THE RELATIONSHIP BETWEEN SAFETY COMMUNICATION AND HUMAN FACTOR ACCIDENT AT THE WORKPLACE – A CONCEPTUAL FRAMEWORK

Yeong Sook Shuen
jocelynf1_sky@hotmail.com

Shah Rollah Abdul Wahab
shah@management.utm.my

Faculty of Management, Universiti Teknologi Malaysia, 81310, Skudai, Johor, Malaysia.

ABSTRACT

Rapid development in industrialization and global economy has contributed to the increased number of workplace injuries and accidents. These days, with the advancement and the reliability of technology, accidents caused by equipment and machinery failures seem to be decreasing. However, human element tends to become a significant contributor in accident at the workplace. Statistical reports and evidences indicate that around 80 to 90 percent of work-related accidents can be attributed to human factors. Notably, the concept of human factor accident has evolved over time. Decades ago, human factor accident has been defined as the contact between man and machine, poor workplace and equipment design at the workplace or within an operation system. In recent years, researches on human factor accident have shown a changing trend. Attention has been focused more on individual factors and organizational factors which contribute to human factor accident at the workplace. Besides, safety communication at the workplace has playing a vital role in reducing human factor accident. Effective communication among the workers and leader is believed to help in reduce the risk of human factor accident to be happened. Thus, this study reviews the literature on human factor accident and safety communication. In order to examine the relationship of safety communication and human factor accident, 300 sets of questionnaire will be distributed to the production workers from manufacturing companies in Negeri Sembilan, Malaysia. In the final part of this paper, the researcher has come out with a conceptual framework of the relationship between safety communication and human factor accident based on the literature reviewed.

Keywords: *Safety Communication, Human Factor Accident, Swiss Cheese Model, Safety, Accident, Individual Factor, Organizational Factor*

1. INTRODUCTION

Industrialization along with growing populations has resulted in an increase in occupational injuries, which is becoming a common occurrence (Arokiasamy and Krishnan, 1994; Rampal and Mohd Nizam, 2006). In Malaysia, statistics have revealed that our country has not been meeting expectations of reducing the number of accidents after implementing many safety policies and also a lot of preventive actions. From that point, Social Security Organization of Malaysia (SOCSO) had announced the latest number of reported accidents as many as 63,557 cases in 2013, an increase of 2,005 cases or 3.26% in comparison to 61,552 cases in 2012. Surprisingly, it is represented in every 10,000 workers, 59 workers were involved in industrial accidents. The total benefits payment in 2013 has increased by RM203.48 million or 10.17% to RM2, 203.49 million as compared to RM2, 000.01 million in 2012.

Accidents are defined as unforeseen and unplanned events (Alicia, 2009). In highly hazardous industries such as aviation, nuclear power plant, construction site, and even manufacturing industry, the number of accident is always leading among all other industries (Qureshi, 2007). However, Lyneis and Madnick (2008) argued that it is almost impossible to prevent accidents from happening in high risk industries. The evidence shows that, each year, about 2 million workers have been killed by job-related accidents and diseases; 270 million of occupational accidents and 160 million of occupational diseases happen each year in the world (Abdul Rahim *et al.,* 2011). Workplace accidents persist to be a quandary and a huge challenge to the management in the organization nowadays (Biggs *et al.,* 2014). Therefore, to effectively avoid or prevent accidents from happening, the managerial personnel have tried their very best to improve workplace safety at their working premises (Wu, 2007).

Occupational accidents and injuries have great impact for individuals, their families and friends, and of course, their employers. Hence, organizations nowadays are taking more proactive ways to prevent accidents from happening. Unfortunately, the increasing accident rate has gained attention from employers, who are beginning to proactively execute accident-preventing action. However, most of the workplace accidents are believed to happen due to behavioural factors (Kim *et al.,* 2002). This is not merely the behaviour of frontline workers but also the management's behavior towards safety issues. These days, with the advancement and the reliability of technology, accidents caused by equipment and machinery failures seem to be decreasing (Hendy, 2003). Evidence indicates that around 80 to 90 percent of work-related accidents can be attributed to human factors (Reason, 1990a; Burton, 2007; Alicia, 2009) and it has been described as a major contributor of workplace accidents (Kariuki and Lowe, 2007). In other words, human factor is believed to be the main reason that causes accidents instead of machinery and hardware problems.

Besides, some of the accident causation models, for instance Heinrich's Domino Model and Safety Pyramid Model which have been very popular and widely adapted in safety research, have revealed the important role of human factor elements in accidents. In general, these models attempt to explain why and how the accident would happen, which could help in accident investigation process. In domino theory, five elements of accident have been identified in sequence: social environment and ancestry, fault of person, unsafe acts and unsafe condition, accident, and lastly, injury (Rad, 2013). This model is in sequence whereby injury is caused by accident; while accident is the result of unsafe conditions. However, unsafe conditions are likely to exist due to the fault of the workers whereas undesirable characteristics of an individual are created by the environment that they are in (Dokas, 2009).

Likewise, another model is also being adapted to explain the causes of accidents, which is the Safety Pyramid Model. In the late 1920s, Heinrich in his most well-known report "The Origin of Accidents" concluded that 88 percent of industrial accidents are caused by

unsafe acts committed by fellow workers; 10 percent are caused by unsafe conditions while the remaining 2 percent are unavoidable (Goecsth, 2011). As the extension of this theory, Safety Pyramid Model has been developed to further explain the chain of accidents. In 1931, Heinrich developed a pyramid-shaped model to explain the relationship of near-missed accidents to minor and major injuries (Storbakken, 2002). Heinrich's pyramid stated that for every 300 near-miss accidents, there will be 29 minor and 1 major incidents (Collins, 2011; Rieder and Bepperling, 2011). Based on this model, researches believed that near-miss incidents must be prevented in the first place in order to eliminate the possibility of reaching each successive level of the pyramid (Rieder and Bepperling, 2011; Storbakken, 2002).

In accident investigation, however, human factor has become increasingly noticeable at the workplace (Stave *et al.,* 2008). More and more concerns have been given by the management and also the academic scholars towards human-caused accidents. Traditionally, accidents were declared to be at fault of the technological dysfunction while human factors tended to be disregarded (Anastácio *et al.,* 2012). But nowadays, the focus of safety research has seemed to be turned to human factor accident.

2. LITERATURE REVIEW

2.1 HUMAN FACTOR ACCIDENT

Human factor has been concluded as the primary cause of accidents in high risk industries (Qureshi, 2007; M Ćorović and Djurovic, 2013; Wang *et al.,* 2013). Tracing back to previous years, human factors often contributed to the occurrence of accidents. For instance, looking back to 1912, the well-known, largest and luxurious ship – Titanic, which was dubbed the "unsinkable ship", was sunk by hitting an iceberg on its maiden voyage (Geraldi *et al.,* 2010), and over 1300 passengers died. This accident could have probably been foreseen and avoidable; yet, one of the factors that led to the tragedy is human factor; wrong decision made by the captain which caused the ship to sink (Labib and Read, 2013). Nevertheless, the concept of human factors has received widespread attentions because of two of the major industrial catastrophes – the ground crash between two large aircrafts in Tenerife in 1977 with a total of 583 fatalities and a nuclear accident on Three Mile Island in 1979, which released radioactive gases and iodine into the environment (Chen *et al.,* 2013). Both of the disasters have been recognized due to inadequate training and human factor failures as disclosed in investigations. Traditionally, human factor is defined as the contact between man and machine, poor workplace and equipment design or other elements of a system (Gordon, 1998; Wogalter *et al.,* 2001; Zink, 2006; Schönbeck *et al.,* 2010; Rahimi and Rausand, 2013) as well as the factors that influence people and their behavior in safety issues (Vogt *et al.,* 2010). In past decades, people believed that human factor does not merely involve human unsafe characteristics but also consists of the design of workplace, task and tools while recognizing the restraint of individual's physical and psychological abilities (Abdelhamid and Everet, 2000).

Recently, the trend of human factor accident has changed; formerly used human factor accident concept is now being extended by researches. Few scholars have been able to convince that human factor can be described as interaction among human and elements of organization (Zink, 2006; Einarsson and Brynjarsson, 2008). Attention has been focused more on individual factor and organizational factor which contribute to human factor accident at the workplace (Schönbeck *et al.,* 2010; Skogdalen, and Vinnem, 2011; Wang *et al.,* 2011; Arfena Deah *et al.,* 2014). Kariuki and Lowe (2007) have defined human factor accident in this study as organizational and job factors, human and individual characteristics which influence behavior and work in the way they can affect safety at the workplace. In Mearns *et al.*'s (2001) study, individual and organizational factors have been recognized as two dominant factors affecting safety at the workplace. Individual factor such as worker's competence level, level of pressure, and self-motivation level are believed to influence safety at the workplace (Arfena Deah, 2013) Meanwhile, decision error, skill-based error, perceptual error and violation are also categorized under individual factors which contribute to human factor accident (Thomas, 2003; Li *et al*., 2008). Besides, organizational factors have been claimed as one of the contributors of human factor accident. Organizational factors include insufficient safety training, poor communication among workers, inadequate safety procedures and safety policies, inappropriate arrangement for evacuation procedures, and safety management failures (Mearns *et al.,* 2001).

Human factor has gained huge attention after the accident of Three Mile Island nuclear power plant disaster in 1979 (Sutton, 2015). Since then, human factor has been concentrated on man-machine relationship and related to human performance (Einarsson and Brynjarsson, 2008). The concept of human factor accident can be traced back from 1977. In earlier stages, human factor is treated as the interaction of human capabilities and limitation of products and workplace environment. Based on these characteristics, Farrell (1977) has developed human factor theory based on a chain of human factor causes of accident (Hosseinian and Torghabeh, 2012). Human factor theory includes three main components: overload, improper response, and improper activity; this theory has emphasized more on incompatibilities of human which then lead to an accident (Abdelhamid and Everett, 2000).

Therefore, in relation to the conceptualization of human factor in earlier years, Hetherington *et al.* (2006) has proposed six dimensions of human factor, which are situation awareness, decision making, fatigue, automation, communication health and stress as well as teamwork. Similarly, O'Connor (2011) has introduced four dimensions of human factor, namely personal stress, stress of others, communication, and command responsibility. However, in recent years, the trend of human factor has turned the points to the failure made by individuals (Howell *et al.,* 2002) and elements of organizational operation system (Burke *et al.,* 2011; Arfena Deah *et al.,* 2014).

Therefore, researchers nowadays tend to put their attention to Swiss Cheese Model (SCM). Investigating both latent and active failures which have been treated as key components in the model has become a popular topic in human factor research. This model has directed the attention towards the individual and organizational factors which may lead to failures (Fox and Ziegler, 2007). This undeniably has become another extension of the human factor theory, which has been widely explained in recent human factor studies.

Based on SCM, human factor studies are more likely to put their attentions on individual and organizational factor in human factor accident (Schönbeck *et al.,* 2010; Skogdalen, and Vinnem, 2011; Wang *et al.,* 2011; Arfena Deah *et al.,* 2014). Wang *et al.* (2011) in their study has assessed the contribution of individual and organizational factors in accidents using Human Factor Analysis and Classification System (HFACS) as well as Bayesian Network (BN). Besides, Schönbeck *et al.* (2010) in their study create a new approach to address individual and organizational factors that affect the performance of safety instrumented system as well as safety integrity level. Arfena Deah *et al.* (2014) have also suggested that human factors in shipping safety can be categorized into three; there are organizational factor, group factor, and individual factor. In this study, Reason's Swiss Cheese Model (SCM) will be focused on for a better understanding on the concept of human factor accident. Meanwhile, two main elements from SCM, which are active failure and latent failure, will be discussed next.

2.2 SWISS CHEESE MODEL

Reason's Swiss Cheese Model has established the basics of analyzing the underlying causes of accident and has become one of the examples of modern accident model. It is known as a metaphor of accident proposed by Reason (1990a) to explain the occurrence of human factor, risk analysis and risk management in safety context which is widely used especially in high risk industries (Perneger, 2005). Reason (2000) proposed that defenses and barriers had accounted for an important role in high technology system. Those defenses could be engineered, direct by individual, or depending on system and managerial controls. Hence, Swiss Cheese Model proposed four layers of defence, namely organizational influence, unsafe supervision, precondition for unsafe acts, and unsafe acts (Shappell and Wiegmann, 2000; Wiegmann and Shappell, 2001; Wu *et al.,* 2009). It hypothesizes that each slice of cheese represents one layer of defense or barriers in a complex system; the holes on each slice and the gaps between the cheese slice represent the failures and errors (active and latent) at the human level of the system. However, in the ideal world, the defensive layers should be intact. Unfortunately, in reality, defence insufficiency always happens like the hole on the slice of Swiss cheese (Reason, 2013).

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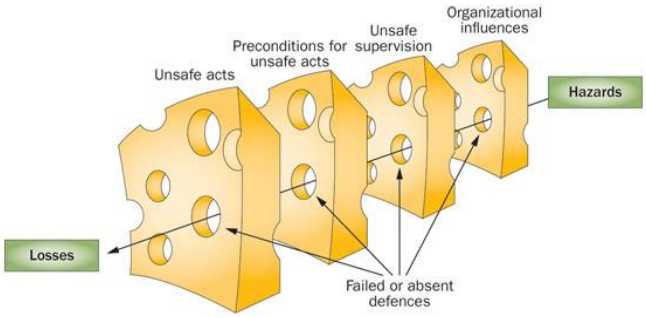
Figure 1.1: Reason's Swiss Cheese Model



However, failure of individual does not occur solely but with the influence of other organizational factors (McFarlane, 1993; Mearns *et al.,* 2001). Several researches have proposed potential causes of human factor accident. For instance, Abdul Rahim *et al.* (2008) believed that the combination of unsafe act and unsafe conditions is the root cause of accidents. Meanwhile, Fox and Ziegler (2007) believed that accidents happened due to systemic factors while human elements are just a part of it. In general, SCM explains the aetiologies of human factor accidents using latent failure and active failure.

2.2.1 ACTIVE FAILURE

Active failure refers to unsafe acts at the "sharp end", which is more noticeable in an accident (Drury, 2000; Wu *et al.,* 2009). Jeffs (2010) has described active failure as "the error at the point of contact between human and some aspects of the larger environment or system interface". Unsafe acts are mostly committed by individuals in the form of decision error (improper acts, misdiagnosed problem), skill-based error (poor procedure, inappropriate use of equipment), perceptual error (misjudged, visual illusion), and violation (violated training rules, practicing unauthorized actions and approaches) (Reason, 1990b; Thomas, 2003; Li *et al,* 2008). Generally, active failure refers to the errors committed by front-line personnel which in turn contribute to immediate result of mishap (Cowan, 2009). According to Jeffs (2010), active failure has been further categorized into three types: slips, lapses, and mistakes. Slips refer to the failure in the execution of an action as planned; lapses refer to omission to execute actions as planned due to failure of memory; while mistakes refer to error of judgment, diagnosis, or application of procedure.

Burke *et al.* (2011) has pointed out three types of factors which increase the number of accidents: individual factor (cognitive error, slips, fatigue, attitudes), micro-organizational factor (safety commitment, safety objectives), and macro-organizational factor (organizational structure, technology, centralize decision making). Hetherington *et al.* (2006) developed a model that focuses on the factors that could result to accidents. Underlying causes (latent failure) and immediate causes (active failure) have been identified in their study. Hetherington *et al.* (2006) also identified immediate causes under personal factors such as stress, fatigue, communication and so on. Meanwhile, organizational and management factors have been categorized as underlying causes of accidents. Based on the empirical evidences above, active failure is believed to involve individual factors such as behaviour and characteristics, physical and mental capabilities, and the abilities of individuals interacting with their job and working

environment, which could probably trigger accidents at the workplace (Skogdalen and Vinnem, 2011).

2.2.2 LATENT FAILURE

Rivera *et al.* (2013) firmly believed that most of the accidents happened due to the reliability of operation system and also operator's error. However, besides deeply investigating human behavior and error orientation, recent safety researches have focused more on identifying organizational systemic problems rather than merely examining individual failures (Thomas, 2003). As mentioned earlier, Swiss Cheese Model (SCM) has demonstrated a complex organizational system with the highlights of latent and active failures that are most probably invisible or unforeseen in an organization. Notably, latent failure has played a crucial role in human factor accident. Latent failure has been defined as hidden causes of accident and usually exists long before an accident occurs (Drury, 2000; Cowan, 2009).

Latent failure in SCM consists of three main categories: organizational influence (resource management, organizational climate, organizational process), unsafe supervision (inadequate supervision, planned inappropriate operation, failure to correct a known problem, supervisory violation), and preconditions of unsafe acts (physical and technological environment, adverse mental and psychological state, crew resource management, personal readiness) (Reason, 1990b; Wiegmann and Shappell, 2001; Li *et al.,* 2008; Wu *et al.,* 2009). Although operator's error is always a factor to blame in most of the accidents, they are believed to be affected by the failure of organizational system, which is basically hidden and overlooked (Rivera *et al.,* 2013). Thus, the management's responsibility is to attentively monitor and disclose latent failures before they lead to adverse events (Zimolong and Elke, 2006).

It is very hard to guarantee a perfect organizational operation system without all possible human elements which could probably cause a damaging accident (Thomas, 2003). According to Reason (1990a), accidents involve both active failures and latent failures. However, after the breakthrough of the accident, active failures are the one always investigated by the management but latent failures are being neglected (Syed Mohamed and Ideris, 2012). Although latent failures are hard to predict, it actually can be identified before accident happens by closely monitoring the system's "vital signs" (Reason, 2013). Li *et al.* (2008) in their research believed that most of the latent failures are related to management and authoritarian structure. Similarly, Rivera *et al.* (2013) identified several possible factors which result in the formation of latent failure: organizational culture, management decisions, the design of procedures, and deficiencies of training.

Swiss Cheese Model has been developed to widen the focus on human factor. It is likely that human factor has encompassed the interaction between individual, group, and organizational elements, which become co-contributors to incidents (Gordon, 1998). According to SCM, disasters are characterized by series of continuous failures rather than a single large failure. Latent failures in organization have posed a great

threat to the result of active failures (Ternov and Akselsson, 2005). Based on the researches, latent failure also stresses on accident potential in terms of mental fatigue, poor communication (Shappell and Wiegmann, 2000), organizational processes, task and environmental conditions, individual unsafe acts and failed defences (Slud *et al.,* 1988).

2.3 SAFETY COMMUNICATION

Communication is the way people convey thoughts, express feelings and deliver information and knowledge among individuals (Cigularov *et al.,* 2010). However, with the term "safety", communication becomes a tool which could help employers manage safety issues; ensure that members in an organization stay away from potential hazards and accidents (Alsamadani *et al.,* 2012). Safety communication is not merely a process of giving and receiving safety information at the workplace; it helps to influence employees' behaviour and attitudes towards safety. Geller (2005) claimed that an organization's safety status is determined by how safety is discussed and disseminated. It is evident that effective safety communication has been shown to affect specific employees' behaviour for example safety performance (Michael *et al.*, 2006). However, miscommunication among the workers, especially between employee and the upper-level management frequently occurs (Mullen *et al.*, 2011) and this might be due to the neglect of constructive safety communications at the workplace, implying that a good safety culture atmosphere does not exist in the organization (Conchie *et al*, 2013).

Safety communication breakdowns had reduced the possibility of workers to take appropriate actions at critical moment and reducing safety performance (Michael *et al.,* 2006; *Kines et al.,* 2010; Maxfield *et al.,* 2011). According to Maxfield *et al.* (2011), communication breakdown can be categorized as honest mistakes and undiscussable. Honest mistakes including poor handwriting, confusing labels, difficult accent, and language barriers which definitely can put people in danger. Therefore, it results to continue performing unsafe acts at the workplace. (Alsamadani *et al.,*2012). Although evidences showed that communication breakdown will directly related to the safety of the human being (Lesch, 2005; Buckley, 2010; Donahue *et al.,* 2012), however, there is still a lack of attention given to safety communication at the workplace (Laughry, 2006; Kines *et al.,* 2010).

The importance of communication is valued once the employees perceived that there is an openness safety communication at the workplace (Neal *et al.,* 2000). Lack of safety communication will probably lead to inadvertent hazard to the workers in the organization. Chen and Chen (2013) believed that, upward safety communication is a crucial element to avoid adverse safety events in the organization. As the result, effective communication between manager and the workers about safety issue has become an important safety intervention at the workplace (Clarke, 2006). In fact, frequently discuss about safety is essential way to acknowledge employees' safety commitment at the workplace (Fruhen *et al.,* 2013). Besides,

management's safety commitment has become a highlighted concern where visible commitment from management helps to enhance workers safety awareness at the workplace (Preece and Stocking, 1999).

In general, safety communication has been defined as a process of communication regarding safety-related issues and problems (Laughery, 2006). In this study, the researcher is believed that safety communication is a major component which could significantly bring a huge influence on accidents. In addition, safety communication has believed to predict human safety behaviour at the workplace (Kaskutas *et al.,* 2013). Thus, the researcher has an interest to examine the degree of safety communication which could affect unsafe behaviour of the workers at the workplace.

3. CONCEPTUAL DEVELOPMENT

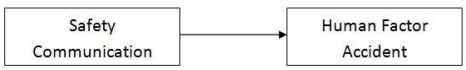
Initially, workplace accident is assumed as unplanned and unpredictable events which may cause damages and injuries in the organization. Nevertheless, it has become obvious that accident is not necessary to solely blame on machinery problems, but it is highly depends on human failures. Based on the literature, it is hypothesized that there is a significant association between safety communication and human factor accident. It has been observed that the impact of effective safety communication is adhering to the accidents caused by individual and organizational failures. According to the previous case, Piper Alpha disaster in 1988 has found that communication failures of on-shore manager were the main contributor on that accident (Paté-Cornell, 1993; Hendershot, 2013). Since then, researchers are trying to examine the impact of safety communication in reducing accident at the workplace. For example, Alsamadani *et al.* (2012) has indicated that open safety communication across all organizational levels enhances safety in construction sector by having a lower accident rates. Cigularov *et al.* (2009) revealed that open safety communication plays an essential role in occupational safety. Other study for instance Brondino *et al.* (2012) had indicated that, by concentrate on improving safety communication could effectively enhance safety performance and reduce accident rate.

Meanwhile, the first theory of communication has been introduced by Shannon and Weaver in 1948. A model of communication system developed by Shannon and Weaver claims that the signal being transmitted with several important components: sender, receiver, sources, message, channel, destination, and noise source. However, in 1990s, research has further addressed the importance of vertical communication in organization (Bartels, 2006). Vertical communication can be divided into downward and upward communication. Effective safety communication moves in vertical direction, either top-down communication or down-top communication to provide and receive the safety information. Therefore, this paper has considered the impact of vertical safety communication on the human factor accident.

Over the past decades, researches have confirmed that inadequate

communication in the workplace is one of the most challenging factors of the accident (Hetherington *et al.,* 2006; Krivonos, 2007; Rothblum, 2000; Ganguly, 2011). Hetherington *et al.* (2006) had examined the safety in shipping sector and in their study revealed that, 42 percent of incidents sampled by the Canadian Transportation and Safety Board involved miscommunication among the pilots and officers. Besides, Krivonos (2007) in his study has stated that, over 70% of safety problems from NASA's Aviation Safety Reporting System were involving communication-related issues. Based on the empirical evidences, it is expected that strong safety communication at the workplace would be more likely to reduce human factor accident in the organization. By far, the relationship between communication and human factor accident has been well established. However, the investigation of the direct effect on safety communication and human factor accident is still under explored. Hence, based on the literature, a conceptual framework is developed and described in figure 1.2.

Figure 1.2: Conceptual Framework



4. CONCLUSION

This study is plans to investigate the relationship between safety communication and human factor accident in Malaysia. Based on the literature reviewed, this study believes that the occurrence of human factor accident can be attributed to two dominant factors, which are individual factor and organizational factor; while effective communication of safety would significantly affect the occurrence of human factor accident at the workplace. As mentioned earlier, Swiss Cheese Model has explained the aetiologies of human factor accidents using latent failure and active failure. However, based on SCM, researchers believe that the aetiologies could be further categorized into two main categories: individual factor and organizational factor (Deverell, 1960; Gordon, 1998; Reason, 2000; Reason, 2005; Wang *et al.,* 2011; Arfena Deah *et al.,* 2014). Failure is not only made by the individual but there is also the hidden failure, which is hard to foresee under organizational operational system and has threatened the safety of personnel at the workplace. Therefore, to reduce human factor accident, effective safety communication among the workers and management, strong safety culture, and leaders who encourage their followers to work safely are essential in an organization.

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