded in the literature as follows:-

- Safety culture *"reflects the attitudes, beliefs, perceptions and values that employees* share *in relation to safety"*. (Cox and Cox 1991, p.93)
- Safety culture is *"the product of individual and group values, perceptions, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of an organisation's health and safety management"*. (HSC, 1993; p.23)

- Safety culture as *"representing the basic values, beliefs and assumptions concerning safety that are embedded in the organization"*. (Clark, 2000, p.75)
- Safety culture is "*a sub-facet of organizational culture, which is thought to affect member's attitudes and behaviour in relation to an organization's ongoing health and safety performance*". (Cooper, 2000, pp.111-136)
- Safety culture is "*a concept which includes the fundamental values, beliefs and practices of safety management system, and also the actions and behaviours for enhancing these values, beliefs and practices*". (OSHC, 2006, p.44)

Cooper (2000, pp.111-136) suggested that the "*Bandura's model of reciprocal determinism has been adapted to reflect the concept of safety culture, that contains three elements which encompass subjective internal psychological factors, observable ongoing safety-related behaviours and objective situational features*". (see Figure 16)

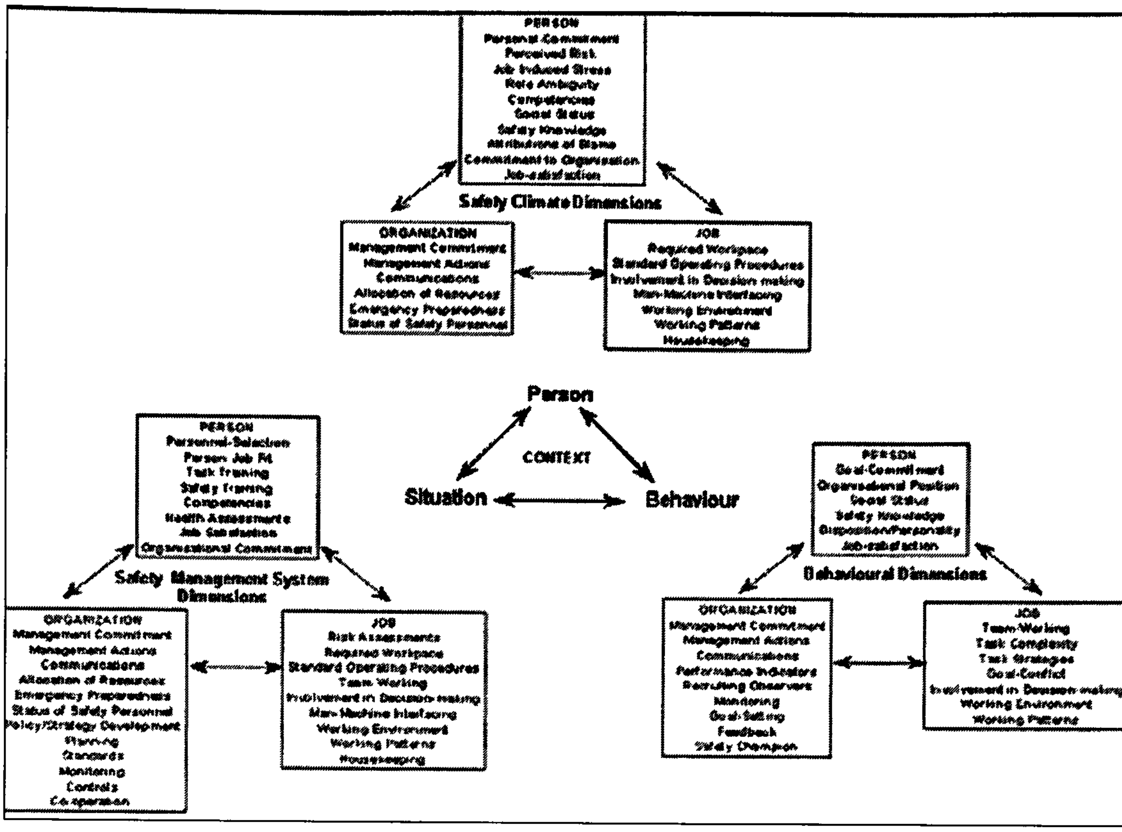


FIGURE 16: RECIPROCAL MODEL OF SAFETY CULTURE APPLIED TO EACH ELEMENT (COOPER, 2000)

Cooper further explains the psychological, behavioural and situational elements of the model can also be broken down into exactly the same reciprocal relationships, thereby allowing the multi-faceted nature of the safety culture construct to be systematically examined.

4.1 THE IMPACT OF ORGANISATIONAL CULTURE ON SAFETY:

Organizational culture on safety represents the amalgamation of individual beliefs, values, perceptions, attitudes and behavioural patterns, as well as group norms that may affect the overall safety performance in an organization. A causation diagram of Eckenfelder's Performance Map (Figure 17) clearly explained the relationships among beliefs, values, culture, attitudes, behaviour, performance and culture.

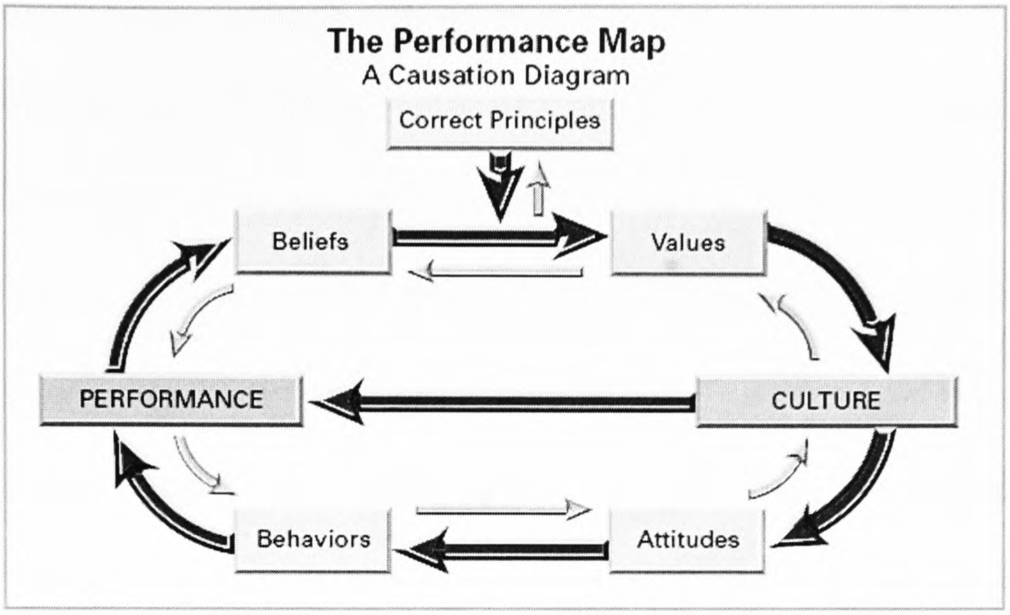


FIGURE 17: THE PERFORMANCE MAP, (ECKENFELDER, 2003, P.32)

Eckenfelder (2003, p.32) states that "*It shows that work on beliefs and values can lead to an organization culture that supports safety and health". "Any time you change what people believe and value, you change their culture and in turn their attitudes. Beliefs and values change every day; that changes culture and consequently attitudes."* Attitude is an important indicator of the organizational safety culture. Reason (1998; pp.293-306) points out that "m*any of the relevant definitions of safety culture emphasize shared attitudes, values and beliefs and stress the interactions with the organization's safety structures and control systems and appropriate behavioural norms*".

Pidgeon (1991, pp.129-140) presented three organizational properties of a good safety culture. He pointed out that *"there are three essential elements of a good safety culture:* norms and rules *for handling hazards (these are explicit or tacit corporate guidelines for defining what is and is not to be regarded as a significant risk); attitudes towards safety (individual and collective beliefs about hazards and the importance of safety, together with the motivation to act on those beliefs);* reflexivity *on safety practice (a search for new meanings in the face of uncertainty and ambiguity about risk)*". Based on the literature review, it is the safety culture of the organization that will influence the effectiveness in implementing the SMS and underlying perceptions, attitudes, and habitual practices of employees at all levels towards safety.

We believe that most accidents stem from human errors. The next big step change in safety has begun and is based on developing positive safety cultures that could influence human attitude and behaviour towards safety at work.

4.2. PARADIGM SHIFT TO CULTIVATE A POSITIVE SAFETY CULTURE!

A "Blame Culture" definitely would deteriorate the overall safety performance in the organization, because everyone is in a negative frame of mind. *"It is our nature to be more comfortable if we can find something or someone else to blame for mistakes."* (Peam et al., 1998, p.11) It is quite often that after an accident has happened, staff members at management level almost have a tendency to blame the accident on the errors of people involved. People who made errors would very likely bear the whole consequences. "*The accident at Unit 2 of the Three-Mile Island nuclear plant (TMI-2) raised awareness of human error and cognitive shortcomings of operators and shifted the attention of safety analysis from technical aspects to human errors, where blame and responsibility were assigned to the person directly involved in the unsafe act.*" (Coquelle et al., 1995, pp.193-202) In fact, blaming the person who triggers the accident does not help to prevent its recurrence, as it is difficult to find out the true causes. In the long run, it can create communication barrier and reduce the degree of safety empowerment. Employees may stop trying to share their safety concerns in the organization. It is unfair to blame the operator who misjudges, misreads or is careless without detailed investigation. Management needs to cultivate a "Positive Safety Culture" and to discourage a "Blame Culture" in the organization.

A positive safety culture serves as a solid foundation for the SMS. It is a "collective acceptance" of safety practices with wholehearted supported from all levels of individual, group, division and organization. Steve et al. (1996, p.90) states that "*At the heart of a positive health and safety culture is the idea that everyone has a role to play and a stake in making their organization safer and healthier*". To say an organization has a positive safety culture, it is essentially the recognition of consistency and efficacy of safety practices throughout the whole organization. It is a long term process and is dependent upon maintaining a high level of employee's involvement and management commitment.

Dr Hillary Bennett states that *"Creating a positive safety culture is recognized by Human Factors psychologists as an essential aspect of effective safety management in any workplace".* and *"Psychologists based at the Keil Centre in Edinburgh have produced a model - the Safety Culture Maturity Model (SCMM) to assist organizations establish their current level of safety culture and identify the actions required to improve their safety culture thus providing a structured safety culture improvement process."* Available from: Bennett H., *Create a positive safety culture. The way forward to safer workplaces*, p.1 http://www.assess.co.nz/pages/SCMMarticle.doc [Accessed 6 April 2008]

The model presented in Figure 18 is set out in a number of iterative stages included level 1- emerging, level 2 - managing, level 3 - involving, level 4 - cooperating and level 5 - continually improving. In the model, organizations progress through increasing levels of safety culture maturity in a continuous improvement process. Fleming (2000, p.4) states that *"It is proposed that organizations progress sequentially through the five levels, by building on the strengths and removing the weaknesses of the previous level. It is therefore not advisable for an organization to attempt to jump or* *skip a level."*

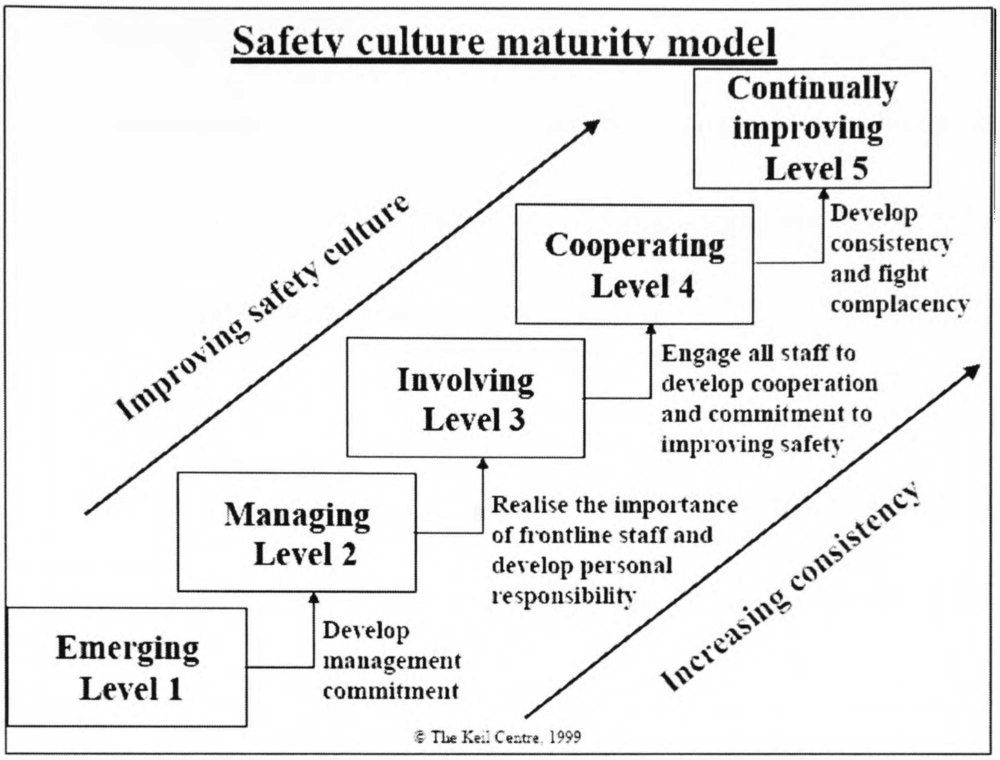


FIGURE 18: SAFETY CULTURE MATURITY MODEL
FROM THE KEIL CENTRE FOR THE HSE OFFSHORE TECHNOLOGY REPORT 2000/049, P.5

A positive safety culture could be developed on the basis of mutual trust; by sharing perceptions of the importance of safety; develop personal responsibility, cooperation and commitment to improving safety; by confidence in the efficacy of preventive control measures. Once developed, it is difficult to change! The following are the advantages of cultivating a positive safety culture in the organization:-

- ✧ It sets the tone for everything that supports safety for the accident prevention;
- ✧ It shares management commitment to safety;
- ✧ It leads to an effective conduct of work safely;

- ✧ It enhances a sense of accountability and responsibility towards safety amongst employees;
- ✧ It encourages employees to report accidents, incidents and near-misses, so as to help all concerned parties to identify underlying causes and make recommendations to prevent recurrence.

Up to this stage, the University's SMS, models of accident causation, human factors and organizational safety culture were critically examined. It was found that accident causation is inextricably linked to human factors such as attitudes and behaviours. The causes of accidents can vary as different people perform different tasks at different workplace environments. Believe that safety culture is the foundation for accident prevention. Departmental management plays a substantial role in cultivating a positive safety culture. They should improve employees' attitudes by focusing on their beliefs and values that lead to an organization culture, as such the desired behaviours will then occur. It is in fact that SMS is an important influence on the safety culture, attitudes and behaviour which in turn impacts on the effectiveness of the SMS and the overall safety performance in an organization. It is thought that an effective SMS and a positive safety culture would help to prevent accidents!

Because individuals' differences and characteristics influence the way things get done in an organization, it has been found that some DSRs are more interested in safety, but some of them are less supportive of safety. DSRs are different in personal dimensions such as sex, age, education attainment, experiences, job nature and length of service in the University. All these factors may lead to the development of different safety attitudes towards the implementation of SMS. Therefore, understanding DSRs safety attitudes and cultivating safety culture in the University are critical to achieving and maintaining excellence in safety performance. One way of evaluating such issues is through the measurement of attitudes to safety held by the DSRs. Measuring DSRs attitudes provides an indication of shared views on particular aspects of their departments, so as to identify areas for further improvement of SMS.

Based on a theoretical consideration in sections 4, 4.1 and 4.2, identified variables "Commitment", "Communication", "Management", "Attitude", "Beliefs", "Safety Culture" and "Responsibility" are consolidated in Table 7.

TABLE 7: KEY VARIABLES IDENTIFIED FROM THE RECIPROCAL MODEL OF SAFETY CULTURE - SAFETY MANAGEMENT DIMENSION, THE PERFORMANCE MAP AND SAFETY CULTURE MATURITY MODEL

IDENTIFIED VARIABLES	THEORY AND MODEL
COMMITMENT, COMMUNICATION, MANAGEMENT	THE RECIPROCAL MODEL OF SAFETY CULTURE - SAFETY MANAGEMENT DIMENSION
ATTITUDE, BELIEFS, SAFETY CULTURE	THE PERFORMANCE MAP
COMMITMENT, RESPONSIBILITY	SAFETY CULTURE MATURITY MODEL

5. KEY VARIABLES EXTRACTED FROM 11 PSYCHOLOGICAL THEORIES AND MODELS FOR CONSTRUCTION OF "DSRS SAFETY ATTITUDE MODEL"

This study has so far examined eleven (11) psychological theories and models regarding attitude, behaviour and safety culture. Based on theoretical considerations, a list of ten (10) variables were extracted from eleven (11) theories and models for construction of the "DSRs Safety Attitude Model" which is summarized in Table 8.

TABLE 8: SOURCES OF TEN (10) VARIABLES IDENTIFIED FROM ELEVEN (11) THEORIES AND MODELS

TEN (10) VARIABLES	SOURCES OF EACH VARIABLE IDENTIFIED FROM:
MANAGEMENT	✧ THE RECIPROCAL MODEL OF SAFETY CULTURE - SAFETY MANAGEMENT DIMENSION
PERCEPTION	✧ THE "SELF-PERCEPTION THEORY" ✧ THE SOCIAL COGNITIVE THEORY (SCT) ✧ BANDURA'S MODEL OF RECIPROCAL DETERMINISM ✧ THE COGNITIVE DISSONANCE THEORY ✧ THE HEALTH BELIEF MODEL
COMMITMENT	✧ SAFETY CULTURE MATURITY MODEL ✧ THE RECIPROCAL MODEL OF SAFETY CULTURE - SAFETY MANAGEMENT DIMENSION
COMMUNICATION	✧ THE RECIPROCAL MODEL OF SAFETY CULTURE - SAFETY MANAGEMENT DIMENSION

BELIEFS	✧ THE PERFORMANCE MAP ✧ A MODEL OF "SEPARATE ENTITIES VIEW" ✧ THE MODEL OF THEORY OF REASONED ACTION (TRA) ✧ THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB) ✧ THE SOCIAL COGNITIVE THEORY (SCT) ✧ BANDURA'S MODEL OF RECIPROCAL DETERMINISM
NORM	✧ THE MODEL OF THEORY OF REASONED ACTION (TRA) ✧ THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB)
RESPONSIBILITY	✧ SAFETY CULTURE MATURITY MODEL
SELF-EFFICACY	✧ THE HEALTH BELIEF MODEL
SAFETY CULTURE	✧ THE PERFORMANCE MAP
ATTITUDE	✧ THE PERFORMANCE MAP ✧ A MODEL OF "SEPARATE ENTITIES VIEW" ✧ THE MODEL OF THEORY OF REASONED ACTION (TRA) ✧ THE MODEL OF THEORY OF PLANNED BEHAVIOUR (TPB) ✧ THE "SELF-PERCEPTION THEORY"

6. RESEARCH QUESTIONS:

The aim of present study is the exploration of DSRs introspection and various cognitive factors which may most likely influence the effectiveness of the implementation of the SMS. The study attempts to answer the following research questions:-

1: *Does the hypothesized model fit the data?*

2: *To what extent does safety culture affect DSRs safety attitude on the* *implementation of SMS at departmental level?*

3: *To what extent does safety culture affect DSRs perceptions on the implementation of SMS at departmental level?*

4: *To what extent does the "Personal Beliefs" of DSRs affect their safety attitudes on the implementation of SMS at departmental level?*

7. CHAPTER SUMMARY:

The critical review of literature has helped lead the writer towards an understanding of the importance of individual differences of DSRs. A total of ten (10) variables were identified from eleven (11) theories and models in this chapter. Research questions also developed. Available information also provides a substantial theoretical framework to develop the research instrument and construction the hypothesized "DSRs Safety Attitude Model". Relationships between ten (10) identified variables in the hypothesized "DSRs Safety Attitude Model" will be discussed in Chapter Five (5).

CHAPTER FIVE

CONSTRUCTION OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL"

1. INTRODUCTION:

This chapter focuses on the construction of the hypothesized "DSRs safety Attitude Model". It is Step 2 "Model Construction" of the basic approach to performing a SEM analysis. After going through the process of literature review, a list of ten (10) variables were identified from eleven (11) psychological theories and models through the process of model specification. The model will be constructed by exploring the relationship between ten (10) identified variables that could potentially influence DSRs safety attitude towards the implementation of SMS. In this study, the "Structural equation modeling (SEM) approach would be employed as a statistical methodology to test the hypothesized "DSRs Safety Attitude Model".

2. WHAT IS THE STATISTICAL INSTRUMENT "STRUCTURAL EQUATION MODELLING" (SEM)?

What is Structural Equation Modeling (SEM)? Different interpretations of SEM are presented and considered.

- *"Structural equation modeling (SEM) is a statistical methodology that takes a confirmatory (i.e., hypothesis-testing) approach to the analysis of a structural theory bearing on some phenomenon. Typically, this theory represents "causal" processes that generate observations on multiple variables."* (Bentler, 1988, pp.317-335)

- ✧ *"The SEM model is an a priori hypothesis about a pattern of linear relationships among a set of observed and unobserved variables. The objective in using SEM is to determine whether the a priori model is valid, rather than to 'find' a suitable model."* (Gefen et al., 2000, pp.1-78)

In its broadest sense, SEM uses various hypothesized models to depict relationships among variables, so as to understand how sets of variables define constructs and how these constructs are related to each other. *"The researcher first specifies a model based on theory, then determines how to measure constructs, collects data, and then inputs the data into the SEM software package. The package fits the data to the specified model and produces the results, which include overall model fit statistics and parameter estimates."* Available from: *"Structural Equation Modeling using AMOS: SEM Basics"* http://www.utexas.edu/its/rc/tutorials/stat/amos/ [Accessed 11 May 2007]

2.1 SEM NOMENCLATURE IN THIS STUDY:

- ✧ *"SEM users represent relationships among observed and unobserved variables using path diagrams. Ovals or circles represent latent variables, while rectangles or squares represent measured variables. Residuals are always unobserved, so they are represented by ovals or circles."* Available from: *"Structural Equation Modeling using AMOS: SEM Basics"* http://www.utexas.edu/its/rc/tutorials/stat/amos/ [Accessed 11 May 2007]

- ✧ *"Structural equation models are schematically portrayed using particular configurations of four geometric symbols — a circle (or ellipse), a square (or rectangle), a single-headed arrow, and a double-headed arrow. By* *convention, circles (or ellipses) represent unobserved latent factors, squares (or rectangles) represent observed variables, single-headed arrows (→) represent the impact of one variable on another, and double-headed arrows (↔) represent covariances or correlations between pairs of variables."* (Byrne, 2001, p.8)

- *"Manifest or observed variables are directly measured by researchers, while latent or unobserved variables are not directly measured but are inferred by the relationships or correlations among measured variables in the analysis."* Available from: *Structural Equation Modeling using AMOS: SEM Basics.* http://www.utexas.edu/its/rc/tutorials/stat/amos/ [Accessed 11 May 2007]

- *"The researcher imposes the structure of the hypothesized model on the sample data, and that tests how well the observed data fit this restricted structure. Because it is highly unlikely that a perfect fit will exist between the observed data and the hypothesized model, these will necessarily be a differential between the two; this differential is termed the residual."* (Byrne, 2001, p.7)

After going through the basic concept of an SEM approach in this study, what comes next will be focused on construction of the hypothesized "DSRs Safety Attitude Model".

3. CONSTRUCTION OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE" MODEL:

Model construction is focused on the rationale of the schematic construction of the hypothesized "DSRs Safety Attitude Model". Steps in construction of the hypothesized model listed in Table 9 will be discussed in details.

Table 9: STEPS IN CONSTRUCTION OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL"

SECTION	STEPS IN CONSTRUCTION OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL"
3.1	MODEL SPECIFICATION
3.2	THE RELATIONSHIP BETWEEN TWO LATENT VARIABLES "SAFETY CULTURE" AND "DSR SAFETY ATTITUDE"
3.3	THE RELATIONSHIP BETWEEN IDENTIFIED VARIABLES (LATENT & OBSERVED) IN THE HYPOTHESIZED "DSRS SAFETY ATTITUDES MODEL":
3.3.1	THE RELATIONSHIP BETWEEN A LATENT VARIABLE "SAFETY CULTURE" AND FIVE (5) OBSERVED VARIABLES "MANAGEMENT", "PERCEPTION", "COMMITMENT", "COMMUNICATION" AND "NORM"
3.3.2	THE RELATIONSHIP BETWEEN A LATENT VARIABLE "ATTITUDE" AND THREE (3) OBSERVED VARIABLES "RESPONSIBILITY", "SELF-EFFICACY" AND "BELIEFS"
3.4	IDENTIFIED VARIABLES (LATENT & OBSERVED) CONVERTED TO FACTOR STRUCTURE OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDES MODEL"
3.4.1	SAFETY CULTURE → SAFETY MANAGEMENT [SM]
3.4.2	SAFETY CULTURE → DSRS PERCEPTIONS OF SAFETY TRAINING [ST]
3.4.3	SAFETY CULTURE → PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC]
3.4.4	SAFETY CULTURE → SAFETY COMMUNICATION [SC]
3.4.5	SAFETY CULTURE → DSRS PERCEPTIONS OF GROUP SAFETY NORMS [SN]
3.4.6	DSR SAFETY ATTITUDE → DSRS PERCEIVED SAFETY RESPONSIBILITY [SR]
3.4.7	DSR SAFETY ATTITUDE → DSRS PERCEIVED SELF-EFFICACY IN MANAGING SAFETY [PE]
3.4.8	DSR SAFETY ATTITUDE → DSRS PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB]
3.5	THE SCHEMA OF "DSRS SAFETY ATTITUDE MODEL"
3.6	THE STRUCTURAL "DSRS SAFETY ATTITUDE MODEL"

3.1 MODEL SPECIFICATION:

"Model specification involves using all of the available relevant theory, research, and information and developing a theoretical model. Thus, prior to any data collection or analysis, the researcher specifies a specific model that should be confirmed with

variance-covariance data. In other words, available information is used to decide which variables to include in the theoretical model (which implicitly also involves which variables not to include in the model) and how these variables are related. Model specification involves determining every relationship and parameter in the model that is of interest to the researcher." (Schumacker et al., 2004, p.62)

Model specification is based on the review of literature; available information is used to decide which variables to be included for construction of the hypothesized "DSRs Safety Attitude Model" and how these variables are related. From the review of literature in the previous chapter, different psychological theories and models from different academics could lead the writer towards an understanding of the importance of individual differences of DSRs in the University.

Through the process of model specification, a list of ten (10) identified variables considered to have substantial influences upon DSR safety attitude is consolidated for construction of the hypothesized "DSRs Safety Attitude Model". (See Table 10)

TABLE 10: THE TEN (10) IDENTIFIED VARIABLES FOR CONSTRUCTION OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL"

TEN (10) IDENTIFIED VARIABLES
MANAGEMENT
PERCEPTION
COMMITMENT
COMMUNICATION
BELIEFS
NORM
RESPONSIBILITY
SELF-EFFICACY
SAFETY CULTURE
ATTITUDE

3.2. THE RELATIONSHIP BETWEEN TWO LATENT VARIABLES "SAFETY CULTURE" AND "DSRS SAFETY ATTITUDE":

The literature review sheds light on reasons DSRs hold different safety attitudes towards the implementation of SMS in the University. DSRs may have different intensity of attitudes to safety, because of their perceptions of safety culture. There is some degree of consensus that organizational factors such as safety culture influence an individual's safety attitude, which in turn influences individual's intention to perform safe behaviour.

The hypothesized "DSRs Safety Attitude Model" in this study, "Safety Culture" and "Attitude" are referred as latent variables. From the literature review, "Attitude" is seen as indicative of the organization's "Safety Culture". The linkage of two (2) latent variables "Safety Culture" → "DSRs Safety Attitude" is supported from the following sources:-

- *"A good safety culture is reflected in the positive safety attitudes and perceptions of the workforce."* (Pidgeon, 1991, pp.129-140)

- *"Safety culture reflects the attitudes, beliefs, perceptions and values that employees share in relation to safety".* (Cox and Cox, 1991, p.93)

- *"Safety culture relates to the attitudes, beliefs, values and norms which underpin these practices."* (Hale et al., 1998, p.68)

- *"Safety culture is a sub-facet of organizational culture, which is thought to affect members' attitudes and behaviour in relation to an organization's ongoing health and safety performance".* (Cooper, 2000, pp.111-136)

✧ *"Attitudes are influenced by the prevailing health and safety culture within the organization, the commitment of the management, the experience of the individual and the influence of the peer group".* (Hughes, 2003, p.71)

It is observed that organizational culture can have an influence on safety performance and safety culture is a subset of an overall organizational culture. A high level of safety culture will produce a positive impact upon the DSRs safety attitude towards the implementation of SMS at departmental level. It is assumed that the latent variable "DSR Safety Attitude" is directly influence by another latent variable "Safety Culture" in the hypothesized "DSRs Safety Attitude Model". For easy reference, a pictorial representation of the relationship between two latent variables "Safety Culture" and "DSR safety Attitude" is depicted in Figure 19. By convention, symbols and notations in the diagram included an ellipse to represent a latent variable and single-headed arrow (→) representing the impact of one variable on another.

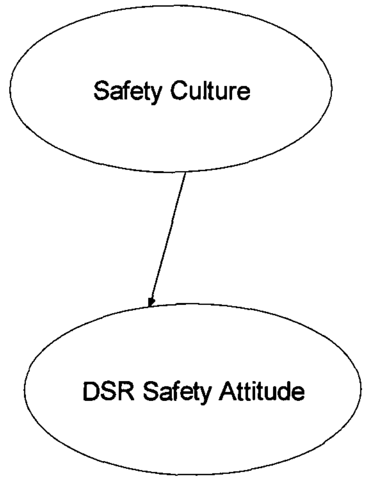


FIGURE 19: THE RELATIONSHIP BETWEEN TWO LATENT VARIABLES "SAFETY CULTURE" AND "DSR SAFETY ATTITUDE"

The next step is to explain relationships of latent and observed variables in the hypothesized "DSRs Safety Attitude Model".

3.3 THE RELATIONSHIP BETWEEN IDENTIFIED VARIABLES (LATENT & OBSERVED) IN THE HYPOTHESIZED "DSRS SAFETY ATTITUDES MODEL":

Individual differences of DSRs arising from personal beliefs, perceptions about risk, perceived self-efficacy in managing safety and social contexts may lead to the development of different safety attitudes towards the implementation of SMS.

For construction of the hypothesized "DSRs Safety Attitude Model", the two latent variables "Safety Culture" and "Attitude" are to be inferred through numbers of observed variables along their paths. Schumacker et al. (2004, pp.11-12) states that "*Latent variable is an unobserved variable that is not directly measured, but is computed using multiple observed variables*" and "*Observed variable is a raw score obtained from a test or measurement instrument on a trait of interest*".

In this study, "Safety Culture" and "Attitude" are referred as latent variables; "Management", "Perception", "Commitment", "Communication", "Beliefs", "Norm", "Responsibility" and "Self-efficacy" are referred as observed variables. For easy reference, a fresh list of eight (8) observed variables and two (2) latent variables with the aim of constructing a hypothesized model is summarized in Table 11.

TABLE 11: A LIST OF EIGHT (8) OBSERVED VARIABLES AND TWO (2) LATENT VARIABLES

LATENT VARIABLES	SAFETY CULTURE, ATTITUDE
OBSERVED VARIABLES	MANAGEMENT, PERCEPTION, COMMITMENT, COMMUNICATION, BELIEFS, NORM, RESPONSIBILITY, SELF-EFFICACY

The relationship between latent variables and observed variables will be discussed in the following sections.

3.3.1 THE RELATIONSHIP BETWEEN A LATENT VARIABLE "SAFETY CULTURE" AND FIVE (5) OBSERVED VARIABLES "MANAGEMENT", "PERCEPTION", "COMMITMENT", "COMMUNICATION" AND "NORM":

From the literature review, "Safety Culture" is a latent variable represented by the five (5) observed variables included "Management", "Perception", "Commitment", "Communication" and "Norm" based on the following rationales:-

- *"Safety culture is defined as the shared values, beliefs, assumptions, and norms which may govern organizational decision making, as well as individual and group attitudes about safety."* (Ciavarelli & Figlock, 1996, pp.1033-1035)

- *"The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by* *confidence in the efficacy of preventive measures."* (HSE, 1997)

- *"Many of the relevant definitions of safety culture emphasize shared attitudes, values and beliefs and stress the interactions with the organization's safety structures and control systems and appropriate behavioural norms*". (Reason, 1998; pp.293-306)

- *Safety management, management commitment, communications, and safety training are key elements in the Safety Management Dimension of the Reciprocal Model of Safety Culture.* (Cooper, 2000, pp.111-136)

Five (5) observed variables included "Management", "Perception", "Commitment", "Communication" and "Norm" are directly influence by "Safety Culture". Linkages between a latent variable "Safety Culture" and five (5) observed variables are summarized in Table 12:-

TABLE 12: LINKAGES BETWEEN A LATENT VARIABLE "SAFETY CULTURE" AND FIVE OBSERVED VARIABLES

LATENT VARIABLE	OBSERVED VARIABLES
SAFETY CULTURE	➢ MANAGEMENT ➢ PERCEPTION ➢ COMMITMENT ➢ COMMUNICATION ➢ NORM

For easy reference, pictorial representation of linkages between a latent variable "Safety Culture" and five observed variables is depicted in Figure 20. By convention, symbols and notations in the diagram included ellipse represent latent variable, rectangle represent observed variable and single-headed arrow (→) represent the impact of one variable on another.

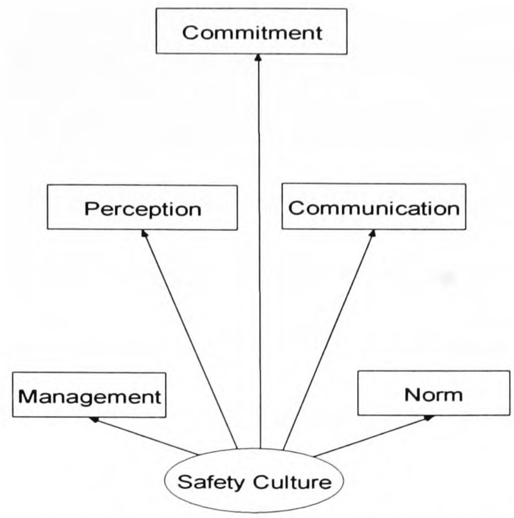


FIGURE 20: LINKAGES BETWEEN A LATENT VARIABLE "SAFETY CULTURE" AND FIVE OBSERVED VARIABLES "MANAGEMENT", "PERCEPTION", "COMMITMENT", "COMMUNICATION" AND "NORM"

3.3.2 THE RELATIONSHIP BETWEEN A LATENT VARIABLE "ATTITUDE" AND THREE (3) OBSERVED VARIABLES "RESPONSIBILITY", "SELF-EFFICACY" AND "BELIEFS":

From the literature review, "Attitude" is a latent variable represented by three (3) observed variables included "Responsibility", "Self-efficacy" and "Beliefs" based on the following rationales:-

- *Any time you change what people believe and value, you change their culture and in turn their attitudes.* (Eckenfelder, 2003, p.32)

- *"Attitudes are formed as a result of continuing experience of situations during a lifetime."* (Stranks, 1994, p.36)*; and "The most effective way of creating a strong sense of efficacy is through mastery experiences".* (Bandura, 1994, pp.71-81) *"The health belief model stipulates that a person's health-related behaviour depends on the person's perception of four critical areas: the severity of a potential illness, the person's susceptibility to*

that illness, the benefits of taking a preventive action, and the barriers to taking that action. The model also incorporates cues to action (e.g., leaving a written reminder to oneself to walk) as important elements in eliciting or maintaining patterns of behaviour. The construct of self-efficacy, or a person's confidence in his or her ability to successfully perform an action, has been added to the model, perhaps allowing it to better account for habitual behaviours, such as a physically active lifestyle."
Available from: Grizzell J., *Health Belief Model,* http://www.csupomona.edu/~jvgrizzell/best_practices/bctheory.html [Accessed 15 September 2007]

- *Workers' safety attitudes and perceptions of risk at the workplace will be influenced by their personal beliefs about risk and safety; personal involvement; individual responsibility.* (Clarke et al., 2004, p.53)

Three (3) observed variables included "Responsibility", "Beliefs" and "Self-efficacy" are directly influenced by "Attitude". Linkages between a latent variable "Attitude" and three (3) observed variables are summarized in Table 13:-

TABLE 13: LINKAGES BETWEEN A LATENT VARIABLE "ATTITUDE" AND THREE OBSERVED VARIABLES

LATENT VARIABLE	OBSERVED VARIABLES
ATTITUDE	➢ RESPONSIBILITY ➢ BELIEFS ➢ SELF-EFFICACY

For easy reference, pictorial representation of linkages between a latent variable "Attitude" and three (3) observed variables is depicted in Figure 21. By convention, symbols and notations in the diagram included ellipse represent latent variable, rectangle represent observed variable and single-headed arrow (→) represent the impact of one variable on another.

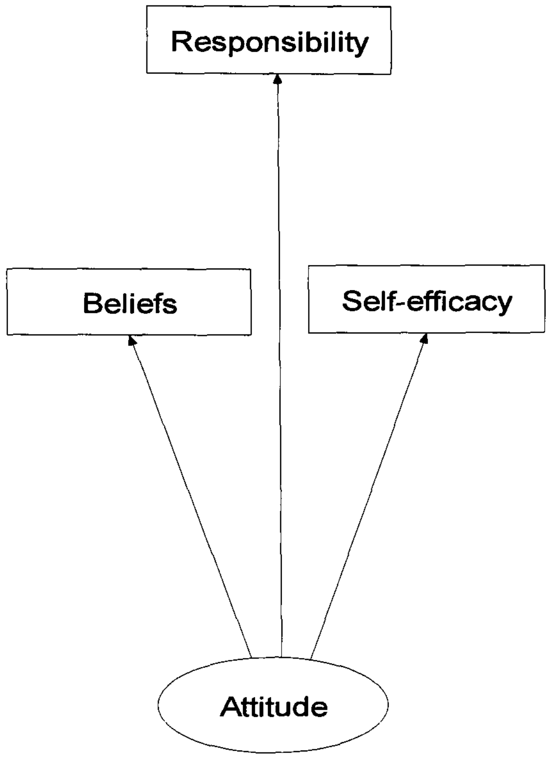


FIGURE 21: LINKAGES BETWEEN A LATENT VARIABLE "ATTITUDE" AND THREE OBSERVED VARIABLES "RESPONSIBILITY", "BELIEFS" AND "SELF-EFFICACY"

After exploring the possible relationship between the ten (10) identified variables, the summary of eight (8) observed variables grouped under two (2) latent variables is listed in Table 14.

TABLE 14: THE EIGHT (8) OBSERVED VARIABLES GROUPED UNDER TWO (2) LATENT VARIABLES

TWO (2) LATENT VARIABLES	EIGHT (8) OBSERVED VARIABLES
SAFETY CULTURE	➢ MANAGEMENT ➢ PERCEPTION ➢ COMMITMENT ➢ COMMUNICATION ➢ NORM
ATTITUDE	➢ RESPONSIBILITY ➢ BELIEFS ➢ SELF-EFFICACY

What comes next is to convert latent and observed variables to factor structure for construction of the hypothesized "DSRs Safety Attitude Model".

3.4 IDENTIFIED VARIABLES (LATENT & OBSERVED) CONVERTED TO FACTOR STRUCTURE OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDES MODEL":

One of the most important issues in SEM is the distinction between observed variables and latent variables. *"Observed variable are the variables that are actually measured, such as manifested performance on a particular test or the measures to specific items or questions on an inventory or questionnaire. In the contrast, latent variables are the hypothetically existing constructs of interest in a study."* (Raykov et al., 2000, pp.8-9)

A hypothetical construct is described as *"A conjectured entity, process, or event that is not observed directly but is assumed to explain an observable phenomenon. It is not merely a summary of the relationships between observable variables but contains surplus meaning over and above such relationships".* Available from: A Dictionary of Psychology, *Hypothetical Construct.* http://www.encyclopedia.com/doc/1O87-hypotheticalconstruct.html [Accessed 22 April 2008]

Jackson et al. (2005, pp.3-13) opine that *"With SEM, one can model not only the relationship between measured variables, but also the relationship between unmeasured, hypothetical constructs."* To construct the hypothesized "DSRs Safety Attitude Model" for SEM analysis, all identified variables are converted to factor structure. (See Table 15)

TABLE 15: SUMMARIZES OF IDENTIFIED VARIABLES CONVERTED TO FACTOR STRUCTURE

TWO (2) LATENT VARIABLES (Hypothetical Constructs)	EIGHT (8) OBSERVED VARIABLES
SAFETY CULTURE	*MANAGEMENT →* SAFETY MANAGEMENT [SM] *PERCEPTION →* DSRs PERCEPTIONS OF SAFETY TRAINING [ST] *COMMITMENT →* PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC] *COMMUNICATION →* SAFETY COMMUNICATION [SC] *NORM →* DSRs PERCEPTIONS OF GROUP SAFETY NORMS [SN]
ATTITUDE → DSR SAFETY ATTITUDE	*RESPONSIBILITY →* DSRs PERCEIVED SAFETY RESPONSIBILITY [SR] *SELF-EFFICACY →* DSRs PERCEIVED SELF-EFFICACY IN MANAGING SAFETY [PE] *BELIEFS →* DSRs PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB]

At this stage, the factor structure of two latent variables and eight (8) observed variables would be discussed in the following sections from 3.4.1to 3.4.8.

3.4.1 SAFETY CULTURE → SAFETY MANAGEMENT [SM]:

An effective SMS can helps to strengthen safety culture and to reduce the incidence of illness and injury in the organization. Taylor et al. (2004, p.511) states that "*The management system creates a safety culture that reinforces safe and healthy work practices while training helps provide the knowledge, skills and practice necessary to sustain this culture*". The purpose of developing, maintaining and implementing SMS is not only to fulfill the legal requirements and morally responsibility, but to instill a consistent and positive safety culture in the organization.

Hale et al. (1998, p.68) state that "*Safety management relates to the actual practices, roles, and functions associated with remaining safe*". In the University, an effective SMS requires active and continuing participation by management and stakeholders to achieve a good safety performance. The University's management commitment is clearly expounded in the Statement of Health and Safety Policy in the University's Safety & Environmental Protection Manual issued in 1997. "*It is the policy of the University to provide for the protection of its personnel, attending students, visitors, facilities and surrounding environment through the development and implementation of a comprehensive safety and environmental protection programme.*" Available from: The Hong Kong University of Science & Technology, *Safety & Environmental Protection Manual* (1997 version) Chapter 1: Policies and Management. http://www.ab.ust.hk/hseo/sm06/ch1.htm [Accessed 28 February 2008]

In ensuring compliance with legal requirements, the University's policy, in-house safety rules and Codes of Practices, as well as to perform morally obligations to stakeholders, all HODs have management responsibility for the overall strategic planning including the provision sufficient resources to DSRs for the implementation of SMS.

Cultivating safety culture should be in-line with the development of SMS and other business operations in the University. DSRs have to foster safety culture and monitoring the performance of safety at work. Through the dedication and support from all stakeholders in past years, the effect of safety management initiatives throughout the University has been become more visible. In this study, DSRs perceptions of safety management in the University will be examined through the questionnaire survey.

3.4.2 SAFETY CULTURE → DSR'S PERCEPTIONS OF SAFETY TRAINING [ST]:

What is the major difference between safe employees and employees who are classified as "accident-prone"? The major difference is that safe employees always follow safety procedures and work safely with a high degree of safety consciousness. This is the matter of individuals' safety perception. In psychology and the cognitive sciences, "*perception is the way in which people interpret the environment or the way in which a person believes or understands a situation*". (Hughes, 2003, p.71)

Stranks (1994, p.55) points out that "*How people perceive risk is associated with a number of behavioural factors – attitude, personality, memory, their ability to process information, the level of training received, the level of arousal and individual skills available*". The consequences of failing to understand safety training can be severe because they can go directly into potentially hazardous situations. As Kletz (1990, p.165) describes "*Someone does not know what to do or, worse still, thinks he knows but does not*". Therefore, safety training in the University has its role in providing an important foundation upon which to develop basic competencies that will help staff members and students understand hazards of their job and perform it more safely.

Safety training is not a panacea in managing safety at work. It should be regarded as a long term management strategy which can help to develop people's competence in managing safety at the workplace. Safety training can also help to promote positive safety culture among the workforce by changing individual's beliefs and attitudes towards safety through the systematic acquisition of knowledge, skills that result in improved overall performance in the organization. Wells Jr. (2003, p.26) points out that "*There are four main areas of a safety program that, when implemented correctly, can help create and maintain a safety culture. Heavy focus has to be placed on training, participation, accident prevention, and accountability when evaluating any existing safety program.*" Providing adequate safety training to employees is a legal responsibility of employers, under the OSHO of Hong Kong Special Administrative Region. It is important that people in the workplace should be properly trained. In this study, DSRs perceptions of safety training in the University will be examined through the questionnaire survey.

3.4.3 SAFETY CULTURE → PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC]:

Management commitment to safety refers to the degree to which an organization's senior management prioritizes safety in decision-making and allocates adequate resources to safety. Cooper (1995, p.2) defines 'commitment to safety' *as "Individual's identification with and involvement in safety activities, characterized by a strong acceptance of and belief in the organizations safety goals and a willingness to exert effort to improve safety in the workplace".*

Safety is an ever-present priority in the organization due to the large potential for injuries, illness and property damages. Cultivating safety culture and developing proper attitudes toward safety at work are a commitment of senior management in the organization. Mearns et al. (2003, pp.641-680) points out that "S*afety management practices as an indicator of the safety culture of upper management.*" From a practical point of view, management can demonstrate their commitment to safety by prioritizing safety in decision-making, providing visible management commitment (for example, participating in workplace safety walks on ad hoc basis) and the allocation of reasonable resources (i.e. manpower, money and time) to safety.

Kam (1995, p.35) *commented that "No safety program or system will be successful without unfailing support from the management"; and "Only with the devoted and sincere support, the morale of the employees will be boosted and the safety system and safety programme will be on a smooth path to success."*

Cultivating a good safety culture requires the strongest possible management commitment from senior management and this commitment will, in turn, produce higher levels of motivation throughout the organization. Hughes (2003, p.66) points out that "*The most important factor affecting the culture is the commitment to health and safety from the top of an organization.*" Indeed, the strongest commitment to safety from senior management not only has positive effects on safety culture, but also reaps tangible rewards in terms of high efficiency, high profitability, high reliability and good company goodwill.

The commitment exhibited by senior management can impact a variety of areas including DSRs' perceptions that safety is valued in the University. ReVelle et al. (1981, p.34) pointed out that "*Management's influence on the worker is too important to be ignored, neglected, or treated casually. Even without proper care and feeding, management's attitudes will be transmitted to the employees, for good or for ill*". Where DSRs perceive managerial attitudes toward safety to be less than adequate, they might become less committed to the workplace safety. Furthermore, overall safety performance can be improved by being committed across all levels of the organization to the goal of eliminating the causes of accidents. "*A positive health and safety culture needs the involvement of the whole workforce just as a successful quality system does. There must be a joint commitment in terms of attitudes and values. The workforce must believe that the safety measures put in place will be effective and followed even when financial and performance targets may be affected.*" (Hughes, 2003 p.64) In this study, DSRs perceptions of management commitment to safety in the University will be examined through the questionnaire survey.

3.4.4 SAFETY CULTURE → SAFETY COMMUNICATION [SC]:

Employees must work safely to protect themselves and others. Effective communication could help to foster safety culture amongst employees at all levels. "*Organizations with good safety cultures can be characterized by a good safety communication system that flows from top to bottom, bi-directionally through both formal and informal communication channels throughout an organization.*" (Cooper, 1995, p.4)

In reality, an accident in one department has lessons for other, but very often the right people do not get the right message effectively. If hazards, risks and causation of accident are not communicated at and through all levels of the organization, there will be little understanding of the risks control to prevent its recurrence. To remove the barrier, management in the organization should cultivate a positive safety culture and enhancing effective safety communication amongst stakeholders.

"A positive safety culture is characterized by 'communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures". (HSC, 1993) In the University, a fundamental element of a positive safety culture is characterized by communications founded on mutual trust, by shared perceptions of the importance of safety between departmental management, DSRs, staff members, students and contractors. Under an open discussion and constructive communication atmosphere, people would freely discuss safety related matters demonstrating actively caring, so as to reduce interpersonal conflicts. In this study, DSRs perceptions of safety communication in the University will be examined through the questionnaire survey.

3.4.5 SAFETY CULTURE → DSR'S PERCEPTIONS OF GROUP SAFETY NORMS [SN]:

Perception is the way people interpret things or the way in which a person believes or understands a situation. Cooper (2003, p.39) states that *"Perception is a key component of human behaviour. It is the mechanism with which a person evaluates inputs from the external environment, which, in turn, determines his/her behavioural response. In conjunction with personality or disposition, attitudes and previous experiences, perceptions comprise a person's unique appraisal of the environment. These perceptions are critical antecedents that precede behaviour as they form a vital part of the human survival instinct."* Many accidents have occurred because people were not aware the existence of risks.

In many situations, group safety norms developed by the workgroup will greatly influence the individual's perception and value on safety. "*Group characteristics, such as the reference group (e.g., safety personnel, managers, employees) to which the person belongs, will affect his/her perceptions of risk.*" (Harding et al., 1984, pp.131-141) The model of TPB clearly explains that the more positive attitudes, subjective norms and PBC; the stronger the intention to perform the behaviour. There are many common examples of this, including the use of personal protective equipment in construction sites (such as wearing of full-body safety-harness while working at height). "*The goal of safety culture is to develop a norm in which employees are aware of the risks in their workplace and are continually on the lookout for hazards.*" (Ostrom et al., 1993, pp.163-172) It is important to understand that perceptions can lead to increases in safety awareness or ignoring safety instructions or taking short cuts at work. Management should attempt to encourage group norms that positively affect the safety culture in the entire organization.

Pidgeon (1998, pp.202-216) found that "*Norms by which a risk is judged are continuously negotiated and re-negotiated through the working practice of the team. These negotiations may lead to risk acceptance if improvements in safety are not prioritized*". Hence, a strong safety culture and positive group safety norms should lead to more positive reactions to various safety issues, including safety practices. A SMS is generally developed to support other safety management initiatives. Therefore, group safety norms should also influence the effectiveness of SMS implementation. In a work situation, if employees do not believe that management or colleagues are concerned with safety, then they are less likely to consider safety as important. In this study, DSRs perceptions of group safety norms in the University will be examined through the questionnaire survey.

Up to this end, the relationship between a latent variable (hypothetical construct) "Safety Culture" and five (5) observed variables included "Safety Management [SM]", "DSRs Perceptions of Safety Training [ST]", "Perceived Management Commitment to Safety [MC]", "Safety Communication [SC]" and "DSRs Perceptions of Group Safety Norms [SN]" had been discussed in detail.

The relationship between a latent variable (hypothetical construct) "DSR Safety Attitude" and (3) observed variables included "DSRs Perceived Safety Responsibility [SR]", "DSRs Perceived Self-efficacy in Managing Safety [PE]" and "DSRs Personal Beliefs in Accident Causation [PB]" will be discussed in the following sections.

3.4.6 DSR SAFETY ATTITUDE → DSRS PERCEIVED SAFETY RESPONSIBILITY [SR]:

DSRs are responsible for ensuring that all operations are performed with the utmost regard for the safety and health of all personnel involved. The effectiveness of SMS is very much depends on individual's attitude of DSR towards safety and how they valued their safety responsibility. Clarke et al. (2004, p.53) states that "*Workers' safety attitudes and perceptions of risk at the workplace will be influenced by their personal beliefs about risk and safety; personal involvement; individual responsibility*". Greater acceptance of individual responsibility for safety will motivate the more positive attitudes towards the implementation of SMS. Cheyne et al. (1998, pp.255-271) indicates that "*Individual responsibility mediates the relationship between personal involvement and safety activities; physical work environment has a direct effect on safety activities, while the relationship with workplace hazards is also mediated by individual responsibility*".

Managing safety is not an easy task. If HOD wants safety to be an integral part of the department's shared values, then, DSRs are the group of people to make it happen. The strength of DSRs' attitudes and added responsibility to safety played major roles at departmental level. Everyone in the workplace may possibly be influence by DSRs attitude and responsibility towards safety. If DSRs are responsible persons, they have consideration for every safety aspect in the workplace. As committed by the management that the University will dedicate all reasonable resources and effort possible to protect its employees, students, facilities, and the environment. HODs have to avoid undercutting DSRs authorities and resources to carry out safety duties. The support from management and staff at all levels is reflected from group safety norms; management commitment and communication do impose a reciprocated effect upon the safety responsibility of the DSRs. In this study, DSRS perceived behavioural control regarding safety responsibility will be examined through the questionnaire survey.

3.4.7 DSR SAFETY ATTITUDE → DSR'S PERCEIVED SELF-EFFICACY IN MANAGING SAFETY [PE]:

In terms of self-efficacy, Geller (2003, p.6) states that *"Self-efficacy refers to a person's belief that he or she can perform a certain procedure or technique. It reflects self-confidence and a 'can do' attitude."*

What is perceived self-efficacy? Bandura (1994, pp.71-81) defines "Perceived self-efficacy" *as "People's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives".* Bandura (2001, pp.1-26) added that *"Perceived self-efficacy is the foundation of human agency and plays* *an important role in the causal structure of social cognitive theory, because efficacy beliefs affect adaptation and change".* This has been examined in detail in the Social Cognitive Theory (self-efficacy) and Theory of Planned Behaviour.

DSRs self-efficacy could possibly affect their attitude toward the implementation of SMS. The success of an effective SMS in the University very much depends on DSRs personal beliefs regarding self-efficacy in managing safety at their workplaces.

Most laboratories in the University are chasing new technologies that are replacing traditional methods for research projects from time to time. The rapid pace of social and technological change requires DSRs to acquire new competencies and to obtain the most update information and technology in dealing health and safety issues at their workplaces. Ones sense of self-efficacy is determined by an array of personal, social, and environmental factors and it reflects ones confidence in the ability to perform specified tasks at designated levels. In this study, DSRS personal beliefs regarding self-efficacy in managing safety will be examined through the questionnaire survey.

3.4.8 DSR SAFETY ATTITUDE → DSR'S PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB]:

Accident causation is complex and generally caused by someone's failure to perform or not to perform something in a certain way. The factors affecting the way people behave safely in a hazardous situation are largely associated with personal beliefs about the causes of accidents. In trying to understand the basis of personal beliefs about the causes of accidents, people must begin by looking at their own beliefs and attitudes. Cooper (1995, p.3) points out that *"Beliefs about the causes of accidents are an important* *element of an effective safety culture because they guide peoples thinking and actions when accidents occur or when trying to solve safety problems".* In general, people's attitudes are accumulated over their lifetimes and are formed by direct personal experiences, as well as influenced by safety culture in the organization. People's attitudes tend to be very stable and more resistant to change once developed. As Robbins (1996, p.180) describes that "*Attitudes are established in the early years of an individual's development by teachers, parents and peer group members; in other words, attitudes are modeled after those of the persons whom people admire, respect or even fear*".

Cooper (1997a, pp.185-202) points out that *"Specific attitudinal biasing factors that affect risk perception in safety include people's personal commitment to safety, their beliefs about the causes of accidents and how stressful they find their jobs".* DSRs personal beliefs in accident causation resulted from their previous experiences. The positive or negative experiences towards a specific object or person have a serious influence on how a person will feel about that object. Gordon (1991, p.54) points out that "*The strength of an attitude depends mainly on the type of experience the individual who holds that attitude has had with the person, object or situation that he/she holds an attitude about: the more direct the experience, the stronger the attitude".* In this study, DSRs personal beliefs in accident causation will be examined through the questionnaire survey.

At this stage, the factor structure of two (2) latent variables (hypothetical constructs) and eight (8) observed variables was discussed in detail. The next stage goes to the formation of "DSRs Safety Attitude Model" schema.

3.5 <u>THE SCHEMA OF "DSRS SAFETY ATTITUDE MODEL":</u>

For the construction of "DSRs Safety Attitude Model", the two (2) latent variables (hypothetical constructs) are "Safety Culture" and "DSR Safety Attitude". At this stage, the model schema is built on two (2) latent variables (hypothetical constructs) in which "DSR Safety Attitude" (the target variable) is directly influence by "Safety Culture" and the eight (8) observed variables are being grouped under these two (2) latent variables (hypothetical constructs). Followings are details of grouping of variables:-

- ✧ "Safety Culture" directly influences on "Safety Management [SM]", "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety Norms" [SN] in a positive way. It is therefore, the five (5) observed variables [SM], [ST], [MC], [SC] and [SN] that are grouped under a latent variable (hypothetical construct) "Safety Culture".

- ✧ "DSR Safety Attitude" (the target variable) directly influences on "DSRs Perceived Safety Responsibility [SR]", "DSRs Perceived Self-efficacy in Managing Safety" [PE] and "DSRs Personal Beliefs in Accident Causation" [PB]. It is therefore, the three (3) observed variables [SR], [PE] and [PB] are grouped under a latent variable (hypothetical construct) "DSR Safety Attitude".

In building a SEM model schema, each of symbols and notation within the framework represents an important component in the analytic process. For easy reference, pictorial representation of the hypothesized "DSRs Safety Attitude Model" schema is depicted in Figure 22. By convention, symbols and notations in the model schema included ellipse represent latent variable, rectangle represent observed variable and single-headed arrow (→) represent the impact of one variable on another.

The Hypothesized "DSRs Safety Attitude Model" Schema

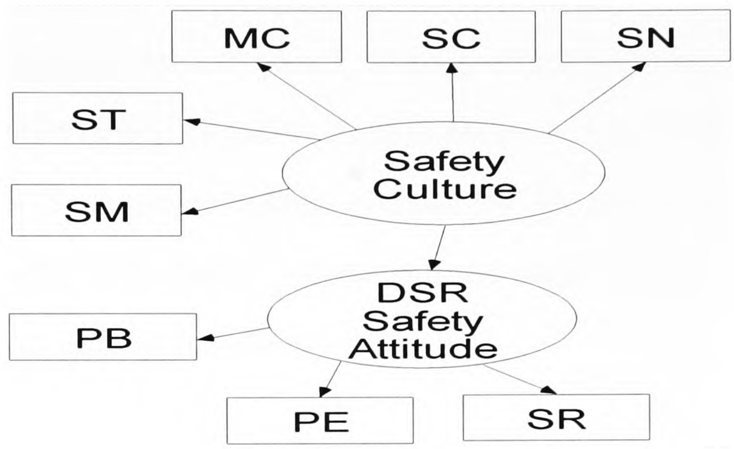


FIGURE 22: THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL" SCHEMA

The model schema is formed to explain the direct and indirect effects amongst eight (8) observed variables and two (2) latent variables. In this study, the latent variable "DSR Safety Attitude" is treated as the target variable. The next stage is goes to build the structural "DSRs Safety Attitude Model".

3.6 THE STRUCTURAL "DSRS SAFETY ATTITUDE MODEL":

The goal in building a structural model with logical paths seeks to confirm whether theoretical underlying constructs are reflected in the observed data. *"In SEM, the terms independent and dependent variables are abandoned; instead variables are referred to as "exogenous" or "endogenous." Endogenous variables are those modeled as* *dependent on other variables, while exogenous are not dependent on other variables."* (Jackson et al., 2005, pp.3-6) From this point and onward, independent (observed) and dependant (latent) variables in the structural model are referred to as exogenous and endogenous variables respectively.

In this study, the structural model contains with eight (8) exogenous variables are representing underlying two endogenous variables (latent variables) namely "Safety Culture" and "DSRs Safety Attitude". An endogenous variable "Safety Culture" was measured by five (5) exogenous variables included SM, ST, MC, SC and SN. Another endogenous variable "DSRs Safety Attitude" (also the target variable) was measured by three (3) exogenous variables included SR, PE and PB.

Raykov et al. (2000, p.1) points out that *"Structural equation modeling provides researchers with a comprehensive method for the quantification and testing of theories. Other major characteristics of structural equation models are that they explicitly take into account the measurement error that is ubiquitous in most disciplines and contain latent variable".*

The error terms represent residual variances within variables not accounted for by pathways hypothesized in the model. *"Structural error terms, also called residual error terms or disturbance terms, which reflect the unexplained variance in the latent endogenous variable(s) due to all unmeasured causes."* Available from: Garson, D., *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 7 December 2007]

"One of the advantages to SEM, is that latent variables are free of random error. This is because error has been estimated and removed, leaving only a common variance." Available from: Stoelting, R. *Structural Equation Modeling / Path Analysis.* http://userwww.sfsu.edu/~efc/classes/biol710/path/SEMwebpage.htm [Accessed 7 December 2007] In structural "DSRs Safety Attitude Model", the only error term of endogenous variable (latent variable) e9 and error terms of eight (8) exogenous variables through e1 to e8 are imposed.

The paths from error terms are:-

- e1 to "Perceived Safety Responsibility [SR]"
- e2 to "DSRs Perceived Self-efficacy in Managing Safety [PE]"
- e3 to "DSRs Personal Beliefs in Accident Causation [PB]"
- e4 to "Safety Management [SM]"
- e5 to "DSRs Perceptions of Safety Training [ST]"
- e6 to "Perceived Management Commitment to Safety [MC]"
- e7 to "Safety Communication [SC]"
- e8 to "DSRs Perceptions of Group Safety Norms [SN]"
- e9 to "DSRs Safety Attitude"

Hence, the structural "DSRs Safety Attitude Model" is developed (in Figure 23) by incorporating error terms (residuals).

The structural "DSRs Safety Attitude Model" is a hypothesized schema depicting the possible relationships that are believed to exist between variables after theoretical evaluations. The direction of arrows on logical paths and the underlying latent construct is believed to "cause" the observed variables. Causal effects are represented by single-headed arrows in the path diagram.

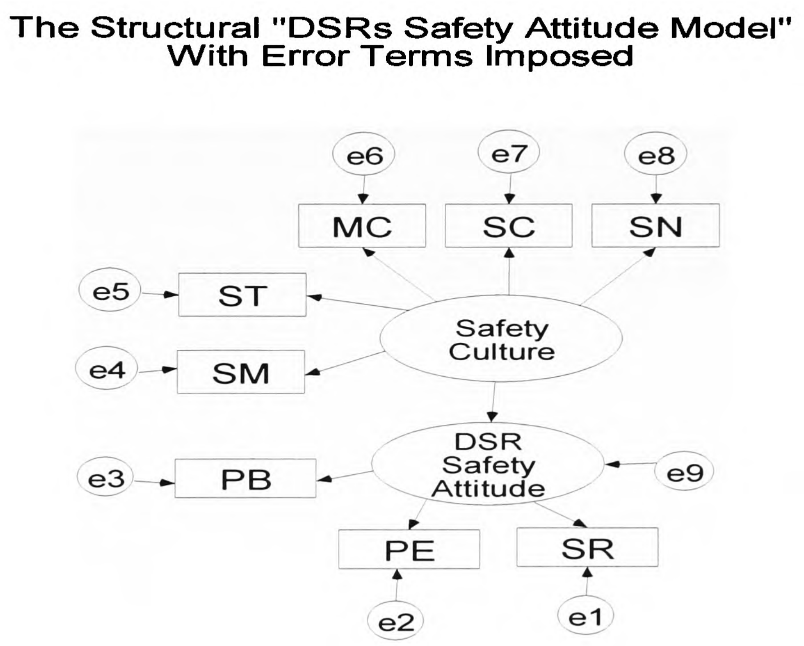


FIGURE 23: THE STRUCTURAL "DSRS SAFETY ATTITUDE MODEL" WITH ERROR TERMS IMPOSED

4. WHAT GOES NEXT?

Model specification is the exercise in justifying a specified model after the theoretical evaluation from literature review. The schema of structural "DSRs Safety Attitude Model" is finally constructed by exploring the relationship between ten (10) identified variables that could potentially influence the DSR safety attitude towards the implementation of SMS at departmental level. The model is a hypothesized schema depicting the possible relationships that are believed to exist between variables. For consistency, the term hypothesized "DSRs Safety Attitude Model" will continue to be used in this study.

The Chapter Six (6) will proceed to the "Step Three - Instrument Construction" and "Step Four - Data Collection" in according to the basic approach to performing a SEM analysis. Based on causal effects amongst ten (10) identified variables in the structural model, it will describe how the questionnaire was designed to cope with all the research hypotheses. Methods of data collection, the testing of validity and reliability of the questionnaire will be discussed in detail. To solve the statistical problems a mathematical technique called Structural Equation Modeling (SEM) is to be employed.

CHAPTER SIX

RESEARCH METHODOLOGY AND STATISTICAL ANALYSIS

1. INTRODUCTION:

The structural "DSRs Safety Attitude Model" was constructed through various complex processes in the previous chapter. This chapter will proceed to the "Step Three - Instrument Construction" and the "Step Four - Data Collection" in accordance with the basic approach to performing a SEM analysis. This is a substantial part containing a detailed description regarding the instrument construction, method of data collection and analysis included the testing of validity and reliability of the survey questionnaire. To minimize the chance of a middle option in attitude survey, a self-reported six (6) points Likert type "DSRs Safety Attitudes Survey" questionnaire was developed to collect data from the targeted group (i.e. DSRs). The survey questionnaire was piloted in 2006 and data collected from the pilot survey was analyzed to evaluate the factorial structure for each distribution.

With respect to analyzing data in the pilot test, Statistical Package for the Social Sciences (SPSS) version 11.0 for Windows was employed to test validity and reliability of the survey questionnaire. With the pilot data, the validity test was conducted by using factor analysis to single out those items which doubly loaded to two or more factors; or alienated factors that did not belong to a specific group. After the validity test, only forty-three (43) items out of seventy-seven (77) original questionnaire items retained for the field survey. Reliability test for internal consistency of all forty-three (43) items also conducted. Results reflects Cronbach's alpha 'α' values ranging from 0.8764 to 0.9349;

over the recommended level of 0.70 and no significant cross-loading among the eight (8) exogenous variables.

With good evidence of validity and reliability being obtained from the pilot test, the survey questionnaire was then restructured into forty-three (43) items for the field survey. Data collected from 144 valid questionnaires in the field survey was tested. Reliability was also re-tested and the result confirmed Cronbach's alpha 'α' values ranging from 0.8297 to 0.9192, over the recommended level of 0.70. The data is highly consistent internally and will be subjected to model testing in Chapter Seven (7).

2. ETHICAL CONSIDERATIONS:

Ethics approval to conduct the study was obtained from the University of HULL. There were no aspects of this study that involved any risk or imposed any adverse effect to the participants. Confidentiality for all respondents was ensured! There was no requirement to put respondent's name and department in each questionnaire.

3. MAJOR STEPS INVOLVED IN THE INSTRUMENT CONSTRUCTION AND DATA COLLECTION FOR SEM ANALYSIS:

This section focused on the "Step Three - Instrument Construction" and the "Step Four - Data Collection" in accordance to the basic approach to performing a SEM analysis. Schumacker et al. (2004, p.2) clearly point out the goal of SEM analysis is *"to determine the extent to which the theoretical model is supported by sample data"*. Major steps involved in developing the research instrument and data collection for SEM analysis is shown in Table 16 for easy reference.

TABLE 16: MAJOR STEPS INVOLVED IN DEVELOPING THE RESEARCH INSTRUMENT AND DATA COLLECTION FOR SEM ANALYSIS

STEP 1	DESIGN OF QUESTIONNAIRE FOR PILOT TEST
STEP 2	IDENTIFICATION OF TARGET POPULATION AND SAMPLE SIZE
STEP 3	COLLECTION OF DATA FOR PILOT TEST
STEP 4	STATISTICAL ANALYSIS - VALIDITY AND RELIABILITY TESTING OF THE QUESTIONNAIRE
STEP 5	RESTRUCTURE OF THE QUESTIONNAIRE FOR FIELD SURVEY.
STEP 6	COLLECTION OF FIELD DATA
STEP 7	RE-TEST OF RELIABILITY

3.1 STEP 1: DESIGN OF QUESTIONNAIRE FOR PILOT TEST:

In this study, the purpose of the questionnaire design for the pilot test was threefold:-

- To develop instruments for measuring responses of DSRs safety attitudes towards the implementation of SMS that probed into the possible relationship between DSRs safety attitudes and various co-factors.
- To gain an in-depth understanding of factors that influenced DSRs safety attitudes towards the implementation of SMS; and
- To determine if any change in the survey design was necessary.

What are the reasons behind to use a self-reported six (6) points Likert type survey questionnaire for an attitude survey in this study?

- *"The role of the questionnaire is to elicit the information that is required to enable the researcher to answer the objectives of the survey. To do this the questionnaire must not only collect the data required, but collect the data in the most accurate way possible."* (Brace, 2004, p.7)

- *"An attitude survey can be used to test a respondent's conviction or emotionals about an object or subject. It is therefore used to determine what a person's physical behaviour towards a psychological object might be."* (Wilson, 2005, p.138)

- *"Attitudes can be measured in a number of ways. The most widely used methods involve some form of self-report. For example, the subject might be given an attitude questionnaire with items that relate to the matter at hand."* (Gleitman, 1991, p.459)

- The commonly used approach to measuring attitude is the itemized rating scale. *"The Likert scale (frequently known as an 'agree–disagree' scale) was first published by psychologist Rensis Likert in 1932. The technique presents respondents with a series of attitude dimensions, for each of which they are asked whether, and how strongly, they agree or disagree, using one of a number of positions on a five-point scale."* (Brace, 2004, p.86)

- *"Likert scale is a widely used technique for scaling attitudes. Respondents are presented with a number of items, some positively phrased and some negatively phrased, which have been found to discriminate most clearly between extreme views on the subject of study".* Available from: Marshall G. (1998). *Likert Scale.* http://www.encyclopedia.com/doc/1O88-Likertscale.html [Accessed 15 April 2008]

Dillion et al. (1994, p.318) highlights two advantages of the Likert scale:

1. *The construction and administration of the scale is relatively easy.*
2. *The simplicity of the instructions and the rating task make it possible to use the postal service to collect data.*

- Oskamp et al. (2005, p.49) states that *"Likert method was the first approach that measured the extent or intensity of the respondent's agreement with each item, rather than simply obtaining a 'yes-no' response. In this method, again, a large number of opinion statements on a given topic are collected, but each one is phrased in such a way that it can be answered on a 6-point rating scale."* Brace (2004, p.85) points out that "*Some practitioners prefer to use a scale with an even number of points. They eliminate the neutral mid-point in an attempt to force those who would otherwise choose it to give an inclination one way or the other."* It is suggested that the exclusion of a neutral point will draw the respondent to make a decision one way or the other.

In this study, to minimize the chance of middle option, a self-reported 6-point Likert type "DSRs Safety Attitudes Survey" questionnaire for a pilot test was developed to collect information from the targeted group (i.e. DSRs). The questionnaire composed of two main parts (i.e. Part A and Part B).

The Part A "Respondent's Data" contains seven (7) demographic factors concerned with respondent's particulars and job aspects including gender, job position, departmental safety role, age group, educational level, years of services in the University and years of service as Departmental Safety Representative.

The Part B "DSRs Safety Attitude Survey" contained seventy-seven (77) items for eight (8) exogenous (observed) variables focused on perception, personal beliefs and perceived behavioural control (self-efficacy) of DSRs towards the implementation of SMS at departmental level. Distribution of seventy-seven (77) questionnaire items in Part B – DSRs Safety Attitude Survey is highlighted in Table 17.

TABLE 17: DISTRIBUTION OF 77 SURVEY QUESTIONS IN PART B - DSRS SAFETY ATTITUDE SURVEY

TWO (2) (ENDOGENOUS VARIBLES)	EIGHT (8) EXOGENOUS VARIABLES IN FACTOR STRUCTURE
SAFETY CULTURE	To evaluate DSRs perceptions, a total of fifty-three (53) items representing respondents' (DSRs) level of agreement to the statement would be developed in the questionnaire for pilot study. **SAFETY MANAGEMENT [SM]** Eleven (11) items [SM 01-11] **DSRS PERCEPTIONS OF SAFETY TRAINING [ST]** Ten (10) items [ST 01-10] **PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC]** Eight (8) items [MC 01-08] **SAFETY COMMUNICATION [SC]** Ten (10) items [SC 01-10] **DSRS PERCEPTIONS OF GROUP SAFETY NORMS [SN]** Fourteen (14) items [SN 01-14]
DSR SAFETY ATTITUDE	To evaluate the Perceived Behavioural Control (PBC) of DSRs, a total of eight (8) items representing respondents' (DSRs) level of agreement to the statement would be developed in the questionnaire for pilot study.

	DSRS PERCEIVED SAFETY RESPONSIBILITY [SR] Eight (8) items [SR 01-08] To evaluate the "Personal Beliefs" of DSRs, a total of sixteen (16) items representing respondents' level of agreement to the statement would be developed in the questionnaire for pilot study. **DSRS PERCEIVED SELF-EFFICACY IN MANAGING SAFETY [PE]** Six (6) items [PE 01-06] **DSRS PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB]** Ten (10) items [PB 01-10]

Respondents need to be helped to express attitudes. To minimize the chance of middle option, a self-reported six (6) points Likert type scale "DSRs Safety Attitudes Survey" questionnaire is developed for pilot test. To indicate level of agreement or disagreement from respondents, the scale is on a continuum ranging from *"Strongly Disagree (1), Disagree (2), Slightly Disagree (3), Slightly Agree (4), Agree (5) to Strongly Agree (6)"* to score each of the seventy-seven (77) items for 8 exogenous variables.

Appendix I summarises a total of forty-one (41) out of seventy-seven (77) questionnaire items for pilot survey adopted or modified from the following sources:

- Seaboch (1994) - "*Effects of Safety Instruction Upon Safety Attitudes and Knowledge of University Students Enrolled in Selected Agricultural Engineering Course* - Appendix D: Initial Safety Attitude Items";

- Health and Safety Executive (2004) – "*Occupational health and safety enforcement strategies to promote concordance in the hospitality industry – Appendix Five - Health and Safety in the Hospitality Industry*

Questionnaire"; and

- ✧ KAM Chi-kit (2002), the thesis "*The Exploration of a Multi-Dimensional Safe Behaviour Model for construction workers in Hong Kong – A Structural Equation Modelling Approach*" - "*Appendix I: The English Version of the Questionnaire on Workers' Safety Perception*".

- ✧ *Safety Survey* [Online]. Available from: http://www.lboro.ac.uk/departments/bs/JIP/SAFESURV.HTM [Accessed 15 January 2006]

To evaluate the relevance of questionnaire items and the extent to which there may be problems in misleading responses, a review of content validity was required. Carmines et al. (1991, p.20) describes the content validity as *"The extent to which a measurement reflects the specific intended domain of content"* and; *"Content validity, also called face validity, has to do with items seeming to measure what they claim to. In content validity one is also concerned with whether the items measure the full domain implied by their label. Use of surveys of panels of content experts or focus groups of representative subjects are ways in which content validity may be established, albeit using subjective judgments."* Available from: Garson, D. *Validity*, http://www2.chass.ncsu.edu/garson/PA765/validity.htm [Accessed 15 April 2008]

The draft questionnaire was reviewed by Dr. Charles C.K. Kam, former Deputy Chief Occupational Safety Officer of Labor Department of HKSAR; Dr. Joseph Kwan, Director of Safety and Environmental Protection Office (SEPO) of the University and Mr. Nigel Wright, my project supervisor in The University of Hull, U.K. before the pilot survey.

Inspiration gained from the consultation was essential in developing seventy-seven (77) questionnaire items for data collection in the pilot survey. After the validation process, the wording of some items was changed by simplifying and rewording, so as to eliminate any ambiguous statements.

A complete set of self-reported "Safety Attitudes Survey" questionnaire contains seventy-seven (77) items together with an introductory letter for the pilot survey is attached in *Appendix II* for reference.

These seventy-seven (77) items in the questionnaire were used to evaluate respondents "DSRs" safety attitudes. To avoid bias to the respondents, all the items have purposely been put into a random order and would be asked in different (positive/negative) ways. Six (6) out of the seventy-seven (77) questionnaire items included SM11, MC03, PB06, PB08, SN03 and SN05 were negatively worded. (See Table 18)

TABLE 18: NEGATIVELY WORDED QUESTIONNAIRE ITEMS

SM11	DEPARTMENTAL MANAGEMENT ONLY REPORT ACCIDENT INVOLVING OF LOST-WORKDAY INJURY TO SEPO.
MC03	DEPARTMENTAL MANAGEMENT "TURNS A BLIND EYE" TO THINGS THAT ARE DONE IN AN UNSAFE MANNER.
PB06	ACCIDENTS IN THE WORKPLACE ARE TOTALLY UNAVOIDABLE, BECAUSE OF "ACTS OF GOD"!
PB08	IT IS NECESSARY TO "TURN A BLIND EYE" TO RULE VIOLATIONS, IF PEOPLE INVOLVED ARE YOUR SUPERIOR.
SN03	PEOPLE WOULD TAKE SHORTCUTS TO PERFORM THEIR TASKS NATURALLY.
SN05	PEOPLE USUALLY TURN A 'BLIND EYE' TO UNSAFE MATTERS.

3.2 STEP 2: IDENTIFICATION OF TARGET POPULATION AND SAMPLE SIZE:

The study is focused on a target group "DSRs" that has been given an enormous responsibility in the implementing SMS at departmental level. For the academic year 2005/2006, a total of 314 staff members performed the duty of DSR at the University. Following is the distribution of 314 DSRs:-

- 111 Departmental Safety Officers/Deputy Departmental Safety Officers from 61 departments/offices;

- 203 staff members with duty of safety supervision in the campus. It was included 108 Fire Safety Ambassadors from 12 departments and 95 staff with additional safety duty from 3 offices namely Estate Management Office, Campus Service Office and Safety & Environmental Protection Office.

Adequacy of sample size has a significant impact on the validity and the reliability of parameter estimates, model fit, and statistical power (i.e. the ability to detect and reject a poor model). Although there is no explicit sample size requirements for structural equation modeling (SEM), Harris et al. (1990, pp.337-360) suggest that "*The recommended ratio of sample size to free parameters in a structural equation model is between 5:1 and 10:1, depending on the number of free parameters in the model*". Hoogland et al. (1998, p.329) also point out that "*The minimum sample size should be ten times the number of free parameters*". Based on recommendations from Harris and Hoogland et al. that the sample size for the pilot survey and field survey in this study is considered appropriate. In this study, sample size issues have received considerable attention. There were 120 DSRs involved in the pilot survey and 194 DSRs involved in the field survey.

3.3 STEP 3: COLLECTION OF DATA FOR PILOT TEST:

It is generally a good idea to run a pilot test before the questionnaire subjected to actual field data testing. A pilot survey was conducted in February 2006 after the approval from my project supervisor. A total of 120 self-reported six (6) points Likert type "DSRs Safety Attitudes Survey" questionnaires with an introductory letter for pilot survey were sent to the target population in February 2006 either by hand or through the internal postal system. Contents of an introductory letter described the purpose, instruction on how to complete the questionnaire and confidentiality of the survey. It was expected that respondents should take approximately 25 minutes to complete the questionnaire. To maintain anonymity, there was no requirement to put respondent's name, signature, department and job title in the questionnaire. All respondents were reminded to return the completed survey questionnaire within 6 days either by hand or via internal mail to the researcher from the date of issue.

The pilot survey data was collected and a total of 102 valid questionnaires (with 85 % response rate) were finally secured. For test of validity and reliability of the research instrument – the questionnaire, a statistical package, SPSS version 11.0 for Windows was used. All pilot data collected were coded and entered into a computer statistical package for factor analysis. The researcher double checked all data to ensure that there were no missing data or errors. Negatively worded items were reverse scored so that their valence matched the positively worded items.

3.4 STEP 4: STATISTICAL ANALYSIS - VALIDITY AND RELIABILITY TESTING OF THE QUESTIONNAIRE:

In evaluating the technical characteristics of a measurement procedure, two features are important, viz. validity and reliability. "*Validity refers to the degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure. While reliability is concerned with the accuracy of the actual measuring instrument or procedure, validity is concerned with the study's success at measuring what the researchers set out to measure.*" Available from: Colorado State University, *Writing Guides Reliability & Validity*. http://writing.colostate.edu/guides/research/relval/pop2b.cfm [Accessed 25 October 2007]

3.4.1 TEST OF VALIDITY FOR PILOT DATA:

Factor analysis is a fundamental component of Structural Equation modeling. Three primary applications of factor analysis include:-

- *Explore data for patterns. Often a researcher is unclear if items or variables have discernible patterns. Factor Analysis can be done in an exploratory fashion to reveal patterns among the inter-relationships of the items.*

- *Data Reduction. Factor analysis can be used to reduce a large number of variables into a smaller and more manageable number of factors. Factor analysis can create factor scores for each subject that represents these higher order variables.*

- *Confirm hypothesis of factor structure. In measurement research when a researcher wishes to validate a scale with a given or hypothesized factor* *structure, Confirmatory Factor Analysis is used.*

Available from: Coughlin M.A. and Knight W., *Confirmatory Factor Analysis: The Basis for the Structural Model.* http://www.spss.com/events/e_id_2134/presentation.ppt#28 [Accessed 6 November 2007]

Cascio (1998, p.99) considers that "*Two issues are of primary concern in validation – what a test or procedure measures and how well it measures*". It is concerned about the degree of accuracy and appropriateness for predicting or drawing inferences about certain criteria. Cook et al. (1979, p.37) defines validity as "*The best available approximation to the truth*". With the pilot data, the validity test on the questionnaire items of "DSRs Safety Attitude Model" constructs was conducted to confirm measurement model construct validity.

"Construct validity seeks agreement between a theoretical concept and a specific measuring device or procedure." Available from: Colorado State University, *Writing Guides Reliability & Validity.* http://writing.colostate.edu/guides/research/relval/pop2b.cfm [Accessed 25 October 2007]

Goodwin (1999, pp.85-100) reports that *"Factor analysis has become such a widely used technique for an estimation of construct validity".* In this study, factor analysis techniques were applied to single out those items which doubly loaded to two or more factors; or to alienate factors that did not belong to a specific group. All identified factors simplify interpretation of these relationships by reducing the observed correlations into as few constructs as possible. These factors were used to represent relationships among many sets of inter-related perceptual questions about the target variable "DSR

Safety Attitude" towards the implementation of SMS at the University. The reduced factors can also be used for further analysis.

In factor analysis, the sampling adequacy is measured by the Kaiser-Meyer-Olkin (KMO) statistics. Garson (2008) states that "*Measured by the Kaiser-Meyer-Olkin (KMO) statistics, sampling adequacy predicts if data are likely to factor well, based on correlation and partial correlation. In the old days of manual factor analysis, this was extremely useful.*" ... "*KMO varies from 0 to 1.0 and KMO overall should be .60 or higher to proceed with factor analysis. If it is not, drop the indicator variables with the lowest individual KMO statistic values, until KMO overall rises above .60. (Some researchers use a more lenient .50 cut-off).*" Available from: Garson D. *Factor Analysis.* http://www2.chass.ncsu.edu/garson/pa765/factor.htm#vars [Accessed 13 April 2008]

3.4.1.1 FACTOR ANALYTIC RESULTS:

FACTOR ANALYSIS – INITIAL TEST

An initial test of the 77 items with extraction method "Principal Component Analysis" followed by an "Oblimin with Kaiser Normalization" rotation method yielded a seventeen (17) factor solution with Eigenvalues greater than one and accounts for 80.058 % (percent) of the explained variance. The analyses shows that in both distributions Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy was 0.682 indicating that the data were appropriate for this analysis. Bartlett Test of Sphericity was significant [Approx Chi-Square = 8357.713, df = 2926, Sig = 0.000], indicating that the correlation matrix is not an identity matrix. An output of the factor analysis with factor loadings greater than or equal to 0.4 is shown in Table 19.

TABLE 19: PATTERN MATRIX (A-1): THE 77 QUESTIONNAIRE ITEMS – FACTOR LOADINGS GREATER THAN OR EQUAL TO 0.4

Pattern Matrix(a)

	Component																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SM01						.906											
SM02																	
SMO3						.896											
SM04																	482
SM05						.927											
SM06																	
SM07						901											
SM08						507											
SM09							-.433										
SM10			.626														
SM11																	
MC01			.775														
MC02			576														
MC03										-.566							
MC04																- 427	
MC05			694														
MC06			.717														
MC07			.670														
MC08			793														
SC01									.868								
SC02									889								
SC03									710								
SC04															401		
SC05									790								
SC06																	
SC07																	-.457
SC08															.793		
SC09															818		
SC10																	

ST01				.739													
ST02				405												-.438	
ST03																	
ST04												-.531					
ST05				.671													
ST06				.807													
ST07																	
ST08				.545													
ST09				704													
ST10																-.470	
PB01		628															
PB02		942															
PB03		910															
PB04							-.790										
PB05		.883															
PB06							- 769										
PB07		599															
PB08										-.762							
PB09								.661									
PB10		934															
SN01											- 771						
SN02					.405						- 550						
SN03										-.601							
SN04					564												
SN05					.557												
SN06					.745												
SN07					720												
SN08					800												
SN09														.756			
SN10														801			
SN11					.593												
SN12													.612				
SN13								.492					-.438				

SN14								.807									
SR01	.477																
SR02	.811																
SR03																	
SR04	.631																
SR05	.572																
SR06	.843																
SR07	.613																
SR08																	-.547
PE01																-.706	
PE02																-.720	
PE03																-.612	
PE04																-.456	
PE05																-.494	
PE06																-.632	

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

A Rotation converged in 37 iterations.

"The factor loadings are the correlation coefficients between the variables (rows) and factors (columns). Factor loadings are the basis for imputing a label to the different factors. Loadings above .6 are usually considered "high" and those below .4 are "low." Available from: Garson D., *Factor Analysis: SPSS Output* http://faculty.chass.ncsu.edu/garson/PA765/factspss.htm [Accessed 13 April 2008]. In this study, items with factor loading less than 0.4 were suppressed.

In the initial test, there are a number of items loading on two factors (e.g. item ST02 loads onto factor 4 and 16), and not all items loaded onto the same factor (e.g. PB04, PB06, PB08, PB09 are alienated items that do not load onto factor "2" with the majority of the rest). A summary of the seven-seven (77) items and associated scales is shown in Table 20.

TABLE 20: SUMMARY OF THE 77 ITEMS AND THE ASSOCIATED SCALES

SCALE	REMAINING ITEMS	ITEMS (FACTOR LOADING LESS THAN 0.4)	ITEMS (LOADING ON TWO OR MORE FACTORS)	ITEMS (ALIENATED)
Safety Management [SM]	SM01, SM03, SM05, SM07, SM08	SM02, SM06, SM11		SM04, SM09, SM10
Perceived Management Commitment to Safety [MC]	MC01, MC02, MC05, MC06, MC07, MC08			MC3, MC4
Safety Communication [SC]	SC01, SC02, SC03, SC05	SC06, SC10		SC04, SC07, SC08, SC09
DSR's Perceptions of Safety Training [ST]	ST01, ST05, ST06, ST08, ST09	ST03, ST07	ST02	ST04, ST10
DSR's Personal Beliefs in Accident Causation [PB]	PB01, PB02, PB03, PB05, PB07, PB10			PB04, PB06, PB08, PB09
DSR's Perceptions of Group Safety Norms [SN]	SN04, SN05, SN06, SN07, SN08, SN11	SN02	SN13	SN01, SN03, SN09, SN10, SN12, SN14
DSR's Perceived Safety Responsibility [SR]	SR01, SR02, SR04, SR05, SR06, SR07	SR03		SR08
DSR's Perceived Efficacy in Managing Safety [PE]	PE01, PE02, PE03, PE04, PE05, PE06			

FACTOR ANALYSIS – SECOND TEST

To further enhance interpretability, items loading on two or more factors or that scattered around were removed. This resulted in the removal of 31 items in the second test. Factor loadings of the 46 items and the associated scales are shown in Table 21.

TABLE 21: PATTERN MATRIX (A-2): FACTOR LOADINGS OF THE 46 QUESTIONNAIRE ITEMS

Pattern Matrix(a)									
	Component								
	1	2	3	4	5	6	7	8	9

SM01					.923				
SMO3					.880				
SM05					916				
SM07					.926				
SM08					.473				
MC01			-.800						
MC02			-.645						
MC05			-.764						
MC06			-.784						
MC07			-.737						
MC08			-.822						
SC01							883		
SC02							.918		
SC03							.707		
SC04									
SC05							.747		
SC08								- 820	
SC09								- 869	
ST01				.740					
ST05				797					
ST06				814					
ST08				.592					
ST09				.724					
PB02		.942							
PB03		.924							
PB05		865							
PB07		.703							
PB10		928							
SN04						-.591			
SN05						-.682			
SN06						- 774			
SN07						- 819			
SN08						-.820			

SN11						-.669			
SR01	492								
SR02	.706								
SR04	.681								
SR05	669								
SR06	.762								
SR07	.497								
PE01									- 809
PE02									-.821
PE03									- 693
PE04									- 618
PE05									-.512
PE06									- 692
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.									
A Rotation converged in 15 iterations.									

The second test of the 46 items with extraction method "Principal Component Analysis" followed by an "Oblimin with Kaiser Normalization" rotation method yielded a nine (9) factor solution with Eigenvalues greater than one and accounts for 78.059 % (percent) of the explained variance. The analyses shows that in both distributions Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy was 0.807, indicating that the data were appropriate for this analysis. Bartlett's Test of Sphericity was significant [Approx Chi-Square = 4870.793, df = 1035, Sig = 0,000], indicating that the correlation matrix is not an identity matrix. It is visualized that only the item SC04 with a factor loading less than 0.4 were suppressed, and item SC08, SC09 are alienated that do not load onto factor "7" with the majority of the rest). Summary of the forty-six (46) items and associated scales is shown in Table 22.

TABLE 22: SUMMARY OF THE 46 ITEMS AND THE ASSOCIATED SCALES

SCALE	**REMAINING ITEMS**	**ITEMS (FACTOR LOADING LESS THAN 0.4)**	**ITEMS (LOADING ON TWO OR MORE FACTORS)**	**ITEMS (ALIENATED)**
Safety Management [SM]	SM01, SM03, SM05, SM07, SM08			
Perceived Management Commitment To Safety [MC]	MC01, MC02, MC05, MC06, MC07, MC08			
Safety Communication [SC]	SC01, SC02, SC03, SC05	SC04		SC08, SC09
DSR's Perceptions of Safety Training [ST]	ST01, ST05, ST06, ST08, ST09			
DSR's Personal Beliefs in Accident Causation [PB]	PB02, PB03, PB05, PB07, PB10			
DSR's Perceptions of Group Safety Norms [SN]	SN04, SN05, SN06, SN07, SN08, SN11			
DSR's Perceived Safety Responsibility [SR]	SR01, SR02, SR04, SR05, SR06, SR07			
DSR's Perceived Efficacy in Managing Safety [PE]	PE01, PE02, PE03, PE04, PE05, PE06			

FACTOR ANALYSIS – THIRD TEST

A further factor analysis (the third test) of the remaining 43 items with Principal Component Extraction followed by an Oblimin with Kaiser Normalization rotation was conducted again with Factor loading less than 0.4 suppressed. The analysis yields eight (8) factors with Eigenvalues greater than one, which together accounted for 77.237 % of the explained variance. The analyses shows that in both distributions Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy was 0.796, indicating that the data were appropriate for this analysis. Bartlett Test of Sphericity was significant [Approx

Chi-Square = 4525.671, df = 903 and Sig. 0.000].

The interpretability of the factor analyses output this time is greatly improved and is shown in Table: 23.

TABLE 23: PATTERN MATRIX (A-3): FACTOR LOADINGS OF THE REMAINING 43 QUESTIONNAIRE ITEMS

Pattern Matrix(a)

	Component							
	1	2	3	4	5	6	7	8
SM01					.926			
SMO3					.879			
SM05					.915			
SM07					.930			
SM08					475			
MC01			-.808					
MC02			- 663					
MC05			- 745					
MC06			- 750					
MC07			-.755					
MC08			- 838					
SC01							.875	
SC02							.901	
SC03							720	
SC05							.767	
ST01				774				
ST05				.823				
ST06				856				
ST08				639				
ST09				.768				
PB02		.939						
PB03		.923						

PB05		.864						
PB07		.701						
PB10		.922						
SN04						-.592		
SN05						- 680		
SN06						-.779		
SN07						-.824		
SN08						- 808		
SN11						- 678		
SR01								-.508
SR02								-.629
SR04								- 686
SR05								- 670
SR06								- 733
SR07								- 515
PE01	787							
PE02	838							
PE03	788							
PE04	700							
PE05	.595							
PE06	791							
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.								
A Rotation converged in 12 iterations.								

It is seen that all the remaining 43 items have been generally grouped together according to the scales. Summary of the remaining forty-three (43) items and associated scales is shown in Table 24.

TABLE 24: SUMMARY OF THE REMAINING 43 ITEMS

SCALE	**REMAINING ITEMS**	**ITEMS (FACTOR LOADING LESS THAN 0.4)**	**ITEMS (LOADING ON TWO OR MORE FACTORS)**	**ITEMS (ALIENATED)**
Safety Management [SM]	SM01, SM03, SM05, SM07,			

	SM08			
Perceived Management Commitment To Safety [MC]	MC01, MC02, MC05, MC06, MC07, MC08			
Safety Communication [SC]	SC01, SC02, SC03, SC05			
DSR's Perceptions of Safety Training [ST]	ST01, ST05, ST06, ST08, ST09			
DSR's Personal Beliefs in Accident Causation [PB]	PB02, PB03, PB05, PB07, PB10			
DSR's Perceptions of Group Safety Norms [SN]	SN04, SN05, SN06, SN07, SN08, SN11			
DSR's Perceived Safety Responsibility [SR]	SR01, SR02, SR04, SR05, SR06, SR07			
DSR's Perceived Efficacy in Managing Safety [PE]	PE01, PE02, PE03, PE04, PE05, PE06			

Data collected from the pilot survey were analyzed to evaluate the factorial structure for each distribution. With the pilot data, the validity test was conducted by using factor analysis to single out those items which doubly loaded to two or more factors; or alienated factors do not belong to a specific group. After the validity test, the validity of the questionnaire items was established. It was anticipated that only forty-three (43) items out of seventy-seven (77) questionnaire items were retained for the field survey. The remaining items were subjected to a reliability test and look for reliability alpha greater than 0.7. Factor loadings less than 0.4 were ignored.

3.4.1.2 TEST OF RELIABILITY FOR PILOT DATA:

Reliability test is used to a measure of its internal consistency. Cascio (1998. p.88) defines the reliability of a measurement procedure *"as its freedom from unsystematic errors of measurement"*. It is the extent to which a measure, procedure or instrument yields the same result on repeated trials. In this study, internal consistency is assessed by the manner in which all DSRs respond in similar ways to similar questions that measure a particular construct (e.g., perceived management commitment to safety).

"Cronbach's alpha is a commonly used measure testing the extent to which multiple indicators for a latent variable belong together. It varies from 0 to 1.0. A common rule of thumb is that the indicators should have a Cronbach's alpha of .7 to judge the set reliable." Available from: Garson, D., *Structural Equation Modeling – Confirmatory factor analysis.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 14 July 2006]

Up to this end, a reliability test for internal consistency of all forty-three (43) items was conducted. Result reflects Cronbach's alpha values of all 43 items ranging from of 0.8764 to 0.9349 over the recommended level of 0.70 and no significant cross-loading among the eight (8) exogenous variables was found. The result of the testing is summarized in Table 25.

TABLE 25: SUMMARY OF RELIABILITY FOR THE REMAINING 43 ITEMS IN PILOT SURVEY

Scale	**Items**	**Cronbach's Alpha 'α'**
Safety Management [SM]	SM01 A departmental safety management system is fully developed in your department / office. SM03 An emergency plan (such as chemical spill, fire) is available in your department / office. SM05 Workplace risk assessments have to be reviewed by authorized persons on a regularly basis. SM07 Proper storage facility for dangerous goods/chemical substances is provided. SM08 SEPO safety manual provides useful guidelines for users.	0.9222

Perceived Management Commitment to Safety [MC]	MC01 Departmental management visibly demonstrates an interest in the safety matters. MC02 Departmental management clearly considers the safety of people to be of great importance. MC05 Departmental management always listens to safety concerns from people. MC06 Departmental management is concerned for the operating cost more than safety. MC07 Departmental management is always provided with sufficient resources to let people get the job done safely. MC08 Safety is given high priority by the departmental management.	0.9239
Safety Communication [SC]	SC01 Safety meeting is conducted on a regularly basis. SC02 People are always informed of unsafe practices. SC03 People are always informed of unsafe conditions in the workplace. SC05 People are freely making suggestions for safety improvement.	0.9119
DSR's Perceptions of Safety Training [ST]	ST01 Safety issues are given high priority in training programs. ST05 Safety training can positively change people's attitudes towards safety. ST06 Safety training can help to reduce accidents. ST08 Safety training can help to improve individual's safety awareness. ST09 Safety training can help to improve departmental safety performance.	0.8986
DSR's Personal Beliefs in Accident Causation [PB]	PB02 Accidents are mainly due to a lack of working experiences from people involved. PB03 Accidents are mainly due to poor attitudes toward safety from people involved.	0.9349

	PB05 Accidents just happen, there is little one can do to avoid them. PB07 Lots of minor injuries are a sign that more serious accidents could also occur. PB10 Safety is the responsibility of SEPO, not others.	
DSR's Perceptions of Group Safety Norms [SN]	SN04 People would report any safety violation to their supervisors. SN05 People usually turn a 'blind eye' to unsafe matters. SN06 People are willing to report every workplace injury to the departmental management regardless of severity. SN07 People have a clear picture of the risks associated with their operations. SN08 People are in favor of legislation to ensure workplace safety. SN11 People's attitude towards safety issues is very positive.	0.8764
DSR's Perceived Safety Responsibility [SR]	SR01 As a DSR, I am clear about my safety responsibility for the department / office. SR02 As a DSR, I have to stop work if any imminent danger occurs. SR04 As a DSR, monitoring of individual's safety performance is part of my duty. SR05 As a DSR, departmental safety is my responsibility, not others. SR06 As a DSR, conduct of the departmental safety meeting is part of my duty. SR07 As a DSR, providing safety information to people involved is part of my duty.	0.9199
DSR's Perceived	PE01 As a DSR, I am capable identifying safety hazards at the workplace.	0.9256

Efficacy in Managing Safety [PE]	PE02 As a DSR, I know what to do in case of an emergency (such as fire, chemical spill). PE03 As a DSR, I am adequately trained in implementing the safety management program. PE04 As a DSR, I am capable of making suggestions on relevant safety control measures. PE05 As a DSR, I know how to apply the permit-to-work system in my department / office. PE06 As a DSR, I know how to conduct the workplace risk assessment.	

Based on the result of the pilot test, all forty-three (43) items in the questionnaire were used for the field survey. The self-reported DSRs safety attitudes survey questionnaire was then restructured into forty-three (43) items for the field survey.

3.5 STEP 5: RESTRUCTURE OF THE QUESTIONNAIRE FOR FIELD SURVEY:

After establishing the validity and reliability of the research instrument – survey questionnaire, the 43 remaining items were refined in the questionnaire for field survey. A complete set of the restructured self-reported six points Likert type "DSRs Safety Attitudes Survey" questionnaire with an introductory letter for field survey is attached in *Appendix III* and "Summary of DSRs Safety Attitudes Survey Questionnaire – Response Options in the field survey" is shown in *Appendix IV*. For easy reference, items are labeled in a sequential order in Table 26.

TABLE 26: REVISED QUESTIONNAIRE WITH THE REMAINING 43 ITEMS FOR FIELD SURVEY

SCALE	REVISED ITEMS
Safety Management [SM]	SM01 = 1, SM03 = 2, SM05 = 3,

	SM07 = 4, SM08 = 5
Perceived Management Commitment To Safety [MC]	MC01 = 6, MC02 = 7, MC05 = 8, MC06 = 9, MC07 = 10, MC08 = 11
Safety Communication [SC]	SC01= 12, SC02 = 13, SC03 = 14, SC05 = 15
DSR's Perceptions of Safety Training [ST]	ST01 = 16, ST05 = 17, ST06 = 18, ST08 = 19, ST09 = 20
DSR's Personal Beliefs in Accident Causation [PB]	PB02 = 21, PB03 = 22, PB05 = 23, PB07=- 24, PB10 = 25
DSR's Perceptions of Group Safety Norms [SN]	SN04 = 26, SN05 = 27, SN06 = 28, SN07 = 29, SN08 = 30, SN11 = 31
DSR's Perceived Safety Responsibility [SR]	SR01 = 32, SR02 = 33, SR04 = 34, SR05 = 35, SR06 = 36, SR07 = 37
DSR's Perceived Efficacy in Managing Safety [PE]	PE01 = 38, PE02 = 39, PE03 = 40, PE04 = 41, PE05 = 42, PE06 = 43

3.6 STEP 6: COLLECTION OF FIELD DATA:

The formal self-reported "DSRs Safety Attitudes Survey" questionnaire for the collection of actual field data contains eight (8) variables that are supposed to have key roles in determining the "DSRs Safety Attitude Model". The launch of formal self-reported questionnaire for field survey was approved by Dr. Joseph Kwan, Director of SEPO before the distribution to all DSRs to fill-in. To ensure effective data collection, the pilot survey would be excluded from the actual field data collection.

Apart from 120 DSRs who conducted the pilot survey, the rest of 194 DSRs who did not participate in pilot survey were invited to join the field survey. The distribution of questionnaires was done through the internal postal system. A total of 194 sets of a self-reported "Safety Attitudes Survey" with an introductory letter (see the *Appendix III*) were distributed to the targeted population via internal mail in May 2006. Contents of an introductory letter described the purpose, instruction on how to complete the questionnaire and confidentiality of the survey. Respondents were requested to complete the survey questionnaire and send it back to the researcher either by internal mail or by hand within two weeks from the date of issue.

Simple guidelines to respondents for completing the questionnaire were also developed. To maintain anonymity, there was no requirement to put respondent's name, signature and department in the questionnaire. Prior to analysis, all questionnaires returned to the writer were coded, entered and double checked by the researcher to ensure that there are no duplicates and missing data. A total of 144 valid questionnaires (with a response rate of 74.23%) were finally secured and formed the basis for the subsequent analyses.

3.7 STEP 7: RE-TEST OF RELIABILITY:

The reliability of each of the questionnaire scales from the 144 field data was verified again by Cronbach's Alpha. A further reliability test of the 43 items was conducted. Cronbach's alpha 'α' values of all forty-three (43) items ranging from 0.8297 to 0.9192 (in Table 27) are over the recommended level of 0.70 and no significant cross-loading was found among the eight (8) exogenous variables. Results indicated that the data are highly reliable. At this stage, both validity and reliability were tested and are over the recommended level. The structural "DSRs Safety Attitude Model" comprising two endogenous variables and eight (8) exogenous variables will be tested empirically in the next chapter.

TABLE 27: SUMMARY OF RELIABILITY FOR THE REMAINING 43 ITEMS IN FIELD SURVEY

Scale	**Items**	**Cronbach's Alpha 'α'**
Safety Management [SM]	SM01, SM03, SM05, SM07, SM08	0.8835
Perceived Management Commitment To Safety [MC]	MC01, MC02, MC05, MC06, MC07, MC08	0.8297
Safety Communication [SC]	SC01, SC02, SC03, SC05	0.8591
DSR's Perceptions of Safety Training	ST01, ST05, ST06, ST08, ST09	0.8799

[ST]		
DSR's Personal Beliefs in Accident Causation [PB]	PB02, PB03, PB05, PB07, PB10	0.9111
DSR's Perceptions of Group Safety Norms [SN]	SN04, SN05, SN06, SN07, SN08, SN11	0.8670
DSR's Perceived Safety Responsibility [SR]	SR01, SR02, SR04, SR05, SR06, SR07	0.9152
DSR's Perceived Efficacy in Managing Safety [PE]	PE01, PE02, PE03, PE04, PE05, PE06	0.9192

Up to this end, actual field data collected from 144 valid questionnaires was tested. Results of reliability test indicated the data was highly consistent internally, Cronbach's alpha 'α' values ranging from 0.8297 to 0.9192. The data would then be subjected to model testing in the next chapter.

4. CHAPTER SUMMARY:

This chapter has given a detailed treatment on the construction of the research instrument – survey questionnaire. Steps in developing, testing of validity and reliability of the research instrument were discussed in detail. Attitude surveys provided insights that are extremely important to assess the safety attitudes of respondents "DSRs". It is considered that use a self-reported questionnaire is more appropriate at eliciting responses on items that are sensitive in this study. For example, questionnaire items of SM11 "Departmental management only report accident involving of lost-working injury to SEPO" and MC06 "Departmental management is concerned for the operating cost more than safety" in the pilot survey. Interview the target group was not included in the pilot and field surveys. Respondents might feel less intimidated to answer a self-reported questionnaire when compared to being confronted an interviewer asking questions they regard as "sensitive". Interviews were not conducted as validation of the items in the questionnaire were derived from the literature and subjected to validation by expert opinion.

It is important to know what variables could directly or indirectly influence the safety attitudes of DSRs towards the implementation of SMS at departmental level. Factor analysis was the primary analytical method used for this project to examine the validity of various items in the questionnaire. Analysis confirmed that a valid and reliable questionnaire was developed and used to conduct the DSRs safety attitudes survey. A very good response was received as well as positive comments on the content of the questionnaire. The results of these studies clearly highlight how attitude is an outcome of a complex interaction of a variety of factors. The survey and analysis examined what personal factors of DSRs are most likely to influence the effectiveness of SMS. As such, the strength, weaknesses of the existing SMS can be reviewed to meet new challenges. The results of the survey will give indications to the University as to how to get DSRs involved in the implementation of SMS in an effective manner. It also indicates how well the safety management philosophies have been integrated into the University's operations. All this helps the University further strengthen the SMS at University's level. The ultimate goal is to foster safety culture amongst stakeholders, so as to ensure a healthy and safe environment in the University.

Chapter Seven (7) will proceed to the "Step Five – Model Testing" in accordance with the basic approach to performing a SEM analysis. The purpose of model testing is to test appropriateness of the structural model.

CHAPTER SEVEN

MODEL TESTING OF

THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL"

1. INTRODUCTION:

The hypothesized "DSRs Safety Attitude Model" tends to explain the direct and indirect effects amongst eight (8) exogenous variables and two (2) endogenous variables. These eight (8) exogenous variables include "Perceived Safety Responsibility" [SR], "DSRs Perceived Self-efficacy in Managing Safety" [PE], "DSRs Personal Beliefs in Accident Causation" [PB], "Safety Management" [SM], "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety Norms" [SN] in the hypothesized model represented in rectangles. The model also included two (2) endogenous variables "Safety Culture" and "DSR Safety Attitude" shown in ovals.

It is assumed that all such variables in one way or other do spell out DSRs safety attitudes associated with safety culture; which in turn affect DSRs safety attitudes towards the implementation of SMS at departmental level.

SEM has the ability to test causal relationships between measured variables in the hypothesized model. This chapter is focused on the "Step Five - Model Testing" and the "Step Six – Results" of the basic approach to performing a SEM analysis. The hypothesized "DSRs Safety Attitude Model" is going to be tested under six (6) key steps of "Model Testing" including model identification, formulating research hypotheses, selection of model fit indexes for Goodness-of-fit tests, evaluate model fit, re-specify the model based on the model's fit and discussion of findings.

Tests were conducted using Structural Equation Modeling "SEM" confirmatory factor analysis (CFA) for analyzing a series of dependence relationships among endogenous and exogenous variables simultaneously. Goodness-of-fit and significances tests are examined. All SEM and CFA were performed using AMOS.

2. JUSTIFICATIONS OF USING SEM FOR TESTING THE FITNESS OF THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL":

Why are researchers and academia using structural equation modeling (SEM) for testing the fitness of hypothesized models? The following justifications are presented:-

- *"A main reason that structural equation models are widely used in many scientific fields of study is that they provide a mechanism for explicitly taking into account measurement error in the observed variables (both dependent and independent) considered in a model. In contrast, traditional regression analysis effectively ignores potential measurement error in all the explanatory (independent) variables included in a model. As a result, regression estimates can be misleading and potentially lead to incorrect substantive conclusions."* (Raykov et al., 2000, p.7)

- *"SEM can also be used to test the plausibility of hypothetical assertions about potential interrelationships between constructs and their observed measures or indicators. Latent variables are hypothesized to be responsible for the* *outcome of observed measures."* (Hershberger et al., 2003, p.4)

- *"SEM is a statistical approach for hypothesis testing of relations between latent and observed variables, providing a possibility for modeling complex dependencies using the illustrative power of path diagrams".* (Larsson, 2005, p.15)

Schumacker et al. (2004, pp.98-99) also listed their reasons to support the use of SEM for model testing:-

- *Researchers are becoming more aware of the need to use multiple observed variables to better understand their area of scientific inquiry.*
- *More recognition is given to the validity and reliability of observed scores from measurement instruments.*
- *Structural equation modeling has improved recently, especially the ability to analyze more advanced statistical models.*
- *SEM software programs have become increasingly user-friendly.*

After the justifications of using SEM for model testing, attention is turned to the process of SEM model testing the fitness of the hypothesized "DSRs Safety Attitude Model".

3. <u>MODEL TESTING:</u>

Schumacker et al. (2004, pp.98-99) explain the goal of SEM analysis is "*To determine the extent to which the theoretical model is supported by sample data. If the sample data support the theoretical model, then more complex theoretical models can be* *hypothesized. If the sample data do not support the theoretical model, then either the original model can be modified and tested or other theoretical models need to be developed and tested. Consequently, SEM tests theoretical models using the scientific method of hypothesis testing to advance our understanding of the complex relationships amongst constructs."*

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are two statistical approaches in SEM model testing. *"Exploratory factor analysis (EFA) seeks to uncover the underlying structure of a relatively large set of variables. The researcher's a priori assumption is that any indicator may be associated with any factor. This is the most common form of factor analysis. There is no prior theory and one uses factor loadings to intuit the factor structure of the data."* Available from: Garson D., *Factor Analysis.* http://www2.chass.ncsu.edu/garson/pa765/factor.htm#concepts [Accessed 13 April 2008]

In this study, CFA is employed for structural equation modeling tests to determine whether a preconceived model underlies a particular set of observations. Following is the justifications:-

- ✧ *"Confirmatory factor analysis models are commonly used to examine patterns of interrelationships among several constructs. Each construct included in the model is usually measured by its own set of observed indicators. Thus, in a confirmatory factor analysis model no specific directional relationships are assumed between the constructs, only that they are correlated with one another."* (Raykov et al., 2000, pp.3-5)

- ✧ *"Confirmatory factor analysis (CFA) seeks to determine if the number of* *factors and the loadings of measured (indicator) variables on them conform to what is expected on the basis of pre-established theory. Indicator variables are selected on the basis of prior theory and factor analysis is used to see if they load as predicted on the expected number of factors."* Available from: Garson D., *Factor Analysis.* http://www2.chass.ncsu.edu/garson/pa765/factor.htm#concepts [Accessed 13 April 2008]

- *"Confirmatory factor analysis (CFA) is a statistical technique used to verify the factor structure of a set of observed variables. CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists. The researcher uses knowledge of the theory, empirical research, or both, postulates the relationship pattern a priori and then tests the hypothesis statistically."* Available from: Suhr, D. *Exploratory or Confirmatory Factor Analysis?* Paper 200-31, University of Northern Colorado, http://www2.sas.com/proceedings/sugi31/200-31.pdf [Accessed 20 February 2008]

"SEM is usually views as a confirmatory rather than exploratory procedure, in that models constructed by researchers using this approach are tested with measures of the degree to which the data fit the models."… "A common misconception about SEM is that it provides statistical evidence of a causal link between variables. The estimated coefficients in SEM tell us nothing about causality per se. Causality can only be inferred from the hypothesized model originally constructed by the researcher, and not merely from the statistical test of that model." (Blanche et al., 1999, pp.262-263) *"The condition with regard to which SEM is most frequently misunderstood is directionality. Directional*

arrows in path diagrams are incorrectly interpreted by some as indicting that directionally has been tested using SEM or is implied by the investigator who has used SEM". (Hoyle, 1995, p.10)

Following are six (6) key steps of "Model Testing" in this study:-

Step 1: Model identification

Step 2: Formulating research hypotheses

Step 3: Selection of model fit indexes for Goodness-of-fit tests

Step 4: Evaluate model fit

Step 5: Re-specify the model based on the model's fit

Step 6: Discussion of findings

Model testing was conducted using Structural Equation Modeling "SEM" for analyzing a series of dependence relationships among endogenous and exogenous variables simultaneously. All SEM and confirmatory factor analysis were performed using AMOS. The procedure was to test statistically the hypothesized models against a correlation matrix constructed from empirical measures of the variables. Steps were employed to test the fitness of the model by comparing the observed correlation matrix for the variable, with a goodness-of-fit statistic, and to interpret the result.

3.1 STEP 1 - MODEL IDENTIFICATION:

This step is to determine whether the model is identified before the test. Schumacker et al. (2004, p.63) states that "*In structural equation modeling, it is crucial that the researcher resolve the identification problem prior to the estimation of parameters*".

"Model Identification concerns whether a unique value for each and every free parameter can be obtained from the observed data. It depends on the model choice and the specification of fixed, constrained and free parameters."... "The parameters of a SEM are the variances, regression coefficients and covariances among variables." Available from: Stoelting, R. *Structural Equation Modeling/Path Analysis,* http://userwww.sfsu.edu/~efc/classes/biol710/path/SEMwebpage.htm [Accessed 24 January 2008]

Identification also refers to the idea that *"There is at least one unique solution for each parameter estimate in a SEM model. Models in which there is only one possible solution for each parameter estimate are said to be just-identified. Models for which there are an infinite number of possible parameter estimate values are said to be underidentified. Finally, models that have more than one possible solution (but one best or optimal solution) for each parameter estimate are considered overidentified."* Available from: *Structural Equation Modeling using AMOS: An Introduction – model identification.* http://www.utexas.edu/its-archive/rc/tutorials/stat/amos/#model identification [Accessed 9 November 2007]

In this study, the hypothesized "DSRs Safety Attitude Model" needs to be overidentified in order to be estimated and in order to test hypotheses about relationships among variables. Hanneman (2000) holds the opinion that *"A SEM model can be interpreted as a set of simultaneous linear equations mathematically. This set of equations represents a hypothesis about the way in which observed variables covary or correlate."* Available from: Hanneman R. A. (2000). *Structural Equation Models: Identification issues* Online Lecture Notes: Sociology 203B. Department of Sociology, University of California, Riverside. http://www.wizard.ucr.edu/~rhannema/soc203b/lectures/identify.html [Accessed 10 November 2007]

The issue of performing identification checks as part of the model fitting process requires mathematical calculation. The variance of the endogenous variables and the regression (path) coefficients associated with them depend on the units with which the variables are measured, but initially this is unknown. The SEM software program permits examination of more complex relationships in the hypothesized model.

The literature review has led to the conclusion that a SEM can be overidentified by having the value of some of the unknown parameters being pre-defined.

"Path Coefficient (path weight) - a path coefficient is a standardized regression coefficient (beta) showing the direct effect of an independent variable on a dependent variable in the path model". Available from: Garson D. *Path Analysis.* http://faculty.chass.ncsu.edu/garson/PA765/path.htm [Accessed 26 July 2008]

In achieving identification of the model, *"It is necessary to assign an arbitrary value to a regression weight associated with the latent variable or error term. Once this is done, the remaining coefficients can be estimated for the remaining paths in the model. Therefore, for each latent variable, one of the paths leading away from it toward one of its indicator measures has been set to 1 by the researcher. This sets the measurement scale of each latent variable, whereas without this the scale would be indeterminate. Likewise, the paths from each error term to each indicator variable are set at 1. With these constraints, the model is identified."* Available from: Garson, D., *Structural Equation Modeling Example Using WinAMOS.* http://www2.chass.ncsu.edu/garson/PA765/semAMOS1.htm [Accessed 28 November 2007]

Note that *"The indicator selected to be constrained to 1.0 is the reference item. Typically one selects as the reference item the one which in factor analysis loads most heavily on the dimension represented by the latent variable, thereby allowing it to anchor the meaning of that dimension."* Available from: Garson, D., *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm. [Accessed 7 December 2007]

It is also noted that *"When one builds a confirmatory factor analysis, the observed variables are also known as "indicator" variables, because they load together on the underlying theoretical construct."* (Jackson et al., 2005, p.2)

Based on Garson's suggestion, a process of model identification is required before subjecting the hypothesized model depicted in Figure 19 to be analyzed by AMOS. In this research, there are two (2) endogenous variables (latent) "Safety Culture" and "DSRs Safety Attitude" in the hypothesized model. "Safety Culture" is represented by five (5) exogenous (observed) variables included "Safety Management" [SM], "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety Norms" [SN]. "DSR Safety Attitude" is represented by three (3) exogenous (observed) variables "DSRs Personal Beliefs in Accident Causation" [PB], "DSRs Perceived Self-efficacy in Managing Safety" [PE] and "Perceived Safety Responsibility" [SR].

Based on theoretical consideration, regression paths included the endogenous variable "Safety Culture" to the exogenous variable "Safety Management" [SM] and the endogenous variable "DSR Safety Attitude" to the exogenous variable "Perceived Safety Responsibility" [SR] have been set to 1 as reference items in the hypothesized model. It is implies that the "Safety Culture" has a positive direct impact on "Safety Management" [SM] and "DSR Safety Attitude" has a positive direct impact on "Perceived Safety Responsibility" [SR]. A review of literature regarding the endogenous variable "Safety Culture" to the exogenous variable "Safety Management" [SM] can be found in "Chapter Four (4) Section 4.2: Paradigm shift to cultivate a Positive Safety Culture" and "Chapter Five (5) Section 3.4.1: Safety Culture → Safety Management [SM]". Review of literature regarding the endogenous variable "DSR Safety Attitude" to the exogenous variable "Perceived Safety Responsibility" [SR] can be found in "Chapter Two Section 3.3.1: Accountability and Responsibility" and "Chapter Five (5) Section 3.4.6: DSR Safety Attitude → DSRs Perceived Safety Responsibility [SR]".

Likewise, paths from error terms to relevant variables were set at 1. Paths are included:-

- e1 to "Perceived Safety Responsibility [SR]"
- e2 to "DSRs Perceived Self-efficacy in Managing Safety [PE]"
- e3 to "DSRs Personal Beliefs in Accident Causation [PB]"
- e4 to "Safety Management [SM]"
- e5 to "DSRs Perceptions of Safety Training [ST]"
- e6 to "Perceived Management Commitment to Safety [MC]"
- e7 to "Safety Communication [SC]"
- e8 to "DSRs Perceptions of Group Safety Norms [SN]"
- e9 to "DSRs Safety Attitude"

At this stage, the path-regressions included "Safety Culture" to "DSR Safety Attitude", "Safety Culture" to [SM], as well as "DSR Safety Attitude" to [SR] is defaulted to unity for model identification. For easy reference, the hypothesized DSRs Safety Attitude Model with parameter constraints imposed was re-drawn in Figure 24.

Research hypotheses sought to confirm whether theoretical underlying constructs are reflected in the observed data by using confirmatory factor analysis "CFA" in this study. After the model identification, step 2, formulating research questions and hypotheses for the study is next.

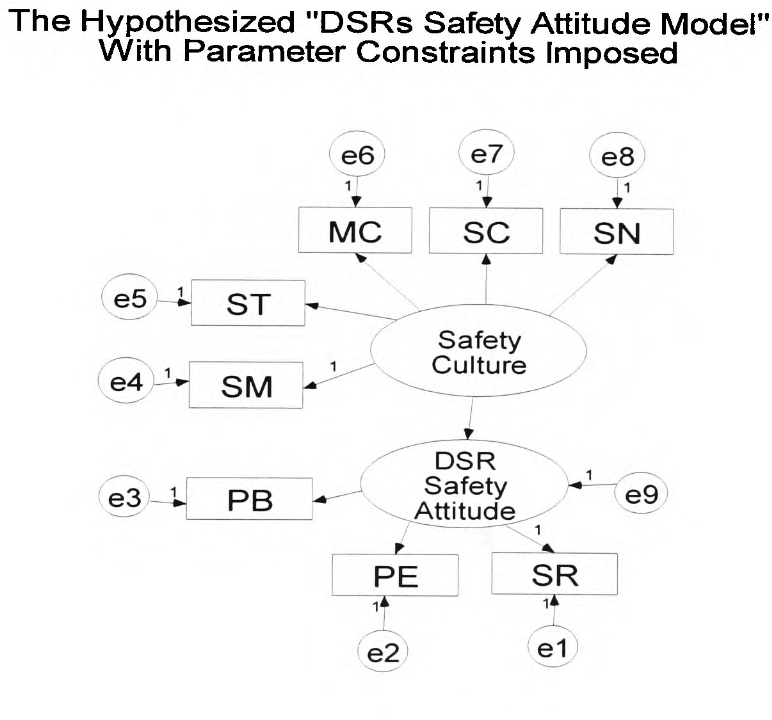


FIGURE 24: THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL" WITH PARAMETER CONSTRAINTS IMPOSED TO [SM] AND [SR]

3.2 STEP 2 - FORMULATING RESEARCH HYPOTHESES:

To test whether the hypothesized model fits the data, the hypothesis of an overall model fitness under test is denoted H0 and is presented below:-

HYPOTHESIS H0: "The DSRs Safety Attitude Model fits the data"

Regarding the testing of research hypotheses between the model constructs, there are seven (7) hypotheses H1-H7 proposed between two (2) endogenous variables (latent) and its associated variables in the hypothesized "DSRs Safety Attitude Model". Their proposed relationships are clearly defined with theoretical support from the literature review.

An overview of four (4) research questions and eight (8) research hypotheses (H0–H7) for the "DSRs Safety Attitude Model" is summarized in Table 28.

TABLE 28: OVERVIEW OF RESEARCH QUESTIONS AND HYPOTHESES BETWEEN THE MODEL CONSTRUCTS

RELATIONSHIPS BETWEEN THE MODEL CONSTRUCTS	RESEARCH QUESTIONS	RESEARCH HYPOTHESES
AN OVERALL MODEL OF "DSRS SAFETY ATTITUDE MODEL"	**RESEARCH QUESTION 1:** Does the hypothesized model fit the data?	**HYPOTHESIS H0:** The DSRs Safety Attitude Model fits the data.
SAFETY CULTURE → DSRS SAFETY ATTITUDE	**RESEARCH QUESTION 2:** To what extent does safety culture affect DSRs safety attitude on the implementation of SMS at departmental level?	**HYPOTHESIS H1:** The extent to which Safety Culture will have a positive direct impact on DSRs Safety Attitude.
SAFETY CULTURE → DSR'S PERCEPTIONS OF SAFETY TRAINING [ST]	**RESEARCH QUESTION 3:** To what extent does safety culture affect DSRs perceptions on the implementation of SMS at	**HYPOTHESIS H2:** The extent to which Safety Culture will have a positive direct impact on DSRs Perceptions of Safety

	departmental level?	Training [ST].
SAFETY CULTURE → PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC]		**HYPOTHESIS H3:** The extent to which Safety Culture will have a positive direct impact on Perceived Management Commitment to Safety [MC]
SAFETY CULTURE → SAFETY COMMUNICATION [SC]		**HYPOTHESIS H4:** The extent to which Safety Culture will have a positive direct impact on Safety Communication [SC].
SAFETY CULTURE → DSR'S PERCEPTIONS OF GROUP SAFETY NORMS [SN]		**HYPOTHESIS H5:** The extent to which Safety Culture will have a positive direct impact on DSRs Perceptions of Group Safety Norms [SN].
DSRS SAFETY ATTITUDE → DSR'S PERCEIVED SELF-EFFICACY IN MANAGING SAFETY [PE]	**RESEARCH QUESTION 4:** To what extent does the "Personal Beliefs" of DSRs affect their safety attitudes on the implementation of SMS at departmental level?	**HYPOTHESIS H6:** The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Perceived Self-efficacy in Managing Safety [PE].
DSRS SAFETY ATTITUDE → DSR'S PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB]		**HYPOTHESIS H7:** The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Personal Beliefs in Accident Causation [PB]

The hypothesis of an overall model fitness under test, denoted H0 and seven (7) other hypotheses (H1-H7) for the causal relationships within the model constructs were proposed. When a good-fitting model is found, the structural parameters of the hypothesized model will be estimated.

For easy reference, the hypothesized "DSRs Safety Attitude Model" with hypotheses (H1-H7) and parameter constraints imposed is depicted in Figure 25.

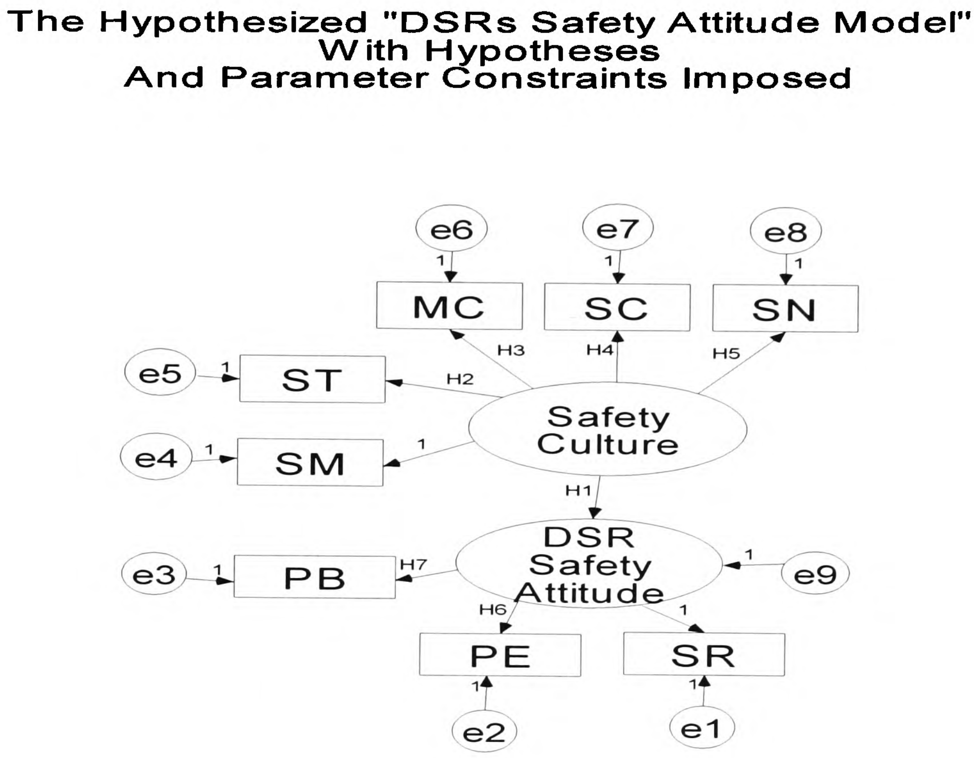


FIGURE 25: THE HYPOTHESIZED "DSRS SAFETY ATTITUDE MODEL" WITH HYPOTHESES (H1-H7) AND PARAMETER CONSTRAINTS IMPOSED

To analyze the model, Step 3, Selection of Model Fit Indexes for Goodness-of-fit tests follows.

3.3 STEP 3 - SELECTION OF MODEL FIT INDEXES FOR GOODNESS-OF-FIT TESTS:

The hypothesized "DSRs Safety Attitude Model" in Figure 25 contains two (2) endogenous variables (latent) with various variables which could help to explain DSRs safety attitude. The hypothesized model will be a predictive model if the model constructs fit the data.

The fundamental question of model testing is imposed to clarify the reason for "Goodness of fit" test. Byrne (2001, p.7) states that *"Once the model is specified, the researcher tests its plausibility based on sample data that comprise all observed variables in the model. The primary task in this model-testing procedure is to determine the goodness of fit between the hypothesized model and the sample data. As such, the researcher imposes the structure of the hypothesized model on the sample data, and then tests how well the observed data fit this restricted structure."*

Perrin (1999, pp.524-624) writes, *"In general, the goodness-of-fit of a model to the data is determined by comparing the observed covariances with the covariances predicted by the model. Large discrepancies between the two sets of covariances are indicative of a poor fitting model"*. Deleus et al. also states that *"A structural equation model implies a structure of the covariance matrix of the variables. Once the model's parameters have been estimated, the resulting model-implied covariance matrix can be compared to an observed or data-based covariance matrix. If the two matrices are consistent with one another, the structural equation model can be considered a plausible explanation for relations between the measures."* Available from: Deleus F. and Van Hulle M. *Modelling the Connectivity Between Terms in the Neuroscience Literature. pp. 3293-94.* http://ieeexplore.ieee.org/iel5/9486/30109/01381207.pdf?arnumber=1381207 [Accessed 26 Feb, 2008] It is concluded that less discrepancies between the two sets of covariances, the better will be the model fitness.

In SEM testing, the careful choice of suitable model fit indexes for assessment of an overall model fit has become a critical issue for the researcher's consideration. To choose appropriate model-fit indexes to support the view that the model being tested is a good fit model is a must, Schumacker et al (2004, pp.100-104) suggested that "*Model fit determines the degree to which the sample variance covariance data fit the structural equation model*" and "*Parsimony refers to the number of estimated parameters required to achieve a specific level of fit. Basically, an overidentified model is compared with a restricted model.*"

Coughlin et al. also explain the term "Parsimony" as:-

- *Better to have a model with fewer paths; and*
- *Able to explain variables with fewer paths and fewer equations;*
- *Similar principle in multiple regression – more economical to be able to predict with fewer predictors.*

Available from: Coughlin M.A. and Knight W., *Confirmatory Factor Analysis: The Basis for the Structural Model.* http://www.spss.com/events/e_id_2134/presentation.ppt#28 [Accessed 6 November, 2007]

The goodness of fit of SEM emphasized model parsimony; a more parsimonious model with fewer estimated parameters is better than a more complex model. This research is looking for a "Fit but Parsimonious" model as the basic principle of parsimony suggests the simplest of similar models is the better choice. While exploring the "DSRs Safety Attitude Model" fitting with the data, the issue of parsimony should not be overlooked. Stapleton (1997) writes, *"One of the goals of science is parsimony, because as William of Occam argued, parsimonious solutions are more likely to be true and are* *therefore typically more generalisable"* (paragraph. 29).

For model testing, different fit indexes for model parsimony carrying different implications. Kam (2002, p.299) states that *"After model testing, AMOS generates a number of statistical outputs including 25 different goodness-of-fit measures. The researcher will have to choose appropriate fit indexes to support the view that the model being tested is a good fit model."*

The fact that there are so many is indicative of both the fact that none are perfect and the importance of model fitting in SEM. *"There is wide disagreement on just which fit indexes to report, but one should avoid the shotgun approach of reporting all of them, which seems to imply the researcher is on a fishing expedition."* Available from: Garson D. *Structural Equation Modeling - Goodness of fit tests* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 29 April 2008]

The warnings of Garson had alerted researchers that there are no pre-determined sets of indexes ready for selection. Any estimates falling outside the admissible range signal a clear indication that either the model is wrong, or the input matrix lacks sufficient information.

To evaluate the overall goodness of fit of the models, a mixture of fit-indexes included the ratio of Chi-square (p) value, Goodness-of-fit index (GFI), Adjusted Goodness-of-fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA) and PCLOSE were employed in this study. The choice of above-mentioned indexes should be justified. A detailed submission has been made in this section on the choice of the model-fit indexes. Following is a detailed explanation on the justification of the choice of fit indexes in this study:-

- **Chi-square (p) value:** Chi-square test was used to test the possible statistical significant differences between variables. It compares the predicted and observed covariance matrix; a zero value indicates that there is no difference between the two representing a perfect fit. The chi-square test is an absolute test of model fit: If the probability value (P) is below 0.05, the model is rejected. Available from: *Interpreting AMOS Output – Section 5.* http://www.utexas.edu/its/rc/tutorials/stat/amos/ [Accessed 28 August 2006]. For model fit acceptance, the Chi-square (p) value should be greater than 0.05. **[p>0.05]**

  Also note that *"The degrees of freedom will be the difference between the number of observations and the number of parameters the model must estimate. A just-identified model is one with no degrees of freedom. An over-identified model is one with positive degrees of freedom."…. "Some researchers divide the Chi-square by the numbers of degrees of freedom. A rule of thumb is that if this ratio is less than 2, it is considered well-fitted; it is considered acceptable if it is less than 3 and definitely not acceptable if greater than 5."* (Jackson et al., 2005, pp.12-13)

- **The Root Mean Square Error of Approximation (RMSEA)** is an absolute fit index and a standardized summary of the average covariance residuals. Loehlin et al. (2004, p.68) states that *"The Root Mean Square Error of Approximation (RMSEA) is a population-based index, which means that it is relatively insensitive to sample size. It has an explicit parsimony adjustment, does not require specification of a baseline model, and one can obtain confidence intervals for it or use it to carry out statistical tests."* McCallum et al. (1996, pp.130-149) also describes that *"While different indicators have been proposed to interpret the goodness of fit of findings from confirmatory factor analyses, the Root Mean Square Error of Approximation (RMSEA) has been regarded as the most informative indicator in structural equation modeling".*

"A value of the RMSEA up to 0.05 would indicate a good model fit. A value of about 0.08 or less would indicate a reasonable error of approximation, and values greater than 0.1 indicate poor model fit" (Browne and Cudeck, 1993, pp.132-162). For model of fit acceptance, a value of RMSEA for a good model should be less than or equal to 0.05 is considered acceptable. **[RMSEA <=0.05]**

- **PCLOSE** is a "p value" that tests the null hypothesis that RMSEA is no greater than 0.05. Available from: Garson, D., (1998) *PA 765 Statnotes:* An Online Textbook. NC State University. http://www2.chass.ncsu.edu/garson/pa765/statnote.htm [Accessed 13 April 2008]

A value of the PCLOSE less than 0.05 would lead to the rejection of the null hypothesis and conclude that the computed RMSEA is greater than 0.05 indicating lack of a close fit. **[PCLOSE>=0.05]**

- **Jörskog-Sörbom Goodness-of-fit Index (GFI)** directly assessed how well a model reproduces the sample data and does not depend explicitly on sample size. It is a measure of the discrepancy between predicted and observed covariance, varying between 0 for no fit and 1 for perfect fit, indicates the proportion of the observed covariance explained by the model covariance. *"A value of 0.9 for all these indices has been proposed as a minimum for model acceptance"* (Bentler et al., 1980, pp.588-606). For model fit acceptance, GFI should be equal to or greater than 0.90. **[GFI>=0.90]**

- **Adjusted Goodness-of-fit Index (AGFI)** provides an index of model parsimony. It is a variant of GFI and a parsimony rewarding measure. For model fit acceptance, AGFI should be equal to or greater than 0.90. **[AGFI>=0.90]**

The rationale on the choice of model-fit indexes was thoroughly discussed. Five model-fit indexes, namely the Chi-square (p) value, Root Mean Square Error of Approximation (RMSEA), PCLOSE, Goodness-of-fit Index (GFI) and Adjusted Goodness-of-fit Index (AGFI) to be adopted for the evaluation of model fitness are consolidated in Table 29. *"Each fit measure is designed to give information about how well your model fits the data in your dataset."* (Jackson et al., 2005, pp.12-13)

TABLE 29: SUMMARY OF MODEL-FIT INDICES

MODEL FIT INDEX	MINIMUM ACCEPTABLE VALUE FOR MODEL FITNESS	MODEL – FIT ACCEPTANCE (YES/NO)
Chi-square (p) value	P > 0.05	Yes
Root Mean Square Error of Approximation (RMSEA)	RMSEA <=0.05	Yes
PCLOSE	PCLOSE >= 0.05	Yes
Goodness-of-fit index (GFI)	GFI>=0.90	Yes
Adjusted goodness-of-fit index (AGFI)	AGFI >= 0.90	Yes

All five (5) selected model indexes will use to determine the adequacy of the hypothesized "DSRs Safety Attitude Model". After imposing all the parameter constraints for model testing, the selection of modification indexes (M.I.) is also required, in order to obtain a better-fitting model.

3.3.1 SELECTION OF MODIFICATION INDICES (MI) FOR MODEL TESTING:

Why the M.I. threshold is set to 4 for model testing? *"It is rare that a model fits well at first. Sometimes model modification is required to obtain a better-fitting model. AMOS allows for the use of modification indices to generate the expected reduction in the overall model fit chi-square for each possible path that can be added to the model."…. "The Threshold for Modification Indices allows you to specify what level of chi-square change is required for a path to be included in the modification index output. The default value is 4.00 because it slightly exceeds the tabled critical value of a chi-square distribution with* *one degree of freedom: 3.84."* Available from: *Interpreting AMOS Output – Section 5.* http://www.utexas.edu/its/rc/tutorials/stat/amos/ [Accessed 28 August 2006]

"The minimum value would be 3.84, since chi-square must drop that amount simply by virtue of having one less parameter (path) in the model." Available from: Garson D., *Structural Equation Modeling - Goodness of fit tests'* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 29 April 2008] After imposing all the parameter constraints with the default value of M.I. is set to 4 for model testing, the next is Step 4 to evaluate model fit of the hypothesized "DSRs Safety Attitude Model" depicted in Figure 25 against data collected.

3.4 STEP 4 - EVALUATE MODEL FIT:

Having specified the hypothesized model in previous sections, this section is focused on the evaluation of model fit via the input of field data collected from the survey. The model was then analyzed using AMOS 5, a statistical package of SPSS. AMOS 5 generated a comprehensive graphical output and text reports on the model constructs such as variances, regression weights and model fit indexes.

Regarding notations in SEM, *"A variance can be indicated by a two-headed arrow, both ends of which point at the same variable, or, more simply by a number within the variable's drawn box or circle. Regression coefficients are represented along single-headed arrows that indicate a hypothesized pathway between two variables (These are the weights applied to variables in linear regression equations). Covariances are* *associated with double-headed, curved arrows between two variables or error terms and indicate no directionality."* Available from: Stoelting, R. *Structural Equation Modeling/Path Analysis.* http://userwww.sfsu.edu/~efc/classes/biol710/path/SEMwebpage.htm [Accessed 24 January 2008]

The AMOS graphical output shows test results of the hypothesized "DSRs Safety Attitude Model" (the default model) in the following sections for discussion.

What is the default model? Garson (2008) explained that "*The default model is the researcher's structural model, always more parsimonious than the saturated model and almost always fitting better than the independence model with which it is compared using goodness of fit measures.*" Available from: Garson, D., *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 29 April 2008]

3.4.1 INTERPRETING THE RESULTS OF DEFAULT MODEL IN AN INITIAL TEST:

At this stage, the default model was analyzed using AMOS. The path diagram and graphical output showing an initial test result is shown in Figure 26.

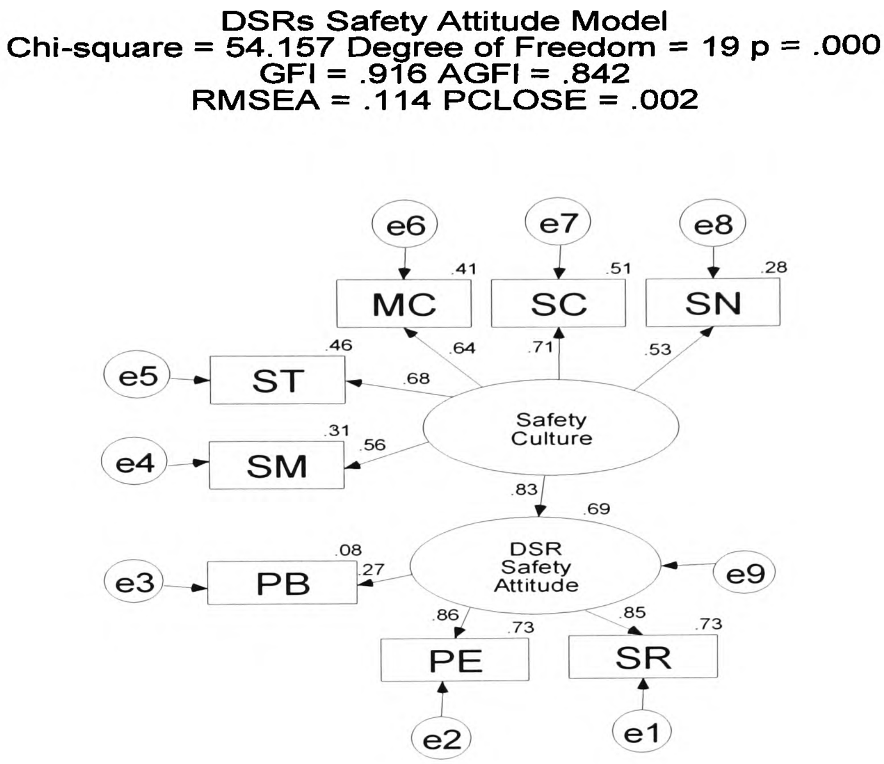


FIGURE 26: AN INITIAL TEST – DSRS' SAFETY ATTITUDE MODEL

Regarding the Goodness-of-fit of the model in Figure 26, initial fit statistics were found unsatisfactory. An initial test of the model fit indexes lead to the conclusion that the hypothesized model should be rejected based on the following reasons:-

1. The model testing yields a chi-square fit statistic of 54.157 with 19 degrees of freedom. The probability level (p-value) for observing the said chi-square value is zero. Since the observed level of significance is less than the cut-off limit of 0.05, the hypothesized model is to be rejected (ACITS, 1999; Garson, 1998).

2. Model fit indexes of GFI, AGFI and RMSEA; only the GFI is of value 0.916

greater that the minimum cut-off value of 0.90 for model acceptance. AGFI and RMSEA are of values falling outside the model acceptance limit. The value of AGFI after model testing is of value 0.842 which is below the acceptance value of 0.90 for model fitness, whereas the RMSEA is 0.114 which is greater than the maximum value of 0.05 for model fitness.

3. The PCLOSE is of value 0.002 less than 0.05 of the model acceptance limit would lead to the rejection of the null hypothesis and conclude that the computed RMSEA is greater than 0.05 indicating lack of a close fit.

For easy reference, test results of the fit statistics are displayed in Table 30:-

TABLE 30: TEST RESULTS OF THE FIT STATISTICS

MODEL FIT INDEX	MINIMUM ACCEPTABLE VALUE FOR MODEL FITNESS	OUTPUT VALUE	MODEL ACCEPTANCE (YES/NO)
Chi-square (p) value	P > 0.05	P=0.000	No
Goodness-of-fit index (GFI)	GFI>=0.90	GFI=0.916	Yes
Adjusted goodness-of-fit index (AGFI)	AGFI >= 0.90	AGFI=0.842	No
Root Mean Square Error of Approximation (RMSEA)	RMSEA <=0.05	RMSEA=0.114	No
PCLOSE	PCLOSE >= 0.05	PCLOSE=0.002	No

It is hypothesized that model fits the data well enough to serve as a useful representation of reality and a parsimonious explanation of the data. An initial test of the model fit indices lead to the conclusion that the default model should be rejected due to the model fit indexes indicate that the data do not fit the model. Schumacker et al. (2004, p.245) suggested that *"If the fit of an implied theoretical model is not acceptable, which is typically the case with an initial model, the next step would be to modify the model and* *subsequently evaluate the new, respecified model.*" Re-specify the model is required for model testing. Details would be discussed in section 3.5.

3.5 STEP 5 - RESPECIFY THE MODEL BASED ON THE MODEL'S FIT:

In connection with the testing of the default model, AMOS generates output with estimated chi-square values "M.I." that are used to justify the inclusion of each path for model fitness improvement. In Table 31, AMOS output listed out six (6) parameters included (ST→PB, SM→SR, MC→SN, SN→MC, PB→ST and SR→SM) with M.I. and the parameter change "Par Change".

TABLE 31: MODIFICATION INDICES OF DEFAULT MODEL - REGRESSION WEIGHTS

	M.I.	Par Change
PB <--- ST	7.990	.330
SR <--- SM	5.905	.159
SN <--- MC	4.793	.160
MC <--- SN	6.155	.170
ST <--- PB	11.480	.156
SM <--- SR	4.438	.126

M.I. for the regression path could lead to the reduction of the chi-square value in the default model. The suitability of each suggested new path should be justified under the theoretical considerations; even if M.I. and "Par change" indicate that model fit will increase if a regression path is added between variables or a covariance arrow is added between indicator error terms. *"The "parameter change," which is the estimated change in the new path coefficient when the model is altered (labeled "Par Change"). "Par change" is the estimated coefficient when adding arrows, since no arrow corresponds to a 0 regression coefficient, and the parameter change is the regression coefficient for the added arrow."* Available from: Garson D. *Structural Equation Modeling,* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 13 Feb 2008]

Before making full use of the M.I. suggested by AMOS in improving model fitness, ACITS (1999) and Arbuckle (1997) have both warned that the function of the MI should not be abused. The inclusion of additional causal paths may distort the theoretical sense of the default model in explaining DSRs' safety attitude towards the implementation of SMS at departmental level and also complicated the testing process. As such, the adoption of the M.I. in improving the model fitness should not rest entirely on the amount of chi-square reduction but should be justified theoretically. *"Caution should be used in model re-specification. Most SEM software will make suggestions for improving the model's fit. Blindly modifying the model according to those suggestions without a good theoretical justification will yield nonsensical, but well-fitted models."* (Jackson et al., 2005, p.12)

In this study, there are two (2) endogenous (latent) variables "Safety Culture" and "DSRs Safety Attitude" in the default model depicted in Figure 23. "Safety Culture" is represented by five (5) exogenous (observed) variables included "Safety Management" [SM], "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety Norms" [SN]. "DSR Safety Attitude" is represented by "DSRs Personal Beliefs in Accident Causation" [PB], "DSRs Perceived Self-efficacy in Managing Safety" [PE] and "Perceived Safety Responsibility" [SR]. At this stage, the inclusion of suggested regression paths is not considered, as the causal relationships between model constructs have already been fully addressed in Chapter Five (5) – Construction of the hypothesized DSRs Safety Attitude Model. After the theoretical evaluation, the inclusion of six (6) suggested regression paths (ST→PB, SM→SR, MC→SN, SN→MC, PB→ST and SR→SM) is rejected.

Now, attention is turned to the six pairs of suggested covariances between the residuals shown in Table 32. As suggested by Jackson et al. (2005, p.12); *"If the SEM software suggests that the fit would be better with the addition of a covariance between variables X and Y and that suggestion makes good theoretical sense to you, then the modification should be made. If there is no reasonable theoretical underpinning, such suggestions should be ignored."* As such, the suitability of each new added path in the default model should be justified under the theoretical considerations.

TABLE 32: MODIFICATION INDICES OF DEFAULT MODEL - COVARIANCES

	M.I.	Par Change
e6 <--> e1	5.167	-1.930
e6 <--> e8	9.114	3.951
e5 <--> e3	12.363	3.065
e4 <--> e9	5.757	1.646

	M.I.	Par Change
e4 <--> e3	5.223	-2.410
e4 <--> e1	9.671	2.034

A total of six pairs of covariances between the residuals e6 <--> e1; e6 <--> e8; e5 <--> e3; e4 <--> e9; e4 <--> e3 and e4 <--> e1 listed in Table 32 are suggested for considerations in improving the model fitness. Based on theoretical evaluations, three pairs of suggested covariance paths (e6 <--> e1; e4 <--> e9 and e4 <--> e1) were not added in the model for testing. Following are the justifications:-

➢ The exclusion of covariation path e6 <--> e1

The e6 and e1 are residuals belonging to exogenous (observed) variables of [MC] and [SR] respectively. [MC] is grouped under an endogenous variable "Safety Culture" and [SR] is grouped under an endogenous variable "DSR Safety Attitude". The exclusion of the suggested covariance path e6 <--> e1 is justified since there is no common variance shared amongst these residuals. Further more, the expected reduction in chi-square statistic is 5.167 when e6 <--> e1 is included which is far below the expected reduction of 9.114, if replaced by e6 <--> e8.

➢ The exclusion of covariation path e4 <--> e9

The e4 is a residual belonging to exogenous (observed) variables of [SM] and e9 is a residual belonging to an endogenous (latent) variable "DSR Safety Attitude" respectively. [SM] is grouped under an endogenous variable (latent) "Safety Culture" and e9 a residual of an endogenous (latent) variable "DSR Safety Attitude". The exclusion of the suggested covariance path e4 <--> e9 is justified since there is no common variance shared amongst these residuals.

- <u>The exclusion of covariation path e4 <--> e1</u>

  The e4 and e1 are residuals belonging to exogenous (observed) variables of [SM] and [SR] respectively. [SM] is grouped under an endogenous (latent) variable "Safety Culture" and [SR] is grouped under an endogenous (latent) variable "DSR Safety Attitude". The exclusion of the suggested covariance path e4 <--> e1 is justified since there is no common variance shared amongst these residuals.

The exclusion of three pairs of suggested covariance paths included e6 <--> e1; e4 <--> e9 and e4 <--> e1 is justified. At this stage, only three pairs of suggested covariance paths e6 <--> e8, e5 <--> e3 and e4 <--> e3 are eligible for inclusion. The following is the theoretical justification:-

- <u>The inclusion of covariance path e6 <--> e8</u>

  The e6 is a residual belonging to "Perceived Management Commitment to Safety" [MC] and e8 is a residual belonging to "DSRs Perceptions of Group Safety Norms" [SN]. The covariance of e6 with e8 could be considered as the existence of a composite of common variables that [MC] and [SN] could depend upon but which are not included in the measurement. Examples of these common variables shared by [MC] and [[SN] could be "Departmental management always listens to safety concerns from people" [MC05] and

"People are willing to report every workplace injury to the departmental management regardless of severity" [SN06]. The inclusion of the suggested covariance path e6 <--> e8 is further secured since the expected reduction in chi-square statistic is 9.114 which is well above the expected reduction of 5.167 when e6 <--> e1 is included.

- <u>The inclusion of covariance path e5 <--> e3</u>

The e5 is a residual belonging to "DSRs Perceptions of Safety Training" [ST] and e3 is a residual belonging to "DSRs Personal Beliefs in Accident Causation" [PB]. The covariance of e5 with e3 could be considered as the existence of a composite of common variables that [ST] and [PB] could depend upon but which are not included in the measurement. Examples of these common variables shared by [ST] and [PB] could be "Safety training can positively change people's attitudes towards safety" [ST05] and "Accidents are mainly due to poor attitudes toward safety from people involved" [PB03]. The inclusion of the suggested covariance path e5 <--> e3 is further secured since the expected reduction in chi-square statistic is 12.363 which could make significant contribution in improving the model fitness.

- <u>The inclusion of covariance path e4 <--> e3</u>

The e4 is a residual belonging to "Safety Management [SM]" and e3 is a residual belonging to "DSRs Personal Beliefs in Accident Causation" [PB]. The covariance of e4 with e3 could be considered as the existence of a composite of common variables that [SM] and [PB] could depend upon but which are not included in the measurement. Examples of these common variables shared by [SM] and [PB] could be "SEPO safety manual provides useful guidelines for users" [SM08] and "Safety is the responsibility of SEPO, not others." [PB10]. The inclusion of the suggested covariance path e4 <--> e3 is further secured since the expected reduction in chi-square statistic is 5.223 which could make significant contribution in improving the model fitness.

At this stage, the three suggested covariance paths included e6 <--> e8; e5 <--> e3 and e4 <--> e3 were added in the model after theoretical justifications. In improving the model fitness, there are two additional covariance paths e6 <--> e7 and e1 <--> e2 also added in the model based on the theoretical considerations. Following is theoretical justifications:-

- <u>The inclusion of an additional covariance path e6 <--> e7 based on theoretical considerations:</u>

  The e6 is a residual belonging to "Perceived Management Commitment to Safety" [MC] and e7 is a residual belonging to "Safety Communication" [SC]. The covariance of e6 with e7 could be considered as the existence of a composite of common variables that [MC] and [SC] could depend upon but which are not included in the measurement. Examples of these common variables shared by [MC] and [SC] could be "Departmental management always listens to safety concerns from people" [MC05] and "People are freely making suggestions for safety improvement" [SC05].

➤ <u>The inclusion of an additional covariance path e2 <--> e1 based on theoretical considerations:</u>

The e2 is a residual belonging to "DSRs Perceived Self-efficacy in Managing Safety" [PE] and e1 is a residual belonging to "Perceived Safety Responsibility" [SR]. The covariance of e2 with e1 could be considered as the existence of a composite of common variables that [PE] and [SR] could depend upon but which are not included in the measurement. Examples of these common variables shared by [PE] and [SR] could be "As a DSR, I am adequately trained in implementing the safety management program" [PE03] and "As a DSR, monitoring of individual's safety performance is part of my duty" [SR04].

Up to this end, a total of five (5) covariance paths (e6 <--> e8; e5 <--> e3, e4 <--> e3, e6 <--> e7 and e1 <--> e2) were added in the model after theoretical justifications. The default model in Figure 27 is re-specified with the additional covariance paths imposed.

**The Re-specified "DSRs Safety Attitude Model"
With Additional Covariance Paths Imposed**

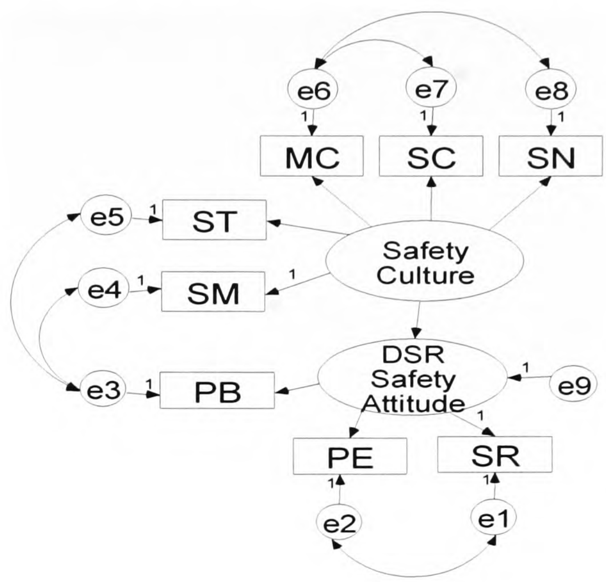


FIGURE 27: THE RE-SPECIFIED DSRS SAFETY ATTITUDE MODEL WITH ADDITIONAL COVARIANCE PATHS IMPOSED

3.5.1 INTERPRETING THE RESULTS OF DEFAULT MODEL IN THE SECOND TEST:

The re-specified model (in Figure 27) was re-tested again to obtain a **"Fit but Parsimonious"** model. Graphical output of the second test is shown in Figure 28. Interpretation the results of the default model in the second test would be discussed in detail.

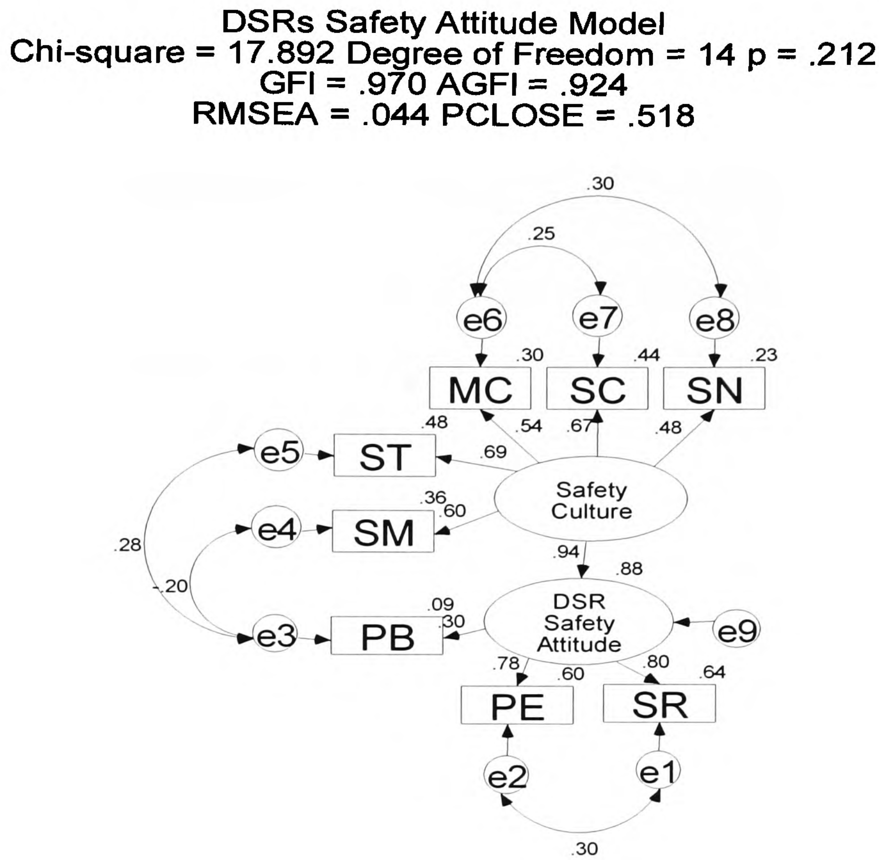


FIGURE 28: THE SECOND TEST OF DSRS SAFETY ATTITUDE MODEL

Concerning the Goodness-of-Fit of the model in Figure 28, the default model should fail to be rejected based on the following reasons:-

1. The model testing yields a chi-square fit statistic of 17.892 with 14 degrees of freedom. The probability level (p-value) for observing the said chi-square value is p = 0.212. Since the observed level of significance is greater than

the cut-off limit of 0.05, the hypothesized model fitness is not to be rejected. (ACITS, 1999; Garson, 1998)

2. The model fit indexes of GFI, AGFI and RMSEA are of value indicating fitness acceptance (GFI= 0.970, AGFI= 0.924 and RMSEA= 0.044).

3. The PCLOSE of value 0.518 greater than 0.05 of the model acceptance limit would lead the null hypothesis to fail to be rejected and conclude that the computed RMSEA is less than 0.05 indicating a close fit.

All five (5) selected model fit indexes were used to judge the statistical significance and substantive meaning of a hypothesized model, so as to guide final model selection. Since all five (5) selected model fit indexes fulfilled the criteria of model acceptance, as such the hypothesis of an overall model fitness **(H0: "The DSRs Safety Attitude Model fits the data")** fail to be rejected.

The fit statistics indicate that the default model provides a good fit to the data. It is concluded that the default model in Figure 28 falls within the criteria of a "Fit but Parsimonious" model in explaining DSRs' safety attitude towards the implementation of SMS at departmental level. For easy reference, test results of the fit statistics are displayed in Table 33.

TABLE 33: TEST RESULTS OF THE FIT STATISTICS

MODEL FIT INDEX	MINIMUM ACCEPTABLE VALUE FOR MODEL FITNESS	OUTPUT VALUE	MODEL ACCEPTANCE (YES/NO)
Chi-square (p) value	P > 0.05	P=0.212	Yes
Goodness-of-fit index (GFI)	GFI>=0.90	GFI=0.970	Yes
Adjusted goodness-of-fit index (AGFI)	AGFI >= 0.90	AGFI=0.924	Yes
Root Mean Square Error of Approximation (RMSEA)	RMSEA <=0.05	RMSEA=0.044	Yes
PCLOSE	PCLOSE >= 0.05	PCLOSE=0.518	Yes

In assessing the overall fitness of the default model, an examination of the five selected model fit indexes with reference to each respective cut-off value is the first step. Perrin (1999, pp.524-624) has suggested that apart from the issue of fitness, the hypothesized relationships in the model should be critically examined.

The next step is to perform significance tests on hypothesizes (H1-H7) between the model constructs.

3.5.2 SIGNIFICANCE TESTS OF THE RESEARCH HYPOTHESIZES (H1-H7) BETWEEN MODEL CONSTRUCTS IN THE HYPOTHESIZED MODEL:

SEM has the ability to test the hypothesized models of the causal relationship between the measured variables. Referring to Perrin's advice, the evaluation of relationships between the variables hypothesized in **H1-H7** of the default model is hence made with reference to the AMOS output. Besides the model fit indexes, the Maximum Likelihood Estimates "MLE" – Regression Weights of the default model displaying the

C.R. and significance of path coefficients is presented in Table 34.

Table 34: MLE - Regression Weights

			Estimate	S.E.	C.R.	P	Label
DSR_Safety_Attitude	<---	Safety_Culture	1.508	.240	6.279	***	par_7
SM	<---	Safety_Culture	1.000				
ST	<---	Safety_Culture	1.034	.170	6.100	***	par_1
MC	<---	Safety_Culture	1.238	.243	5.090	***	par_2
SC	<---	Safety_Culture	.984	.166	5.945	***	par_3
SN	<---	Safety_Culture	1.089	.235	4.644	***	par_4
SR	<---	DSR_Safety_Attitude	1.000				
PE	<---	DSR_Safety_Attitude	.969	.093	10.373	***	par_5
PB	<---	DSR_Safety_Attitude	.402	.158	2.550	.011	par_6

Note that *"The MAXIMUM LIKELIHOOD ESTIMATES (MLE) estimates of the regression weights below are the estimated path coefficients for the arrows in the model.", "Standard errors are also given for the path coefficients", and "C.R." is the critical ratio, which is the estimate divided by its standard error."* Available from: Garson D., *Structural Equation Modeling Example Using WinAMOS.* http://www2.chass.ncsu.edu/garson/PA765/semAMOS1.htm. [Accessed 28 November 2007] In short, MLE reflects how likely that the observed values of the dependent may be predicted from the observed values of the independents.

Regarding relationships of Critical Ratio (C.R.) between the significance of path coefficients and the significance of factor covariances: *"When the Critical Ratio (CR) is > 1.96 for a regression weight, that path is significant at the .05 level (that is, its estimated path parameter is significant)" and "The significance of estimated covariances among the latent variables are assessed in the same manner: if they have a C.R. > 1.96, they are significant".* Available from: Garson D. *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm. [Accessed 7 December 2007] Thus, using a significance level of 0.05, any critical ratio that exceeds 1.96 in magnitude would be called significant.

Interpretations for the significance of research hypothesized relationships in the default model are summarized in Table 35.

TABLE 35: INTERPRETATIONS THE SIGNIFICANCE OF RESEARCH HYPOTHESIZES (H1-H7)

HYPOTHESIS H1: The extent to which Safety Culture will have a positive direct impact on DSRs Safety Attitude. Estimated path coefficients = 1.508 and C.R. = 6.279 Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of SAFETY CULTURE → DSRS SAFETY ATTITUDE is significantly greater than zero at the 0.05 level. It is concluded that the extent to which Safety Culture will have a positive direct impact on DSRs Safety Attitude and the hypothesis H1 is "fails to be rejected".
HYPOTHESIS H2: The extent to which Safety culture will have a positive direct impact on DSRs Perceptions of Safety Training [ST]. Estimated path coefficients = 1.034 and C.R. = 6.1 Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of SAFETY CULTURE → DSR'S PERCEPTIONS OF SAFETY TRAINING [ST] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which Safety culture will have a positive direct impact on DSRs Perceptions of Safety Training [ST] and the hypothesis H2 is "fails to be rejected".
HYPOTHESIS H3: The extent to which Safety Culture will have a positive direct impact on Perceived Management Commitment to Safety [MC] Estimated path coefficients = 1.238 and C.R. = 5.09 Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of SAFETY CULTURE → PERCEIVED MANAGEMENT COMMITMENT TO SAFETY [MC] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which Safety culture will have a positive direct impact on Perceived Management Commitment to Safety [MC] and the hypothesis H3 is "fails to be rejected".
HYPOTHESIS H4: The extent to which Safety culture will have a positive direct impact on Safety Communication [SC]. Estimated path coefficients = 0.984 and C.R. = 5.945

Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of SAFETY CULTURE → SAFETY COMMUNICATION [SC] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which Safety culture will have a positive direct impact on Safety Communication [SC] and the hypothesis H4 is "fails to be rejected".

HYPOTHESIS H5: The extent to which Safety Culture will have a positive direct impact on DSRs Perceptions of Group Safety Norms [SN].

Estimated path coefficients = 1.089 and C.R. = 4.644

Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of SAFETY CULTURE →DSR'S PERCEPTIONS OF GROUP SAFETY NORMS [SN] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which Safety culture will have a positive direct impact on DSRs Perceptions of Group Safety Norms [SN] and the hypothesis H5 is "fails to be rejected".

HYPOTHESIS H6: The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Perceived Self-efficacy in Managing Safety [PE].

Estimated path coefficients = 0.969 and C.R. = 10.373

Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of DSRS SAFETY ATTITUDE → DSRS PERCEIVED SAFETY RESPONSIBILITY [SR] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Perceived Self-efficacy in Managing Safety [PE] and the hypothesis H6 is "fails to be rejected".

HYPOTHESIS H7: The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Personal Beliefs in Accident Causation [PB]

Estimated path coefficients = 0.402 and C.R. = 2.55

Remarks: Since the C.R. is greater than 1.96 in magnitude and the regression weight of DSRs SAFETY ATTITUDE →DSR'S PERSONAL BELIEFS IN ACCIDENT CAUSATION [PB] is significantly greater than zero at the 0.05 level. It is concluded that the extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Personal Beliefs In Accident Causation [PB] and the hypothesis H7 is "fails to be rejected".

It is noted that *"SEM models can never be accepted; they can only fail to be rejected. This leads researchers to provisionally accept a given model."* ... *"SEM software programs require researchers to be very explicit in specifying models. While models that fit the data well can only be provisionally accepted, models that do not fit the data well can* *be absolutely rejected."* Available from: *Structural Equation Modeling using AMOS: An Introduction – model identification* [Online]. http://www.utexas.edu/its-archive/rc/tutorials/stat/amos/#model identification [Accessed 9 November 2007]

Perrin (1999) also states that "*The maximum-likelihood algorithm used to estimate the parameters in the model minimizes a chi-square statistic that compares the observed and predicted covariances. This same chi-square can be used to test the null hypothesis that the model fits the data. This hypothesis is stating that the discrepancy between the observed and predicted covariances is equal to zero. Therefore, we do not want to reject the null hypothesis"* (paragraph.2).

For easy reference, the test result of research hypothesizes (H1-H7) is summarized in Table 36.

TABLE 36: TEST RESULTS OF RESEARCH HYPOTHESIZES (H1-H7)

RESEARCH HYPOTHESIZES	ESTIMATED PATH COEFFICIENTS	PATH COEFFICIENTS	C.R.	HYPOTHESIS REJECTED?
Hypothesis H1: The extent to which Safety Culture will have a positive direct impact on DSRs Safety Attitude.	1.508	.240	6.279	FAIL TO BE REJECTED
Hypothesis H2: The extent to which Safety culture will have a positive direct impact on DSRs Perceptions of Safety Training [ST].	1.034	.170	6.100	FAIL TO BE REJECTED
Hypothesis H3: The extent to which Safety Culture will have	1.238	.243	5.090	FAIL TO BE REJECTED

a positive direct impact on Perceived Management Commitment to Safety [MC].				
Hypothesis H4: The extent to which Safety culture will have a positive direct impact on Safety Communication [SC].	.984	.166	5.945	FAIL TO BE REJECTED
Hypothesis H5: The extent to which Safety Culture will have a positive direct impact on DSRs Perceptions of Group Safety Norms [SN].	1.089	.235	4.644	FAIL TO BE REJECTED
Hypothesis H6: The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Perceived Self-efficacy in Managing Safety [PE].	.969	.093	10.373	FAIL TO BE REJECTED
Hypothesis H7: The extent to which DSRs Safety Attitude will have a positive direct impact on DSRs Personal Beliefs in Accident Causation [PB]	.402	.158	2.550	FAIL TO BE REJECTED

Test results evidenced that the hypothesized "DSRs Safety Attitude Model" fits the data. The implications of test results reflect the importance of DSRs safety attitude towards the implementation of SMS at departmental level. It should be of interest to the management of the University to review the criteria of DSRs selection.

3.6 STEP 6 – DISCUSSION OF FINDINGS:

With the acceptances of the Goodness-of-Fit and research hypothesizes of the default model, the research findings regarding significance of the factor covariances; predictive power, indirect, direct and total effects amongst variables would be discussed in detail.

3.6.1 SIGNIFICANCE TESTS OF THE FACTOR COVARIANCES

Regarding tests of the significance of factor covariances, "*When the Critical Ratio (CR) is > 1.96 for a regression weight, that path is significant at the .05 level (that is, its estimated path parameter is significant)*".... "*The significance of estimated covariances among the latent variables are assessed in the same manner: if they have a c.r. > 1.96, they are significant.*" Available from: Garson, D., (2008). *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 9 November 2007]

TABLE 37: COVARIANCES OF THE DEFAULT MODEL

			Estimate	S.E.	C.R.	P	Label
e6	<-->	e7	2.174	.871	2.497	.013	par_8
e6	<-->	e8	4.795	1.478	3.243	.001	par_9
e4	<-->	e3	-2.335	1.147	-2.036	.042	par_10
e5	<-->	e3	2.674	1.083	2.469	.014	par_11
e1	<-->	e2	1.914	3.359	.570	.569	par_12

In table 37, only the C.R. of covariance of "e1 <--> e2" is 0.57 which less than 1.96 in magnitude. Besides that, the C.R. of four (4) other covariances included "e6 <--> e7", "e6 <--> e8", "e4 <--> e3" and "e5 <--> e3" are greater than 1.96 in magnitude, as such they are significant. It is summarized that:-

- Covariance of "e6 <--> e7", means that e6 and e7 influences on each other is significant.
- Covariance of "e6 <--> e8", means that e6 and e8 influences on each other is significant.
- Covariance of "e4 <--> e3", means that e4 and e3 influences on each other is significant.
- Covariance of "e5 <--> e3", means that e5 and e3 influences on each other is significant.
- Covariance of "e1 <--> e2", means that e1 and e2 influences on each other is not significant.

Through AMOS, the above direct cause-and-effect relationships amongst endogenous and exogenous variables in the model were carefully examined and clarified.

3.6.2 INDIRECT, DIRECT AND TOTAL EFFECTS AMONGST EXOGENOUS VARIABLES AND ENDOGENOUS VARIABLES OF THE "DSRS SAFETY ATTITUDE MODEL":

Regarding the structural coefficients in the default model, Garson (2008) reminded that *"Researchers should report not only goodness-of-fit measures but also should report the structural coefficients so that the strength of paths in the model can be* *assessed. Readers should not be left with the impression that a model is strong simply because the "fit" is high. When correlations are low, path coefficients may be so low as not to be significant....even when fit indexes show "good fit."* Available from: Garson D. *Structural Equation Modeling.* http://www2.chass.ncsu.edu/garson/pa765/structur.htm [Accessed 13 Feb 2008]

AMOS produces indirect, direct and total effects amongst endogenous and exogenous variables in the default model. Path coefficients indicted in the Table 38 could help to explain indirect and direct effects in the default model.

TABLE 38: STANDARDIZED REGRESSION WEIGHTS OF THE DEFAULT MODEL

			Estimate
DSR_Safety_Attitude	<---	Safety_Culture	.936
SM	<---	Safety_Culture	.601
ST	<---	Safety_Culture	.691
MC	<---	Safety_Culture	.544
SC	<---	Safety_Culture	.665
SN	<---	Safety_Culture	.477
SR	<---	DSR_Safety_Attitude	.802
PE	<---	DSR_Safety_Attitude	.775
PB	<---	DSR_Safety_Attitude	.298

The following are direct and indirect effects of the default model:-

- "Safety Culture" structure with 0.936 path coefficient is a determinant of "DSR Safety Attitude" structure. In the table, it is visualized that "Safety Culture" structure imposed the strongest direct influence on "DSR Safety Attitude" compared with "SR", "PE", "PB", "SM', "ST", "MC", "SC" and

"SN".

- Three exogenous variables including "SR", "PE" and "PB" depends directly on "DSR Safety Attitude" structure. From the table, it is visualized that amongst these three exogenous variables, the "DSR Safety Attitude" structure with 0.802 path coefficient imposed the strongest direct influence on "SR".

- Three exogenous variables included "SR", "PE" and "PB" depends indirectly on "Safety Culture" structure. From the table, it is visualized that amongst these three exogenous variables, the indirect effect of "Safety Culture" structure with 0.751 path coefficient (0.936 0. 802) imposed the strongest indirect influence on "SR".

- Five exogenous variables included "SM', "ST", "MC", "SC" and "SN" depends directly on "Safety Culture" structure. From the table, it is visualized that amongst these five exogenous variables, the direct effect of "Safety Culture" structure with 0.647 path coefficient (0.936 0. 691) imposed the strongest direct influence on "ST".

In terms of total effects amongst endogenous and exogenous variables in the default model, Table 39 is a matrix extracted from the AMOS model testing output. For easy reference, total effect upon the "DSR Safety Attitude" is underscored.

	Safety_Culture	DSR_Safety_Attitude
DSR_Safety_Attitude	.936	.000
PB	.279	.298
PE	.725	.775
SR	.751	.802
SN	.477	.000
SC	.665	.000
MC	.544	.000
ST	.691	.000
SM	.601	.000

It is summarized that:-

- "DSR Safety Attitude" depends directly on "Safety Culture". From the table, it is visualized that "Safety Culture" imposed the strongest influence on "DSR Safety Attitude". The total effect of "Safety Culture" on "DSR Safety Attitude" is 0.936.

- The three exogenous variables included "SR", "PE" and "PB" depends directly on "DSR Safety Attitude". From the table, it is visualized that "DSR Safety Attitude" imposed the strongest influence on "SR". The total effect of "DSR Safety Attitude" on "SR" is 0.802.

- Five exogenous variables included “SM’, “ST”, “MC”, “SC” and “SN” depends directly on “Safety Culture”. From the table, it is visualized that “Safety Culture” imposed the strongest influence on “ST”. The total effect of “Safety Culture” on “ST” is 0.691.

Indirect, direct and total effects amongst endogenous and exogenous variables in the default model were discussed. It is evidenced that “Safety Culture” structure imposed the strongest direct influence on “DSR Safety Attitude” structure in implementing the SMS at departmental level. The evidence has further substantiated the reliability of the default model in this study.

3.6.3 PREDICTIVE POWER OF THE “DSRS SAFETY ATTITUDE MODEL”:

In regarding predictive power of the default model, Kam (2002, p.336) states that *“A way to visualize the predictive power is to examine the percentage of the variance explained, i.e. the Coefficient of Determination (R^2) - the square of the coefficient of correlation (R).”*

As a rule of thumb, Krus (2003) proposed that that *“Correlation coefficients (R) between .00 and .30 are considered weak, those between .30 and .70 are moderate and coefficients between .70 and 1.00 are considered high”.* Available from: Krus, D. (2003). *Visual statistics with Multimedia Chapter 9 Correlation: Interpretations,* Cruise Scientific. http://iimk.ac.in/gsdl/cgi-bin/library?e=d-000-00---0statis--00-0-0--0prompt-10---4------0-1l--1-en-50---20-about---00031-001-1-0utfZz-8-00&a=d&c=statis&cl=CL1&d=HASH0185d5fe8b40f067f8a54ab4.4.3

[Accessed 9 November 2007] Extending Krus's proposal to the Coefficient of Determination (R^2), a moderate value of R^2 should range from 0.09 ($0.30^2=0.09$) to 0.49 ($0.70^2 = 0.49$). Whereas a high value of R^2 should range from 0.49 to 1.

TABLE 40: SQUARED MULTIPLE CORRELATIONS OF THE DEFAULT MODEL

	Estimate
DSR_Safety_Attitude	.876
PB	.089
PE	.601
SR	.644
SN	.228
SC	.443
MC	.296
ST	.477
SM	.362

From the AMOS output in the Table 40, it is summarized that:-

- "DSRS Safety Attitude", "PE" and "SR" imposed a high value of "Squared Multiple Corrections" in the default model.

- "PB", "SN", "SC", "MC", "ST" and "SM" imposed a moderate value of "Squared Multiple Corrections" in the default model.

In view of the overall amount of variance explained, the default model appears to be logical and reasonable. "Squared Multiple Corrections" in the default model ranging from a moderate value of 0.089 (8.9%) to a high value of 0.876 (87.6 %). Especially, the critical variable "DSR Safety Attitude" imposed a high value of 0.876 (87.6%) in the default model. The model is considered to be a highly predictive model in explaining DSRs safety attitudes towards the implementation of SMS at departmental level.

4. LIMITATIONS OF THE STUDY:

The present research has identified ten (10) variables which provide the important implications with regard to DSRs safety attitude towards the implementation of SMS at departmental level. This study had several limitations that merit attention:-

- This research relied entirely on self-report measures of DSRs safety attitudes, which may suffer from inaccuracy in report. Reliance on self-report can be problematic and may threaten the validity of the findings. As Ajzen (1991, pp.179-211) states that "*By directly measuring an attitude are several limitations presented; attitudes are often changing, social norms influence attitudes, the level of experienced control affects ones attitudes, as well as do the beliefs directed towards performing the behaviour affect the behaviour*". It is possible that DSRs could be biased in their replies, and some of them may have felt uncomfortable in replying honestly to certain questions. From the survey, it was found that different DSRs safety attitude implies different perception towards safety. Validity and reliability of the survey was depends on sample size. The results are time dependent. Since the observed response was in the year of 2006, as such, there is every possibility of a lagged effect that is not properly captured in this modeling effort.

- An extensive range of potential predictors (observed variables and latent variables) were tested in the present research. It is possible that if other variables had been included in the model in the present study, a better fitting or more appropriate model may have been identified. Although an extensive range of factors were tested in the present research that may impose certain effect on DSRs safety attitude. It is conceivable that many factors which may also be relevant were not included in the current study, because of practical limitations. An exhaustive examination of each and everyone is far beyond the capability of this one-man study.
- Direction of arrows in a structural equation model represents the researcher's hypotheses of causality within a system. The choice of variables and pathways is also based on a researcher's assumptions that will limit the structural equation model's ability to recreate the sample covariance and variance patterns that have been observed in nature.

5. CHAPTER SUMMARY:

In this study, DSRs safety attitude towards the implementation of SMS in the University was critically examined. The present research has identified factors and practical implications that are associated with various co-factors of DSRs safety attitudes. There are eight exogenous variables grouped under two endogenous (latent) variables "Safety Culture" and "DSR Safety Attitude" in the "DSRs Safety Attitude Model". "Safety Culture" directly influences on "DSR Safety Attitude", "Safety Management [SM]", "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety

Norms" [SN] in a positive way. Similarly, "DSR Safety Attitude" directly influences on "DSRs Perceived Safety Responsibility [SR]", "DSRs Perceived Self-efficacy in Managing Safety" [PE] and "DSRs Personal Beliefs in Accident Causation" [PB].

The SEM model was tested by examining the goodness of fit of the model against a collection of data measuring the variables included in the model. Assessment of model fit was based on multiple criteria including model-fit indexes of Chi-square (p) value, Goodness-of-fit index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA) and PCLOSE. The default model in Figure 28 was tested and the results obtained from CFA on the default model adequately reflects a good fit to the observed data with Chi-square ($\chi 2$ = 17.892), Degree of Freedom (df = 14), Probability level (p = .212); GFI = 0.970; AGFI = 0.924, RMSEA = 0.044, PClose = 0.518 and all the items loaded significantly on the constructs was measured with $p < 0.05$. Since all the five (5) selected model fit indexes fulfilled the criteria of model acceptance, as such the hypothesis of an overall model fitness Hypothesis H_0: "The DSRs Safety Attitude Model fits the data" failed to be rejected. It is concluded that the default model "DSRs Safety Attitude Model" falls within the criteria of a "Fit but Parsimonious" model in explaining DSRs safety attitude towards the implementation of SMS at departmental level. Testing of the default model constructs also involved a set of seven (7) hypotheses (H_1-H_7). From the test, seven (7) hypotheses (H_1-H_7) also failed to be rejected. It is reflected in the significance of research hypothesized relationships (H_1-H_7) in the default model concurred with the hypothesized model structure. Moreover, the directions of the all the paths were positive as anticipated.

The excellent fit of the data from the questionnaire to the hypothesized "DSRs

Safety Attitude Model" provides further evidence of the validity and reliability to the questionnaire. Data collected with the questionnaire shows a "Fit but Parsimonious" model confirming that the questionnaire has been based upon a valid overall model. From the test result, the strength of "Safety Culture", "DSR Safety Attitude" and "Perceived Safety Responsibility [SR]" once again played central roles with regard to the implementation of SMS at departmental level. Significance of the factor covariances together with predictive power, as well as indirect, direct and total effects amongst exogenous variables and endogenous variables of the default model were also tested. All of the paths between the endogenous (latent) variables were statistically significant. It was further secured that the hypothesized "DSRs Safety Attitude Model" fits the sample data well. Results and findings on DSRs safety attitudes towards the implementation of SMS at departmental level in the University were discussed in detail. In general, DSRs have a positive attitude towards the implementation of SMS at departmental level.

The conclusion, recommendation and contribution of this study will be discussed in Chapter Eight (8).

CHAPTER EIGHT

RECOMMENDATIONS, CONCLUSION AND CONTRIBUTION OF THE STUDY

1. INTRODUCTION:

The title of this study is "THE EXPLORATION OF A SAFETY ATTITUDE MODEL FOR DEPARTMENTAL SAFETY REPRESENTATIVES TOWARDS THE IMPLEMENTATION OF A SAFETY MANAGEMENT SYSTEM IN AN INSTITUTE OF TERTIARY EDUCATION IN HONG KONG".

An attempt has been made to study the DSRs safety attitudes by exploring the relationships of DSRs introspection and various cognitive factors which may most likely influence the effectiveness of SMS implementation in the University. A total of ten (10) variables were identified from the review of eleven (11) psychological theories and models. It provided the theoretical framework on construction of the hypothesized "DSRs Safety Attitude Model". Major steps involved in developing the research instrument "Safety Attitude Survey Questionnaire" and data collection for SEM analysis are shown in Table 16. To minimize the chance of middle option, a self-reported 6-point Likert type survey questionnaire contains seventy-seven (77) items for eight (8) exogenous variables was developed for pilot survey. Data collected from the targeted group (i.e. DSRs) and a total of 102 valid questionnaires (with 85 % response rate) were finally secured. The validity was tested and established by using factor analysis to single out those items which doubly loaded on two or more factors; or alienated factors that did not belong to a specific group. The sampling adequacy was measured by the Kaiser-Meyer-Olkin (KMO) statistics.

KMO value should be 0.60 or higher to proceed with factor analysis. Internal consistency also assessed and Cronbach's alpha 'α' values of all 43 items ranging from of 0.8764 to 0.9349 over the recommended level of 0.70 and no significant cross-loading among the eight (8) exogenous variables was found. Based on the result of the pilot test, only forty-three (43) items out of seventy-seven (77) questionnaire items were retained for the field survey. In the field survey, a total of 144 valid questionnaires (with a response rate of 74.23%) were finally secured and formed the basis for the subsequent analyses. A further reliability test was conducted and Cronbach's alpha 'α' values of all forty-three (43) items ranging from 0.8297 to 0.9192 (in Table 27) were over the recommended level of 0.70 and no significant cross-loading was found among the eight (8) exogenous variables. From the survey results, both validity and reliability were over the recommended level. It is concluded that the "Safety Attitude Survey Questionnaire" used to evaluate DSRs safety attitude towards the implementation of SMS is highly reliable.

In this study, all SEM and confirmatory factor analyses were performed using AMOS. The hypothesized "DSRs Safety Attitude Model" was developed and tested throughout the six steps including "Model Identification", "Formulating Research Hypotheses", "Selection of Model Fit Indexes for Goodness-of-fit tests", "Evaluate Model Fit", "Re-specify the Model based on the Model's Fit" and "Discussion of Findings".

Research hypotheses sought to confirm whether or not theoretical underlying constructs are reflected in the observed data by using confirmatory factor analysis "CFA". The eight (8) hypotheses imposed the hypothesized "DSRs Safety Attitude Model" were tested. Test results of the fit statistics from the re-specified model shown in Table 33 adequately reflects a good fit to the observed data with Chi-square ($\chi 2$ = 17.892), Degree of

Freedom (df = 14), Probability level ($p = .212$); GFI = 0.970; AGFI = 0.924, RMSEA = 0.044, PClose = 0.518 and all the items loaded significantly on the constructs was measured with $p < 0.05$. From the results of hypotheses testing, it was evident that the hypothesis H_0 "The DSRs Safety Attitude Model fits the data" failed to be rejected; since all the five (5) selected model fit indexes fulfilled the criteria of model acceptance. H_1–H_7 also failed to be rejected and has indicated that the endogenous variable "DSR Safety Attitude" is directly influenced by endogenous variable "Safety Culture". The endogenous variable "Safety Culture" is directly influenced on five (5) exogenous variables including "Safety Management [SM]", "DSRs Perceptions of Safety Training" [ST], "Perceived Management Commitment to Safety" [MC], "Safety Communication" [SC] and "DSRs Perceptions of Group Safety Norms" [SN]. The endogenous variable "DSR Safety Attitude" (the target variable) is directly influenced on three (3) exogenous variables included "DSRs Perceived Safety Responsibility [SR]", "DSRs Perceived Self-efficacy in Managing Safety" [PE] and "DSRs Personal Beliefs in Accident Causation" [PB].

The excellent fit of the data from the questionnaire to the hypothesized "DSRs Safety Attitude Model" provided further evidence of validity and reliability to the questionnaire. Significance of research hypotheses between model constructs concurred with the hypothesized model structure. Moreover, significance of the factor covariances together with predictive power, as well as indirect, direct and total effects amongst exogenous variables and endogenous variables of the hypothesized model were tested. All the paths between the endogenous variables were statistically significant. It further demonstrated that the hypothesized "DSRs Safety Attitude Model" fits the sample data well. It is concluded that the hypothesized "DSRs Safety Attitude Model" falls within the criteria of a "Fit but Parsimonious" model.

An understanding of and reasoning about human factors is important in sustaining a high level of safety performance. Yet, the aim of this study has given a substantial consideration to the factors that could influence DSR safety attitudes toward the implementation of SMS.

2. RECOMMENDATIONS:

Based upon this study, the two-tiers strategic management approach that could help the University's management building momentum in sustaining safety, so as to further enhance the effectiveness of SMS implementation is recommended. Geller (2005, p.305) pointed out that *"Sports psychologists talk about momentum as a gain in psychological power – including confidence, self-efficacy, and personal control – that changes perceptions and attitudes, and enhances both mental and physical performance. It all starts with noticing a run of individual or team achievement".*

FOR CAMPUS COMMUNITY:

- **VISIBLE MANAGEMENT COMMITMENT TO SAFETY**

  This study demonstrates that "Perceived Management Commitment to Safety" is directly influences by "Safety Culture". How management's safety attitude is transmitted to stakeholders depends on how accurately the management commitment to safety perceived by them. "*Management commitment produces higher levels of motivation and concern for health and safety throughout the organisation. It is indicated by the proportion of resources (time, money, people) and support allocated to health and safety management and by the status given to health and safety versus production,* *cost etc. The active involvement of senior management in the health and safety system is very important" ..."It is important that management is perceived as sincerely committed to safety. If not, employees will generally assume that they are expected to put commercial interests first, and safety initiatives or programmes will be undermined by cynicism."* Available from: *Common topic 4: Safety Culture, p.1.* http://www.hse.gov.uk/humanfactors/comah/common4.pdf [Assessed 9 December 2008].

DSRs and other stakeholders' perceptions on management commitment to safety may be subject to negative stereotyping by the departmental management. *"Where employees perceive managerial attitudes and actions toward safety to be less than adequate, problems may ensure that affects the effective functioning of the organization as a whole, as the workforce become less committed to the organization per se, because management are seen as unwilling to provide a safe working environment."*(Cooper 1995. p.2)

Geller (2005, p.321) points out that *"Commitments are most influential when they are public, active, and perceived as voluntary or not coerced".* No SMS will be successful without visible management commitment throughout the operation in the University. Departmental management demonstrates not only an interest, but a long term visible commitment in maintaining adequate resources and support for safety. When stakeholders notice that staff at management level is adopting a very committed attitude towards safety in terms of time, efforts and resources, they will perceive that safety is whole-heartedly supported from the University.

➢ **<u>A POSITIVE SAFETY CULTURE BECOMES AN INTEGRAL PART OF THE UNIVERSITY'S CULTURE :</u>**

Organizational factors and individual factors that have effects on the safety culture are complicated. *"The concept of risk depends on our mind and culture and is invented to help us understand and cope with the danger and uncertainties of life."* *"In the beginning, reactions towards obvious risks may occur, but may be difficult to express, and safety has to be trusted. After an introductory period, during which risk and safety knowledge may be low, perception may be higher, but along with increased experience risks may become accepted as normal."* (Stave, 2005, pp.15-16) This study demonstrates that "DSR Safety Attitude" and "DSRs Perceptions of Group Safety Norms" are directly influenced by "Safety Culture". Everley (1995, pp.19-22) points out that *"The greater improvement in safety performance may rest upon a greater understanding of employees and their attitudes and behaviours in the workplace"*. In cultivating a positive safety culture, it is important to understand how the individual thinks and behaves in relation to safety within the University. Group safety norms developed by the workgroup will greatly influence the individual's perception of risk and value on safety, so as to influence safety culture either positively or negatively. Pidgeon (1998, pp.202-216) presented four organisational properties of a 'good' safety culture:

- *Senior management commitment to safety (both actions and words).*
- *Attitudes of shared care and concern about hazards, and also about their impacts upon people, distributed throughout all levels of an organisation.*
- *Norms and rules that permit a flexible approach to dealing with both well-defined and ill-defined hazardous conditions.*
- *Reflection on practice (or organisational learning) through such things as monitoring, incident analysis and feedback systems.*

"Paradigms are powerful perceptions, or biases, if you will. Whatever your attitude toward a particular experience, or your expectation of how things will work out, that's your paradigm."(Geller, 2005, p.298) Implementing the SMS will only be effective where a positive safety culture exists throughout all stakeholders. A paradigm shift is needed for building momentum for safety. The University's management needs to cultivate a positive safety culture through interactions with stakeholders. Safety promotion and recognising safety contributions could help to achieve the goal. *"The more recognition a person received, the better they feel about themselves. And the better people feel about themselves, the more they will actively care for the safety of others."* (Geller, 2005, pp.316) A successful SMS results when a positive safety culture becomes an integral part of the University's culture. It encourages every individual to project a positive safety attitude toward safety at work.

➢ **<u>EFFECTIVE COMMUNICATION ACROSS STAKEHOLDERS:</u>**

An effective communication with stakeholders is critical in the process of consultation, decision making for safety improvement and taking corrective action to eliminate hazards. Cooper (1995, p.5) points out that *"The perceived effectiveness of the organisation's safety committees may be judged from varying perspectives. To some extent they can be seen as an indirect measure of the safety communication flow, the prevailing industrial relations context in which the committees function, and management commitment toward safety. In addition, safety committees are judged by how well they influence and improve health & safety in the organization. The more rapidly their recommendations are implemented and publicised the more they will be seen to be effective, and the more credibility they accrue."*

This study demonstrates that "Safety Communication" is directly influenced by "Safety Culture". The poor communication among department management, DSRs and stakeholders seemed to be an invisible barrier to sustaining participation in safety initiatives. Stave (2005, p.18) points out that *"If risks and safety are not communicated at and through all levels of the organisation, there will be little understanding of the risks and safety.* It is human nature that the workforce usually just keep their mouths shut. To cultivate a positive safety culture, an effective safety communication is necessary in providing feedback to management, safety committee, DSRs and stakeholders about all safety related matters both good things and bad things. The establishment of clear channels of communication between them should not be overlooked. Early communication can reduce uncertainty and enhance stakeholders' participation in striving safety for excellence. HODs have to encourage stakeholders to report hazards, safety violations and non-compliances of legal requirements without blame from line supervisor and fellow workers. To enhance further the effectiveness of communication across "Rank and file", HOD therefore has responsibility to ensure that safety information is disseminated to the work force.

> **<u>"SAFETY" IS A SHARED RESPONSIBILITY:</u>**

The DSR is responsible for ensuring that all operations are performed with the utmost regard for the safety at the designated workplace. The effectiveness of SMS very much depends on the individual DSR's attitude towards safety and how he/she valued roles and responsibility of DSR. This study demonstrates that "DSRs Perceived Safety Responsibility" is directly influenced by "DSRs Safety Attitude".

"Many of today's safety management systems are built on control. Managing risk through control does not take into account the fact that individuals are intentional in how they define and carry out tasks." (Stave, 2005, p.13) In the University, safety responsibility shared by stakeholder is in-doubt. Some people still rely heavily on DSRs' effort in implementing SMS at departmental level. Too much work load and too

heavy safety responsibility could influence DSRs' attitudes toward safety. The complexity of operations requires that safety responsibility is shared among all stakeholders in the campus community. Safety should not be the sole responsibility of the University's safety professionals and DSRs. It should be a shared safety responsibility among stakeholders including staff members at all levels, students and contractors. To ensure the campus is a safer place, individuals should be held responsible for safety on their own and others. *"Experienced employees should feel especially responsible to demonstrate safe work practices to new employees. People look for guidance in unfamiliar situations. So supervisors should give new hires opportunities to work with experienced employees who are most enthusiastic about safety-related activities."*(Geller, 2005, p.322)

An individual's safety responsibility has to be stated in the University's policy and through the formal job descriptions. When stakeholders recognize "Safety is a Shared Responsibility", collaboration across them will demonstrate the synergy of team work. As such, the University can turn safety into a much easier job.

- **<u>SMS IS AN INTERGAL PART OF THE UNIVERSITY'S MANAGEMENT FUNCTIONS:</u>**

Cultivating a positive safety culture in the University's community is vitally important from the safety management perspective. This study demonstrates that "Safety Management" is directly influenced by "Safety

Culture".

The University always treasures people's lives by taking proactive approaches in controlling hazards and reducing risk exposures. This goal can only be successfully achieved by continuously and systematically improving the safety management, reducing hazards and at-risk behaviour through cultivating a positive safety culture in the University. To a large extent, the effectiveness of SMS relies on the culture wherein each individual contributes to and is responsible for safety.

Stave (2005, p.15) points out that *"A constant demand for effective resource allocation and short-term revenues from investment may result in priorities that are in opposition to safety, reducing redundancy, cutting margins, increasing work pace, and reducing time for reflection and learning."* Geller et al. (2003, p.4) points out that *"Safety is a value not a priority of a job"*; he states that *"Employees know safety is not number one – profit is. If the company does not make money, there are no jobs, and there's no need for occupational safety. So stop putting safety in a position to compete with profit-making. Instead, give safety a separate and special category – value". "The term 'priority' implies importance and a sense of urgency. A priority today might not be a priority tomorrow. Depending upon the demands of the moment, one priority often gets shifted for another. Safety should be a 'value' that employees bring to every job, regardless of the ongoing priorities or task requirements."* (Geller, 2005, p.33) Applying Geller's safety philosophy in the University' environment, this can only happen when everyone in the University considers that safety is a crucial factor as important of and the same value as teaching, technology research and development.

From the safety management perspective, creating and nurturing a culture of safety ingrains safety into every aspect, making safety an integral part of every process in daily operations is necessary. If the SMS is not integrated, it will function independently of other management functions. This usually results in safety deficiencies being overlooked and not communicated throughout all stakeholders. To ensure a safe campus, there is a need to integrate SMS into the University's management functions. Frick (2000, p.316) summarized the underlying motives commonly given for such a change as:

- *improvement of occupational health and safety performance;*
- *ensuring a more capable organization for planning, implementation and control of the required occupational safety and health measures; and*
- *improving motivation for occupational safety and health of managerial staff and employees at all levels.*

<u>FOR DSRS:</u>

- **<u>BETTER EDUCATION AND TRAINING:</u>**

Most accidents are caused by human errors. Generally, causes of accidents might be due to the operator's lack of safety knowledge and training, poor attitude and awareness toward safety, unsafe behaviour and failure to follow safety procedures. In the University's environment, advances in technologies, new legislative requirements, the potential for costly medical claims from work related injuries, "Hurry-Hurry" culture and "to do more with less resources" strategy combined to make the duty of DSRs more complex and tougher than ever before.

This study demonstrates that "DSRs Perceptions of Safety Training" is directly influenced by "Safety Culture". Pidgeon (1991, pp.129-40) states that *"A good safety culture is reflected in the positive safety attitudes and perceptions of the workforce"* and *"How people perceive risk is associated with a number of behavioural factors – attitude, personality, memory, their ability to process information, the level of training received, the level of arousal and individual skills available*". (Stranks, 1994, p.55)

Different DSRs may perceive levels of risks quite differently. A high level of safety culture will produce a positive impact upon the DSR's safety attitude towards the implementation of SMS at departmental level. Their safety attitudes and competences may facilitate or hinder the effectiveness of their actions in implementing SMS at departmental level. Do they have the knowledge, skills to accomplish their role? All these factors have correspondingly increased the importance of both education and training for DSRs. Geller (2005, p.290) points out that *"Training programs that only teach step-by-step procedures can be perceived as a top-down 'flavor of the month'. Educating people about the principles or rationale behind a new safety policy, program or process enables understanding and critical* *thinking. It also allows you to customize procedures for particular work situations."* To provide only training is inadequate to enable DSRs perform their duties in an effective manner. Stranks (1994, p.103) suggest that *"The systematic development of attitude, knowledge and skill patterns required by the individual to perform adequately a given task or job. It is often integrated with further education".*

In enhancing the effectiveness of the implementation of SMS and improving an overall safety performance, appropriate safety education and training could be very useful for DSRs to acquire the knowledge and skills. Educate and train them so they are confident they can handle safety tasks. Building-up DSRs' safety attitude at work by education and training not only boost up a sense of safety awareness and emergency response, but also helps to cultivate a positive safety culture. It is suggested that safety education and training for DSRs should be reviewed on the basis of University's needs.

➢ **EMPOWERMENT:**

Cooper (1997a, pp.185-202) states that *"Specific attitudinal biasing factors that affect risk perception in safety include people's personal commitment to safety, their beliefs about the causes of accidents and how stressful they find their jobs."* This study demonstrates that "DSRs Perceived Self-efficacy in Managing Safety" and "DSRs Personal Beliefs in Accident Causation" are directly influenced by "DSR Safety Attitude".

DSR safety attitude could significantly influence stakeholders' attitudes and behaviour either positively or negatively towards safety at work, so as to influence an entire safety culture in the University. *"The role of safety representatives in promoting a positive safety culture is to assist in the development and monitoring of communication links between management and the shop floor on matters of company safety policy. As such safety representatives need to be respected diplomats with enhanced status if they are to positively influence events in the workplace"* (Cooper, 1995, p.5) DSR's position in the hierarchy is an indicator of the University's management commitment to safety. Without visible commitment, mutual respects from the management and other stakeholders, DSRs would never make the SMS a success. To improve workplace safety; it is suggested that DSRs be appointed at an appropriate level and empowered with the authority in establishing, developing, maintaining, implementing, controlling and monitoring of SMS.

Menéndez et al. (2008, p.12) *states that "Empowerment of safety representatives does not only involve participation but also control on their resources and activities. Three main specific aspects are related to the empowerment of safety representatives need to be emphasized here. The first is the need to achieve visibility and respect from management, health and safety professionals. Secondly, safety representatives need to have the recognition and support from the assembly of workers (not only the union membership) as well as from the union inside the company. A third issue is* *the need of getting a clear and formal recognition from the government."* Geller (1994, pp.18-24) also points out that "*Empowerment refers to an individual's perceptions or attitudes as a result of a delegation of authority or responsibility by upper-level management. An empowered attitude can lead to increased motivation to 'make a difference', to go beyond the call of duty for organizational safety and take responsibility for ensuring safe operations".* When DSRs are empowered with safety duties, they have substantial voices and influential power in safety decisions and hold themselves responsible for their decisions and actions.

3. <u>CONCLUSION:</u>

The main objectives in this study have been addressed through the model testing and hypotheses testing. From the research findings, the main conclusion of this study is that DSRs in general have a positive safety attitude which influences the effectiveness of the implementation of SMS in the University. A substantial association was found between DSRs safety attitude and safety culture influences on the overall safety performance in the University.

A landmark decision has been made for the tertiary education sector in Hong Kong to change the undergraduate program from a 3-year to a 4-year in 2012. Unfortunately, the world is facing the worst economic crisis in 2008. The University, other tertiary institutions, industrial and non-industrial sectors are no exemption in suffering the retrenchment of resources for daily operations and future development. In coping with change, the University's strategy "do more with less resource" and perhaps the intensification of work may give rise to increase safety risks. It is important that the

University's management have to understand the effect and consequence that DSRs safety attitudes have either positive or negative impacts on the effectiveness of the implementation of SMS. The research results have provided practical implications to the University's management to understand what personal factors of DSRs are likely to influence the effectiveness of SMS and how well the safety management philosophy has been integrated into the University's operations. Achieving a high level of safety performance, careful selection and appointment of DSRs are challenges for the University's management.

4. DIRECTIONS FOR FUTURE STUDIES:

The "DSRs Safety Attitude Model" provided a theoretical background in explaining how the complexity of DSRs attitudinal factors influence the effectiveness of SMS implementation. Cultivating a positive safety culture is becoming a prime concern for accident prevention and safety culture has to become as part of an organizational culture. When considering future researches, two significant questions emerge as directions for further studies. First, to what extent do DSRs safety attitudes influence on the culture of safety in the organization? Second, to what extent does the culture of safety influences on the entire organizational culture? To address these two questions in future research would greatly enhance an understanding the important role of DSRs in cultivating safety culture in the organization.

5. CONTRIBUTION OF THE STUDY:

The research on safety attitudes sheds light on the reasons DSRs hold the attitudes they do and the degree to which attitudes influence the effectiveness of SMS implementation. The thesis has been brought to the end, hopefully this research not only contributed to the University but also applicable to other tertiary institutions, industrial and non-industrial sectors for two main reasons.

First, the research instrument "A Self-reported 6-point Likert type Safety Attitudes Survey Questionnaire" was developed. The results reported throughout this thesis confirm that the questionnaire is a reliable tool to measure the extent of DSRs safety attitudes toward the implementation of SMS. It is suggested that researchers, safety professionals and departmental management in other tertiary institutions, industrial and non-industrial sectors could modify the questionnaire for further studies of attitudinal and behavioural issues. Second, the "DSRs Safety Attitude Model" provides a systematic research framework to explore the extent of DSRs' safety attitudes toward the implementation of SMS. It is suggested that researchers, safety professionals and departmental management in other tertiary institutions, industrial and non-industrial sectors could generalise the application of the "DSRs Safety Attitude Model" as a tool for further investigation of attitudinal and behavioural issues. Finally, it is also the intention of this research to contribute the best of its effort to draw people's attention and understanding of the important role of human factors in sustaining a high level of safety performance under the self-regulatory safety management approach.

This study is concluded by the following statements:

<u>"KNOWLEDGE IS LIKE A GARDEN:</u>

<u>IF IT IS NOT CULTIVATED, IT CANNOT BE HARVESTED"</u>

(GUINEA, AFRICAN PROVERB)

<u>"LEARNING IS A NEVER-ENDING PROCESS"</u>

SEIGO TADA (1922-1997)

HANSHI SEIGO TADA, THE FOUNDER AND MY GRAND MASTER IN ALL JAPAN SEIGOKAN KARATEDO ASSOCIATION

<u>"LIFE-LONG LEARNING IS A WAY IN SUSTAINING THE SUCCESS"</u>

Chi-moon LI (JUNE 2009)

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APPENDIX 1

SOURCES OF ADOPTED AND MODIFIED QUESTIONNAIRE ITEMS FOR PILOT SURVEY:

- Health and Safety Executive HSE (2004). "*Research Report 259 – Occupational health and safety enforcement strategies to promote concordance in the hospitality industry*", Prepared by King's College London.

- KAM Chi-kit (2002), *The Exploration of a Multi-Dimensional Safe Behaviour Model for construction workers in Hong Kong – A Structural Equation Modelling Approach - Appendix 1: The English Version of the Questionnaire on Workers; Safety Perception.* PhD. Diss., University of Hull.

- *Safety Survey.* Available from: http://www.lboro.ac.uk/departments/bs/JIP/SAFESURV.HTM [Accessed 15 January 2006].

- Seaboch (1994) "*Effects of Safety Instruction upon Safety Attitudes and Knowledge of University Students enrolled in selected Agricultural Engineering Courses*" *Appendix D: Initial Safety Attitude Items.*

APPENDIX 1

1. **Safety Management [SM]** Eleven (11) items [SM 01-11] to address "Safety management" [SM]:		**SOURCES OF ADOPTED AND MODIFIED QUESTIONNAIRE ITEMS**
SM02	Safety procedures in your department are easy to understand.	***Most safety rules are cumbersome.*** Seaboch (1994) - Appendix D: Item 5
SM10	"Accident prevention rather than cure" is the main safety management strategy in your department / office.	***Accidents do not happen to careful people.*** Seaboch (1994) - Appendix D: Item 58
SM11	Departmental management only report accident involving of lost-workday injury to SEPO.	***Management acts only after accidents have occurred.*** Safety Survey – Question 19
2. Perceived Management Commitment To Safety [MC] Eight (8) items [MC 01-08] to address "Perceived management commitment to safety" [MC]		
MC01	Departmental management visibly demonstrates an interest in the safety matters.	***In my workplace managers show interest in my safety.*** Kam (2002) Appendix I: Item 6
MC02	Departmental management clearly considers the safety of people to be of great importance.	***Management clearly considers the safety of employees of great importance.*** Safety Survey - Question 5
MC03	Departmental management "turns a blind eye" to things that are done in an unsafe manner.	***In my workplace management turn a blind eye to safety issues.*** Kam (2002) Appendix I: Item 5

MC04	Departmental management encourages people to report any unsafe act and unsafe condition.	***Manager encouraged me to provide inputs and suggestions for the purpose of improving the safety and health in my work area.*** Kam (2002) Appendix I: Item 9
MC06	Departmental management is concerned for the operating cost more than safety.	***Productivity is more important than safety.*** Seaboch (1994) - Appendix D: Item 70
2. Perceived Management Commitment To Safety [MC] **Eight (8) items [MC 01-08] to address "Perceived management commitment to safety" [MC]**		
MC08	Safety is given high priority by the departmental management.	***Sometimes production has to be given priority over safety.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire
3. Safety Communication [SC] Ten (10) items [SC 01-10] to address "Safety communication" [SC],		
SC 02	People are always informed of unsafe practices.	***I often point out unsafe situations to my friends.*** Seaboch (1994) - Appendix D: Item 40
SC 03	People are always informed of unsafe conditions in the workplace.	***I often point out unsafe situations to my friends.*** Seaboch (1994) - Appendix D: Item 40
SC 04	People are welcome to share their safety concerns with others.	***Management has encouraged open communication about safety and health throughout the workplace.*** Kam (2002) Appendix I: Item 8

SC 05	People are freely making suggestions for safety improvement.	***Manager encouraged me to provide inputs and suggestions for the purpose of improving the safety and health in my work area.*** Kam (2002) Appendix I: Item 9
SC 09	Health and safety publications/magazines are circulated for perusal.	***Safety information is always brought to my attention by my line manager/supervisor.*** Safety Survey – Question 31
SC 10	Information regarding health and safety training and seminar is provided.	***Safety information is always brought to my attention by my line manager/supervisor.*** Safety Survey-Question – 31
4. DSR's Perceptions of Safety Training [ST] Ten (10) items [ST 01-10] to address "DSR's perceptions of safety training" [ST],		
ST 02	People are adequately trained to perform their tasks safely.	***Workers should be trained for safe practices.*** Seaboch (1994) - Appendix D: Item 24
5. DSR's Personal Beliefs in Accident Causation [PB] Ten (10) items [PB 01-10] to address "DSR's personal beliefs in accident causation" [PB],		
PB 01	Accidents are mainly due to a lack of safety knowledge from people involved.	***Accidents are usually caused by a machine failure.*** Seaboch (1994) - Appendix D: Item 9
PB 02	Accidents are mainly due to a lack of working experiences from people involved.	***Accidents and near-misses are caused by bad management.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.
PB 03	Accidents are mainly due to poor attitudes toward safety from people involved.	***Accidents and near-misses are caused by bad management.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.
PB 04	Accidents are mainly due to a lack of safety supervision.	***Accidents and near-misses are caused by bad management.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.

PB 05	Accidents just happen, there is little one can do to avoid them.	***Accidents just happen, there is little one can do to avoid them.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.
PB 06	Accidents in the workplace are totally unavoidable, because of "Acts of God"!	***Accidents are uncontrollable.*** Seaboch (1994) - Appendix D: Item 12
PB 07	Lots of minor injuries are a sign that more serious accidents could also occur.	***Lots of small injuries are a sign that more serious accidents could also occur.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.
5. DSR's Personal Beliefs in Accident Causation [PB] Ten (10) items [PB 01-10] to address "DSR's personal beliefs in accident causation" [PB],		
PB 08	It is necessary to "turn a blind eye" to rule violations, if people involved are your superior.	***Sometimes it is necessary to turn a blind eye to rule violations.*** HSE (2004) - Health and Safety in the Hospitality Industry – Questionnaire.
PB 09	Safety is the management responsibility, not others.	***Safety is the government's problem, not mine.*** Seaboch (1994) - Appendix D: Item 27
PB 10	Safety is the responsibility of SEPO, not others.	***Safety is the government's problem, not mine.*** Seaboch (1994) - Appendix D: Item 27
6. DSR's Perceptions of Group Safety Norms [SN] Fourteen (14) items [SN 01-14] to address "DSR's perceptions of group safety norms" [SN],		
SN 02	People would take every possible safety measures to prevent accident.	***My colleagues strive to fulfill the safety rules.*** Kam (2002) Appendix I: Item 16

SN 03	People would take shortcuts to perform their tasks naturally.	***There are often situations where a competent operator can bypass safety systems in order to get a job done.*** Seaboch (1994) - Appendix D: Item 16
SN 04	People would report any safety violation to their supervisors.	***I am strongly encouraged to report unsafe conditions.*** Safety Survey – Question 15
SN 05	People usually turn a 'blind eye' to unsafe matters.	***In my workplace management turn a blind eye to safety issues.*** Kam (2002) Appendix I: Item 5
SN 06	People are willing to report every workplace injury to the departmental management regardless of severity.	***I am strongly encouraged to report unsafe conditions.*** Safety Survey Question – 15
6. DSR's Perceptions of Group Safety Norms [SN] Fourteen (14) items [SN 01-14] to address "DSR's perceptions of group safety norms" [SN],		
SN 08	People are in favor of legislation to ensure workplace safety.	***The only reason teachers stress safety is to reduce or eliminate their legal liability in case something happens.*** Seaboch (1994) - Appendix D: Item 10
SN 10	People talking about safety is one thing; but practicing is another.	***Talking about safety is one thing; practicing it is another.*** Seaboch (1994) - Appendix D: Item 19
SN 12	People recognize that the workplace is a safer place to work than other organizations they have worked for.	***This is a safer place to work than other companies I have worked for.*** Safety Survey-Question 14
7. DSR's Perceived Safety Responsibility [SR] Eight (8) items [SR 01-08] to address "DSR's perceived safety responsibility" [SR]		
SR 01	As a DSR, I am clear about my safety responsibility for the department / office.	***I am clear about what my responsibilities are for health and safety.*** Kam (2002) Appendix I: Item 40

SR 02	As a DSR, I have to stop work if any imminent danger occurs.	***I will stop the task if that presents potential serious safety or health hazard.*** Kam (2002) Appendix I: Item 77
SR 03	As a DSR, I always point out any unsafe act or unsafe condition to people involved.	***I often point out unsafe situations to my friends.*** Seaboch (1994) - Appendix D: Item 40
SR 04	As a DSR, monitoring of individual's safety performance is part of my duty.	***I can influence health and safety performance here.*** Safety Survey-Question – 29
SR 08	"Health and Safety should be everybody's business".	***Safety is everyone's business.*** Seaboch (1994) - Appendix D: Item 47
8. DSR's Perceived Efficacy in Managing Safety [PE] Six (6) items [PE 01-06] to address "DSR's perceived efficacy in managing safety" [PE].		
PE 01	As a DSR, I am capable identifying safety hazards at the workplace.	***I have known of situations where people have gotten hurt because they honestly did not know something was dangerous.*** Seaboch (1994) - Appendix D: Item 14
PE 02	As a DSR, I know what to do in case of an emergency (such as fire, chemical spill).	***Thanks to my resourcefulness, I know how to handle unforeseen dangerous situations safely.*** Kam (2002) Appendix I: Item 33

Appendix II

A COMPLETE SET OF SELF-REPORTED "SAFETY ATTITUDES SURVEY" QUESTIONNAIRE WITH AN INTRODUCTORY LETTER PREPARED FOR PILOT SURVEY:

INTRODUCTORY LETTER:

Distribution to: All Departmental Safety Representatives (DSRs)

(Departmental Safety Officers, Deputy Departmental Safety Officers and staff members with duty of safety supervision)

From: LI Chi-moon, Health and Safety Officer, SEPO

Date: 9 February 2006

SAFETY ATTITUDES SURVEY *(PILOT TEST)*

For the research project of "<u>THE EXPLORATION OF A SAFETY ATTITUDE MODEL FOR DEPARTMENTAL SAFETY REPRESENTATIVES TOWARDS THE IMPLEMENTATION OF A SAFETY MANAGEMENT SYSTEM IN AN INSTITUTE OF TERTIARY EDUCATION IN HONG KONG</u>"

I am studying the course of PhD Education (Part-time) offered by the University of HULL, U.K. The purpose of the survey is to obtain feedback from departmental safety representatives (DSRs) about their attitudes towards to the implementation of safety management system at departmental level. Results of this survey will be used for my research study, and will also be made available to the Safety & Environmental Protection Office (SEPO) for reviewing the effectiveness of the current safety management system.

The questionnaire is divided into "PART A – Respondent's Data with 8 items" and "PART B - Safety Attitudes Survey with 77 statements". Please try to answer all of the questions accurately to the best of your judgment. The success of the survey depends on your contribution.

Please kindly return the questionnaire to me "C.M.LI – SEPO" by internal mail on or before 14 February 2006. All information will remain confidential.

Should you have any query about this survey, please feel free to contact me via email "cmlsea@ust.hk". Many thanks for your kind assistance!

C.M.LI

SAFETY ATTITUDES SURVEY

FOR THE RESEARCH PROJECT OF *"The Exploration of a Safety Attitude Model for Departmental Safety Representatives Towards the Implementation Of A Safety Management System in An Institute of Tertiary Education in Hong Kong*

PART A: Respondent's Data

Please make a *tick* in the appropriate box "□" that best describes your response on each question.

1. Gender:

   □ 1. Male

   □ 2. Female

2. Which of the following best describes your position?

   □ 1. Researcher / Teaching Staff
   □ 2. Engineer / Technical Staff
   □ 3. Administrative / Clerical Staff

3. What is your role in the departmental/office:

   □ 1. DSO

   □ 2. Deputy DSO

   □ 3. Staff member with duty of safety supervision

4. Age Group:

   □ 1. (< 21), □ 2. (21-30), □ 3. (31-40),

   □ 4. (41-50), □ 5. (51-60), □ 6. (> 60)

5. Highest Educational Level Attained:

   □ 1. (Doctoral Degree), □ 2. (Master's Degree), □ 3. (Bachelor's Degree),

   □ 4. (Diploma), □ 5. (Certificate)

6. How long have you been employed in the organization?

□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (> 11 yrs)

7. How long have you been appointed as Departmental Safety Representative?

□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (>11 yrs)

8. Department / Office:________________________(Write it down, "Optional")

PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.						
1. Safety Management [SM]						

SM 01	A departmental safety management system is fully developed in your department / office.	1	2	3	4	5	6
SM 02	Safety procedures in your department are easy to understand.	1	2	3	4	5	6
SM 03	An emergency plan (such as chemical spill, fire) is available in your department / office.	1	2	3	4	5	6
SM 04	Safety procedure is frequently reviewed.	1	2	3	4	5	6
SM 05	Workplace risk assessments have to be reviewed by authorized persons on a regularly basis.	1	2	3	4	5	6
SM 06	People are always equipped with proper tools and equipment to perform the job safely.	1	2	3	4	5	6
SM 07	Proper storage facility for dangerous goods/chemical substances is provided.	1	2	3	4	5	6

SM 08	SEPO safety manual provides useful guidelines for users.	1	2	3	4	5	6
SM 09	SEPO plays an active role in managing safety in the campus.	1	2	3	4	5	6
SM 10	"Accident prevention rather than cure" is the main safety management strategy in your department / office.	1	2	3	4	5	6
SM 11	Departmental management only report accident involving of lost-workday injury to SEPO.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
2. Perceived Management Commitment To Safety [MC]							
MC 01	Departmental management visibly demonstrates an interest in the safety matters.	1	2	3	4	5	6

MC 02	Departmental management clearly considers the safety of people to be of great importance.	1	2	3	4	5	6
MC 03	Departmental management "turns a blind eye" to things that are done in an unsafe manner.	1	2	3	4	5	6
MC 04	Departmental management encourages people to report any unsafe act and unsafe condition.	1	2	3	4	5	6
MC 05	Departmental management always listens to safety concerns from people.	1	2	3	4	5	6
MC 06	Departmental management is concerned for the operating cost more than safety.	1	2	3	4	5	6
MC 07	Departmental management is always provided with sufficient resources to let people get the job done safely.	1	2	3	4	5	6
MC 08	Safety is given high priority by the departmental management.	1	2	3	4	5	6

3. Safety Communication [SC]							
SC 01	Safety meeting is conducted on a regularly basis.	1	2	3	4	5	6
SC 02	People are always informed of unsafe practices.	1	2	3	4	5	6
<u>**PART B: Safety Attitudes Survey**</u> Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
SC 03	People are always informed of unsafe conditions in the workplace.	1	2	3	4	5	6
SC 04	People are welcome to share their safety concerns with others.	1	2	3	4	5	6
SC 05	People are freely making suggestions for safety improvement.	1	2	3	4	5	6

SC 06	Changes in working procedures and their effect on safety are effectively communicated to people involved.	1	2	3	4	5	6
SC 07	Results of safety inspection are communicated to the responsible parties for follow up action.	1	2	3	4	5	6
SC 08	Identified safety and health concerns are addressed in a timely manner	1	2	3	4	5	6
SC 09	Health and safety publications/magazines are circulated for perusal.	1	2	3	4	5	6
SC 10	Information regarding health and safety training and seminar is provided.	1	2	3	4	5	6
4. DSR's Perceptions of Safety Training [ST]							
ST 01	Safety issues are given high priority in training programs.	1	2	3	4	5	6
ST 02	People are adequately trained to perform their tasks safely.	1	2	3	4	5	6

ST 03	Training need analysis has been conducted for different trades.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
ST 04	Safety training program offered by SEPO meets with departmental training needs.	1	2	3	4	5	6
ST 05	Safety training can positively change people's attitudes towards safety.	1	2	3	4	5	6
ST 06	Safety training can help to reduce accidents.	1	2	3	4	5	6
ST 07	Safety rules have been clearly explained to participants in the induction training.	1	2	3	4	5	6
ST 08	Safety training can help to improve individual's safety awareness.	1	2	3	4	5	6

ST 09	Safety training can help to improve departmental safety performance.	1	2	3	4	5	6
ST 10	A "Permit-to-work" system has been introduced to participants in the induction training.	1	2	3	4	5	6
5. DSR's Personal Beliefs in Accident Causation [PB]							
PB 01	Accidents are mainly due to a lack of safety knowledge from people involved.	1	2	3	4	5	6
PB 02	Accidents are mainly due to a lack of working experiences from people involved.	1	2	3	4	5	6
PB 03	Accidents are mainly due to poor attitudes toward safety from people involved.	1	2	3	4	5	6
PB 04	Accidents are mainly due to a lack of safety supervision.	1	2	3	4	5	6

PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
PB 05	Accidents just happen, there is little one can do to avoid them.	1	2	3	4	5	6
PB 06	Accidents in the workplace are totally unavoidable, because of "Acts of God"!	1	2	3	4	5	6
PB 07	Lots of minor injuries are a sign that more serious accidents could also occur.	1	2	3	4	5	6
PB 08	It is necessary to "turn a blind eye" to rule violations, if people involved are your superior.	1	2	3	4	5	6
PB 09	Safety is the management responsibility, not others.	1	2	3	4	5	6
PB 10	Safety is the responsibility of SEPO, not others.	1	2	3	4	5	6

6. DSR's Perceptions of Group Safety Norms [SN]							
SN 01	People would refuse to work, if proper personal protection equipment (PPE) is not provided.	1	2	3	4	5	6
SN 02	People would take every possible safety measures to prevent accident.	1	2	3	4	5	6
SN 03	People would take shortcuts to perform their tasks naturally.	1	2	3	4	5	6
SN 04	People would report any safety violation to their supervisors.	1	2	3	4	5	6
SN 05	People usually turn a 'blind eye' to unsafe matters.	1	2	3	4	5	6
<u>PART B: Safety Attitudes Survey</u> Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							

SN 06	People are willing to report every workplace injury to the departmental management regardless of severity.	1	2	3	4	5	6
SN 07	People have a clear picture of the risks associated with their operations.	1	2	3	4	5	6
SN 08	People are in favor of legislation to ensure workplace safety.	1	2	3	4	5	6
SN 09	People fear that there will be negative consequences associated with reporting errors to the departmental management.	1	2	3	4	5	6
SN 10	People talking about safety is one thing; but practicing is another.	1	2	3	4	5	6
SN 11	People's attitude towards safety issues is very positive.	1	2	3	4	5	6
SN 12	People recognize that the workplace is a safer place to work than other organizations they have worked for.	1	2	3	4	5	6

SN 13	"Sanctions for mistakes" is widely accepted by individuals.	1	2	3	4	5	6
SN 14	A "Blame Culture" is widely accepted in your department / office.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
7. DSR's Perceived Safety Responsibility [SR]							
SR 01	As a DSR, I am clear about my safety responsibility for the department / office.	1	2	3	4	5	6
SR 02	As a DSR, I have to stop work if any imminent danger occurs.	1	2	3	4	5	6
SR 03	As a DSR, I always point out any unsafe act or unsafe condition to people involved.	1	2	3	4	5	6

SR 04	As a DSR, monitoring of individual's safety performance is part of my duty.	1	2	3	4	5	6
SR 05	As a DSR, departmental safety is my responsibility, not others.	1	2	3	4	5	6
SR 06	As a DSR, conduct of the departmental safety meeting is part of my duty.	1	2	3	4	5	6
SR 07	As a DSR, providing safety information to people involved is part of my duty.	1	2	3	4	5	6
SR 08	"Health and Safety should be everybody's business".	1	2	3	4	5	6
8. DSR's Perceived Efficacy in Managing Safety [PE]							
PE 01	As a DSR, I am capable identifying safety hazards at the workplace.	1	2	3	4	5	6
PE 02	As a DSR, I know what to do in case of an emergency (such as fire, chemical spill).	1	2	3	4	5	6

PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
PE 03	As a DSR, I am adequately trained in implementing the safety management program.	1	2	3	4	5	6
PE 04	As a DSR, I am capable of making suggestions on relevant safety control measures.	1	2	3	4	5	6
PE 05	As a DSR, I know how to apply the permit-to-work system in my department / office.	1	2	3	4	5	6
PE 06	As a DSR, I know how to conduct the workplace risk assessment.	1	2	3	4	5	6

Remarks: Do you have any other comments about health and safety in your workplace?

Please check that you have answered all questions. Thank you very much for taking the time to complete the questionnaire. Your participation is highly appreciated!

Appendix III

A COMPLETE SET OF THE RESTRUCTURED SELF-REPORTED "SAFETY ATTITUDES SURVEY" QUESTIONNAIRE WITH AN INTRODUCTORY LETTER PREPARED FOR FIELD SURVEY.

INTRODUCTORY LETTER:

Distribution to: All Departmental Safety Representatives (DSRs)

(Departmental Safety Officers, Deputy Departmental Safety Officers and staff members with duty of safety supervision)

From: LI Chi-moon, Health and Safety Officer, SEPO

Date: 15 May 2006

SAFETY ATTITUDES SURVEY

For the research project of "THE EXPLORATION OF A SAFETY ATTITUDE MODEL FOR DEPARTMENTAL SAFETY REPRESENTATIVES TOWARDS THE IMPLEMENTATION OF A SAFETY MANAGEMENT SYSTEM IN AN INSTITUTE OF TERTIARY EDUCATION IN HONG KONG"

I am studying the course of PhD Education (Part-time) offered by the University of HULL, U.K. The purpose of the survey is to obtain feedback from departmental safety representatives (DSRs) about their attitudes towards the implementation of safety management system at departmental level. Results of this survey will be used for my research study, and will also be made available to the Safety & Environmental Protection Office (SEPO) for reviewing the effectiveness of the current safety management system.

The questionnaire is divided into "PART A – Respondent's Data with 8 items" and "PART B - Safety Attitudes Survey with 43 statements". Please try to answer all of the questions accurately to the best of your judgment. The success of the survey depends on your contribution.

Please kindly return the questionnaire to me "C.M.LI – SEPO" by internal mail on or before 31 May 2006. All information will remain confidential. Should you have any query about this survey, please feel free to contact me via email "cmlsea@ust.hk". Many thanks for your kind assistance!

C.M.LI

SAFETY ATTITUDES SURVEY

FOR THE RESEARCH PROJECT OF *"The Exploration of a Safety Attitude Model for Departmental Safety Representatives Towards the Implementation Of A Safety Management System in An Institute of Tertiary Education in Hong Kong*

PART A: Respondent's Data

Please make a *tick* in the appropriate box "□" that best describes your response on each question.

3. Gender:

□ 1. Male

□ 2. Female

4. Which of the following best describes your position?

□ 1. Researcher / Teaching Staff
□ 2. Engineer / Technical Staff
□ 3. Administrative / Clerical Staff

3. What is your role in the departmental/office:

□ 1. DSO

□ 2. Deputy DSO

□ 3. Staff member with duty of safety supervision

4. Age Group:

□ 1. (< 21), □ 2. (21-30), □ 3. (31-40),

□ 4. (41-50), □ 5. (51-60), □ 6. (> 60)

5. Highest Educational Level Attained:

□ 1. (Doctoral Degree), □ 2. (Master's Degree), □ 3. (Bachelor's Degree),

□ 4. (Diploma), □ 5. (Certificate)

6. How long have you been employed in the organization?

□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (> 11 yrs)

7. How long have you been appointed as Departmental Safety Representative?

□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (>11 yrs)

8. Department / Office:________________________(Write it down, "Optional")

PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.						
1. Safety Management [SM]						

01	A departmental safety management system is fully developed in your department / office.	1	2	3	4	5	6
02	An emergency plan (such as chemical spill, fire) is available in your department / office.	1	2	3	4	5	6
03	Workplace risk assessments have to be reviewed by authorized persons on a regularly basis.	1	2	3	4	5	6
04	Proper storage facility for dangerous goods/chemical substances is provided.	1	2	3	4	5	6
05	SEPO safety manual provides useful guidelines for users.	1	2	3	4	5	6
2. Perceived Management Commitment To Safety [MC]							
06	Departmental management visibly demonstrates an interest in the safety matters.	1	2	3	4	5	6
07	Departmental management clearly considers the safety of people to be of great importance.	1	2	3	4	5	6

08	Departmental management always listens to safety concerns from people.	1	2	3	4	5	6
09	Departmental management is concerned for the operating cost more than safety.	1	2	3	4	5	6
10	Departmental management is always provided with sufficient resources to let people get the job done safely.	1	2	3	4	5	6
11	Safety is given high priority by the departmental management.	1	2	3	4	5	6
3. Safety Communication [SC]							
12	Safety meeting is conducted on a regularly basis.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
13	People are always informed of unsafe practices.	1	2	3	4	5	6

14	People are always informed of unsafe conditions in the workplace.	1	2	3	4	5	6
15	People are freely making suggestions for safety improvement.	1	2	3	4	5	6
4. DSR's Perceptions of Safety Training [ST]							
16	Safety issues are given high priority in training programs.	1	2	3	4	5	6
17	Safety training can positively change people's attitudes towards safety.	1	2	3	4	5	6
18	Safety training can help to reduce accidents.	1	2	3	4	5	6
19	Safety training can help to improve individual's safety awareness.	1	2	3	4	5	6
20	Safety training can help to improve departmental safety performance.	1	2	3	4	5	6
5. DSR's Personal Beliefs in Accident Causation [PB]							
21	Accidents are mainly due to a lack of working experiences from people involved.	1	2	3	4	5	6

22	Accidents are mainly due to poor attitudes toward safety from people involved.	1	2	3	4	5	6
23	Accidents just happen, there is little one can do to avoid them.	1	2	3	4	5	6
24	Lots of minor injuries are a sign that more serious accidents could also occur.	1	2	3	4	5	6
25	Safety is the responsibility of SEPO, not others.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
6. DSR's Perceptions of Group Safety Norms [SN]							
26	People would report any safety violation to their supervisors.	1	2	3	4	5	6

27	People usually turn a 'blind eye' to unsafe matters.	1	2	3	4	5	6
28	People are willing to report every workplace injury to the departmental management regardless of severity.	1	2	3	4	5	6
29	People have a clear picture of the risks associated with their operations.	1	2	3	4	5	6
30	People are in favor of legislation to ensure workplace safety.	1	2	3	4	5	6
31	People's attitude towards safety issues is very positive.	1	2	3	4	5	6
7. DSR's Perceived Safety Responsibility [SR]							
32	As a DSR, I am clear about my safety responsibility for the department / office.	1	2	3	4	5	6
33	As a DSR, I have to stop work if any imminent danger occurs.	1	2	3	4	5	6

34	As a DSR, monitoring of individual's safety performance is part of my duty.	1	2	3	4	5	6
35	As a DSR, departmental safety is my responsibility, not others.	1	2	3	4	5	6
PART B: Safety Attitudes Survey Please indicate your level of agreement with each of the statements in the table below by ticking the appropriate box.							
36	As a DSR, conduct of the departmental safety meeting is part of my duty.	1	2	3	4	5	6
37	As a DSR, providing safety information to people involved is part of my duty.	1	2	3	4	5	6
38	As a DSR, I am capable identifying safety hazards at the workplace.	1	2	3	4	5	6
39	As a DSR, I know what to do in case of an emergency (such as fire, chemical spill).	1	2	3	4	5	6

8. DSR's Perceived Efficacy in Managing Safety [PE]							
40	As a DSR, I am adequately trained in implementing the safety management program.	1	2	3	4	5	6
41	As a DSR, I am capable of making suggestions on relevant safety control measures.	1	2	3	4	5	, 6
42	As a DSR, I know how to apply the permit-to-work system in my department / office.	1	2	3	4	5	6
43	As a DSR, I know how to conduct the workplace risk assessment.	1	2	3	4	5	6

Remarks: Do you have any other comments about health and safety in your workplace?

____

____

Please check that you have answered all questions. Thank you very much for taking the time to complete the questionnaire. Your participation is highly appreciated!

APPENDIX IV

DSRS SAFETY ATTITUDES SURVEY QUESTIONNAIRE RESPONSE OPTIONS IN THE FIELD SURVEY:

PART A: RESPONDENT'S DATA	RESPONSE OPTIONS
1. Gender	Male / Female
2. Nature of Position	□ 1. Researcher / Teaching Staff □ 2. Engineer / Technical Staff □ 3. Administrative / Clerical Staff
3. Role in the departmental/office	□ 1. DSO, □ 2. Deputy DSO □ 3. Staff member with duty of safety supervision
4. Age Group	□ 1. (< 21), □ 2. (21-30), □ 3. (31-40), □ 4. (41-50), □ 5. (51-60), □ 6. (> 60)
5. Highest Educational Level Attained	□ 1. (Doctoral Degree), □ 2. (Master's Degree), □ 3. (Bachelor's Degree), □ 4. (Diploma), □ 5. (Certificate)
6. How long have you been employed in the organization?	□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (> 11 yrs)

7. How long have you been appointed as Departmental Safety Representative?		□ 1. (< 3 yrs), □ 2. (3-5 yrs), □ 3. (6-8 yrs), □ 4. (9-11 yrs), □ 5. (>11 yrs)
8. Department / Office		Optional
PART B: SAFETY ATTITUDES SURVEY		**RESPONSE OPTIONS**
1. Safety Management [SM]		
01	A departmental safety management system is fully developed in your department / office.	Strongly Disagree to Strongly Agree
02	An emergency plan (such as chemical spill, fire) is available in your department / office.	Strongly Disagree to Strongly Agree
03	Workplace risk assessments have to be reviewed by authorized persons on a regularly basis.	Strongly Disagree to Strongly Agree
04	Proper storage facility for dangerous goods/chemical substances is provided.	Strongly Disagree to Strongly Agree
05	SEPO safety manual provides useful guidelines for users.	Strongly Disagree to Strongly Agree
2. Perceived Management Commitment To Safety [MC]		
06	Departmental management visibly demonstrates an interest in the safety matters.	Strongly Disagree to Strongly Agree
07	Departmental management clearly considers the safety of people to be of great importance.	Strongly Disagree to Strongly Agree
08	Departmental management always listens to safety concerns from people.	Strongly Disagree to Strongly Agree
09	Departmental management is concerned for the operating cost more than safety.	Strongly Disagree to Strongly Agree
10	Departmental management is always provided with sufficient resources to let people get the job done safely.	Strongly Disagree to Strongly Agree

11	Safety is given high priority by the departmental management.	Strongly Disagree to Strongly Agree
3. Safety Communication [SC]		
12	Safety meeting is conducted on a regularly basis.	Strongly Disagree to Strongly Agree
13	People are always informed of unsafe practices.	Strongly Disagree to Strongly Agree
14	People are always informed of unsafe conditions in the workplace.	Strongly Disagree to Strongly Agree
15	People are freely making suggestions for safety improvement.	Strongly Disagree to Strongly Agree
4. DSR's Perceptions of Safety Training [ST]		
16	Safety issues are given high priority in training programs.	Strongly Disagree to Strongly Agree
17	Safety training can positively change people's attitudes towards safety.	Strongly Disagree to Strongly Agree
18	Safety training can help to reduce accidents.	Strongly Disagree to Strongly Agree
19	Safety training can help to improve individual's safety awareness.	Strongly Disagree to Strongly Agree
20	Safety training can help to improve departmental safety performance.	Strongly Disagree to Strongly Agree
5. DSR's Personal Beliefs in Accident Causation [PB]		
21	Accidents are mainly due to a lack of working experiences from people involved.	Strongly Disagree to Strongly Agree
22	Accidents are mainly due to poor attitudes toward safety from people involved.	Strongly Disagree to Strongly Agree
23	Accidents just happen, there is little one can do to avoid them.	Strongly Disagree to Strongly Agree
24	Lots of minor injuries are a sign that more serious accidents could also occur.	Strongly Disagree to Strongly Agree
25	Safety is the responsibility of SEPO, not others.	Strongly Disagree to Strongly Agree
6. DSR's Perceptions of Group Safety Norms [SN]		

26	People would report any safety violation to their supervisors.	Strongly Disagree to Strongly Agree
27	People usually turn a 'blind eye' to unsafe matters.	Strongly Disagree to Strongly Agree
28	People are willing to report every workplace injury to the departmental management regardless of severity.	Strongly Disagree to Strongly Agree
29	People have a clear picture of the risks associated with their operations.	Strongly Disagree to Strongly Agree
30	People are in favor of legislation to ensure workplace safety.	Strongly Disagree to Strongly Agree
31	People's attitude towards safety issues is very positive.	Strongly Disagree to Strongly Agree
7. DSR's Perceived Safety Responsibility [SR]		
32	As a DSR, I am clear about my safety responsibility for the department / office.	Strongly Disagree to Strongly Agree
33	As a DSR, I have to stop work if any imminent danger occurs.	Strongly Disagree to Strongly Agree
34	As a DSR, monitoring of individual's safety performance is part of my duty.	Strongly Disagree to Strongly Agree
35	As a DSR, departmental safety is my responsibility, not others.	Strongly Disagree to Strongly Agree
36	As a DSR, conduct of the departmental safety meeting is part of my duty.	Strongly Disagree to Strongly Agree
37	As a DSR, providing safety information to people involved is part of my duty.	Strongly Disagree to Strongly Agree
38	As a DSR, I am capable identifying safety hazards at the workplace.	Strongly Disagree to Strongly Agree
39	As a DSR, I know what to do in case of an emergency (such as fire, chemical spill).	Strongly Disagree to Strongly Agree

8. DSR's Perceived Efficacy in Managing Safety [PE]		
40	As a DSR, I am adequately trained in implementing the safety management program.	Strongly Disagree to Strongly Agree
41	As a DSR, I am capable of making suggestions on relevant safety control measures.	Strongly Disagree to Strongly Agree
42	As a DSR, I know how to apply the permit-to-work system in my department / office.	Strongly Disagree to Strongly Agree
43	As a DSR, I know how to conduct the workplace risk assessment.	Strongly Disagree to Strongly Agree