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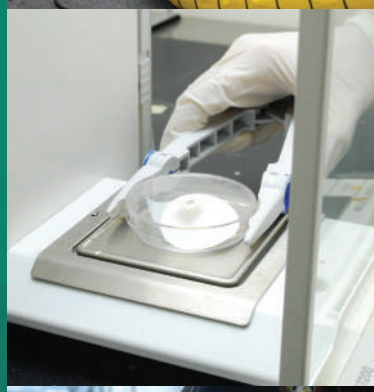

Special Issue

3rd Scientific Conference on Occupational Safety and Health: Sci - Cosh 2014

15-16 October 2014

National Institute of Occupational Safety and Health (NIOSH)
Ministry of Human Resources Malaysia

Journal of Occupational Safety and Health

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Journal of Occupational Safety and Health

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Introducing the Journal of Occupational Safety and Health

The National Institute of Occupational Safety and Health (NIOSH) is delighted to announce the publication of Journal of Occupational Safety and Health.(JOSH).

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JOSH is poised to become an essential resource in our efforts to promote and protect the safety and health of workers.

From the Editor in Chief

Workplace safety is a priority. Much needs to be done to encourage employees, employers and industries to put occupational safety and health at the top of their agenda. The most important thing is our commitment in taking action; our commitment to make the necessary changes to ensure that safety is at the forefront of everyone's thinking.

The Journal of Occupational Safety and Health, (JOSH) the first to be published in Malaysia, aims to boost awareness on safety and health in the workplace.

It is no longer sufficient to simply identifying the hazards and assessing the risks. We aim to increase understanding on the OSH management system. We aim to strengthen commitment to workplace safety and better working conditions. We believe these aims can be achieved through participations and involvement from every industry.

We hope the contents of the journal will be read and reviewed by a wider audience hence it will have a broader academic base, and there should be an increased cumulative experience to draw on for debate and comment within the journal.

It is our hope that the journal will benefit all readers, as our purpose is to serve the interest of everybody from all industries. Prime Focus will be on issues that are of direct relevance to our day-to-day practices.

I would personally like to take this opportunity to welcome all our readers and contributors to the first issue of the journal. I look forward to receive contributions from the OSH community in Malaysia and elsewhere for our next issues.

Ir. Hj. Rosli Bin Husin
Editor-in-chief

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Current Status of Industrial Accident Learning in Malaysia

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Abstract

In general, the industrial accident rate in Malaysia is decreasing. However, statistically it is still relatively high if compared with that of other developing nations. One of the reasons why accidents keep on happening is poor learning from accidents. This paper discusses the level of accident learning, based on accident reports submitted to the Department of Occupational Safety and Health (DOSH) Malaysia and the Society Security Organization (SOCSO) Malaysia involving a total of 1,291 accident cases. Based on the quality and completeness of accident reports, the levels of learning were classified into five accident causation levels which are no, limited, fair, good and excellent learning.

Keywords: Accident Report, Accident Analysis; Level of Learning; Accident Causation; Action Plan

Introduction

In Malaysia, it is a legal requirement under Occupational Safety and Health Act (OSHA) 1994 for employers to report any accident at the workplace. At the company level, considerable resources have been used for investigation and reporting of accident cases to the Department of Occupational Safety and Health (DOSH) Malaysia such as via JKKP 6 and Form 21 from the SOCSO database. Such accident reporting form will enable the analysis and continuous learning process of unwanted industrial occurrence. These analyses would provide a better understanding on how accidents occur at the workplace.

Although the occupational accident rate in Malaysia is decreasing recently, statistically it is still high if compared with that of other developing and developed nations such as Singapore. One of the major reasons accidents keep on happening is poor learning from the accidents, evident from their recurrence. In fact, according to Drogaris (1993), for the large majority (>95%) of accidents, the causes are known, foreseeable and can be prevented by using the existing knowledge and technology. The poor accident learning may be due to weaknesses in accident reporting as a result of poor input quality, poor investigation, lack of analysis, and wrong interpretation of evidence (Kletz, 2009) as well as an ineffective dissemination of information (Lindberg and Hansson, 2006). Thus, only one third of the accident cases studied is considered to provide lessons learnt on a broader basis (Jacobsson *et al*., 2010).

Currently in Malaysia, the level of learning from accident reports is less studied and almost ignored. This paper explores accident learning by examining accident reports submitted to DOSH Malaysia and Society Security Organization (SOCSO) Malaysia involving 1,291 accident cases. Based on the quality and completeness of information available in each accident report, the levels of learning were classified into five accident causation tiers, namely, no, limited, fair, good and excellent learning. The findings of the study are essential in knowing the quality and level of the accident learning in Malaysia so that appropriate action plans could be implemented for enhancing learning from accidents.

Research Approach

In this study, 1,291 accident cases from DOSH and SOCSO databases are analyzed by using data mining methodology. The overall goal of this study is to extract information from accident reports and transform it into an understandable structure i.e. qualitative data for frequency analysis. The level of accident learning based on the accident causation level was measured by examining the accidents reports i.e. JKKP 6 from DOSH as well as Form 21 from the SOCSO database.

In order to determine the level of accident learning, the understanding of *"What can we learn from accident reports?"* should be questioned. The level of accident learning within the accident reports was determined based on the accident causation level. The

accident causation level comprises the three important breakdowns of causes that required the investigation of its underlying causes of accidents. The breakdown of causes comprises first, direct causes which emphasized on what kind or type of accidents that leads to employees' injuries or properties damaged. Second, indirect cause or known as contributing factors which considered two elements: unsafe acts and unsafe conditions and while the third is root causes of accidents. These root causes of accidents are crucial parts in investigating the main causes of accidents or incident occurrences. In summary, any accident reports categorized as no learning means the report did not give any information on the causes of accidents. Meanwhile, an excellent category of accident learning provides at least three causal factor analyses i.e. direct, immediate and root causes with good corrective action to prevent similar accidents.

Results and Discussions

In this paper as many as 1,291 accident cases reported to DOSH and SOCSO were analyzed to find the industrial accident learning in Malaysia. Based on the frequency analysis of the accident reports, the current status of the industrial accident learning in Malaysia is summarized in Figure 1. As shown in the figure, majority of accident reports were classified as providing a poor learning (59%). Only 9% of accident reports provide a good and excellent learning. Meanwhile, about 30% of accident reports give fairly industrial learning, while 2% of them are classified as no learning at all.

The study reveals that there is serious quality problem in the accident reporting system in Malaysia. More than 60% of accident reports fail to provide sufficient information for accident prevention that for effective learning from accidents. The finding clearly indicates the reason why a similar accident occurs frequently in Malaysian industry.

Analysis shows that there are several weaknesses of accident reported to DOSH and SOCSO databases. Large majority of accident reports were incompletely submitted. This may due to lack of analysis and investigation as discussed in detail by Professor Trevor Kletz in his outstanding publication (Kletz, 2009). In most accident reports, the accidents were reported in very simple way and lacking the essential accident information especially on why and how the accident happened. Almost all of the accident reports tell only plain statement on the direct cause of accident without meaningful explanation what was really going on. Furthermore, most of the accident reports did not emphasize on accident causation in detail thus provides limited accident learning. Here are some examples of accident report that clearly indicate their quality.

Box 1 is an example of accident report that provides no learning. The weakness of this category is the accident reports only describe the effect from the accident to the workers. No clear explanation was given on the causes of accident. In this example, the accident might not be investigated and the report was prepared by a clerk i.e. an incompetent person. Accident may have occurred at a small and medium enterprise (SME).

Box 2 is an example for poor accident learning. In this example, the common weaknesses are due to limited accident information that was documented especially on direct causes of accidents/incidents. There was no further contributing information and root causes of accident suggested for instant factors such as working environment, ladder condition, human factors, weather etc. In this example, the accident may happen in the services sector that in practice they have limited knowledge, information and accessibility in relation with the site hazard of the company being served. The report might be prepared by the supervisory level that has limited safety knowledge.

Box 3 is an example for fair accident learning. The accident learning for fair level was providing information on direct and contributing cause however information for root cause was lacking. To identify the root causes, the investigator/reporter should have a solid working experience and OSH knowledge.

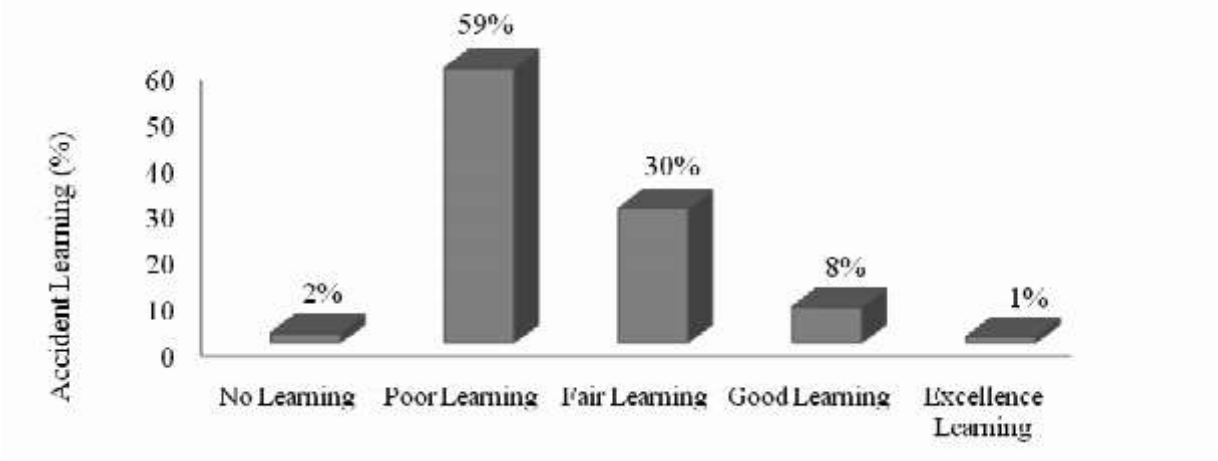

Figure 1: The level of accident learning in Malaysia.

Box 1 (No learning level)

Report: The workers' fingers were injured.
Accident Analysis: no analysis can be done due to insufficient information.

Box 2 (Poor learning level)

Report: Worker fell from a ladder at a height of approximately 3.5 meters while installing the new phone lines for residential customers.
Accident Analysis: Direct cause: Fell from a ladder at a height of approximately 3.5 meters.

Meanwhile, ***Box 4*** is an example of a good quality accident report that facilitates learning. Here, all of the causal factors (direct, contributing and root causes) of the accident are reported and analyzed. However the report contains insufficient recommendation for accident prevention and mitigation.

Box 5 describes an example for excellent level of accident learning. This level of learning provides learning very well where all three causal factor analysis (direct, contributing and root causes) has been analyzed in a detailed way with further improvement being documented.

Box 3 (Fair learning level)

Report: The victim was hit by a forklift during crossing the forklift path and suffered a chest injury.

Accident Analysis: Direct cause: Hit by a forklift. Indirect cause: Unsafe act: Using the forklift path instead pedestrian walkways. Root Cause: Did not describe for root cause.

Box 4 (Good learning level)

Report: Burns on the back of body after forklift handled by victim hits drain valve. The drain valve broke and hot water splashed unto his body. The victim had driven the forklift at more than the allowed speed in that area. The victim had never attended the forklift training. There is no safety operating procedure (SOP) for forklift drivers.

Accident Analysis: Direct cause: Burns at the back of body after drain valve broke and hot water splashed victim's body. Indirect cause: Unsafe act: Drive forklift at high speed. Root cause: No forklift training, SOP and control measure for forklift usage.

Recommendation: Suggested but may not be sufficient to prevent accidents.

Box 5 (Excellent learning level)

Before: At 8 am, the victim saw the machine in dirty condition at the casting area. *During*: The victim was trapped in the casting machine while cleaning it without switching off the machine.
After: The victim suffered severe injury which required the victim's hand to be amputated up to the arm.
Additional info: No HIRARC has been done at casting area, supervisor is not in casting area at that time and no SOP provided. Control measure need to be taken where, any working process need supervision, provide SOP at the nearest machine area. Implement HIRARC immediately and machine maintenance is required.

Accident Analysis: Direct cause: The victim was trapped in the casting machine which caused severe hand injury. Indirect cause: Unsafe act: Did not switch off machine while handling. Root cause: No supervision, HIRARC and SOP.

Recommendation: Any working process needs supervision, provides SOP. Implement HIRARC immediately, machine maintenance is required and train other workers.

Conclusion

The study on the quality of the accident report and its industrial accident learning was completed, utilizing 1,291 accident reports available in DOSH and SOCSO databases. The results show that the majority (>60%) of the accident reports are providing limited industrial accident learning, thus hindering meaningful analysis and learning process. Only less than 10% of the accident reports provide good quality reports that facilitate learning for accident prevention. It can be concluded that there is an urgent need to provide assistance and training to guide affected companies to produce meaningful accident reports as depicted in Box 5 (Excellent learning level). To enhance the industrial accident learning in Malaysia, we need to continuously educate workers or plant owners on the importance of their participation by proper accident investigation and reporting. Extensive efforts should be taken to focus on in-depth analysis and detailed investigation to identify the underlying causes of accident. The OSH values on *"what"* and *"why"* accidents occur need to be highlighted and disseminated to promote industrial accident learning via workshop, training, forum and seminars.

Sufficient time and resources for investigation process would also assist in identifying the root causes of accidents. The form of accident reports (JKKP 6 and FORM 21) used could be improvised. The current practice on the disseminating accident information through physical means seems to be less effective to enhance accident learning. A new systematic and online accident reporting system framework is proposed to provide better utilization of accident data. An accident database with a good data retrieving system is preferred for an effective accident analysis and learning from accidents.

Acknowledgements

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Does Personality affect Safety Performance?

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Abstract

Purpose – The aims of this concept paper are to critically review and identify gaps in current literature on personality and safety performance, provide a definition of personality and safety performance, explore the role of personality on safety performance, come out with recommendation for future research. Design/methodology/approach – Review and synthesis of literature. Findings – All dimensions of Big Five Personality (Openness to Experiences, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) have contributed to the safety performance. Research limitations/ implications –Personality for this concept paper refers to the Model of Big Five. Future studies should explore other personality types such as Myers Briggs Personality and Holland Personality. Practical implications – The authors recommended that organizations need to design test of personality specially for safety and health and use it during the interview session in order to select the right candidate to serve them for enhancing safety performance. Originality/ value – This concept paper offers a set of interesting lessons for organizations by providing the positive personality that must be apply by employees based on Big Five Personality model that will assist to improve safety performance.

Keywords – Personality, Safety Performance, Health and Safety Paper type – Conceptual paper

Introduction

As long as accidents and injuries happen at work, in control organizations will attempt to increase workplace protection (Clarke, 2006; Clarke & Robertson, 2008; Hogan & Foster, 2013). Most organizations consider that "error-prone" individuals contribute to workplace accidents (Wallace, 2004) and suggested that 60% to 80% of accidents are attributed to people issues (Cooper, 1998). However, the search for personality related with safety performance has managed to scant results and inadequate conclusions (Hogan & Foster, 2013).

Literature Review

Personality

The word personality comes from the Middle English word of "persona" means masks worn by actors stage (Li, 2005). Personality traits formed by the interaction between the individual and the environment. In this regard the life, experiences, and changes in the life of an individual play an important role (Azizi *et al.*, 2011).

Individual personality functions in explaining and predicting human behaviour. Personality differences also show the individual characteristics that could answer the question of why the behaviour is happen (Liao & Lee, 2009). Individual personality will determine why the individual has more or less involvement on the job. With this information, organizations can identify individuals best suit the specific characteristics of the job and can prevent individuals from choosing an inappropriate (Liao & Lee, 2009).

Safety Performance

Safety performance can be considered a safety assessment process for both individual and organizational levels (Yang et al., 2009). Safety performance used to see how organizations can prevent accidents and error (De Koster *et al*., 2011).

At the organizational level, safety performance is seen as an assessment which help organizations evaluate the effectiveness of management within the context control and eliminate accidents or injuries in the workplace (Khdair *et al*., 2012). Wu *et al*., (2011) has defined the safety performance as an activity which is undertaken by the department to ensure safety. Safety performance is defined as the level of safety compliances and safety participation (Clarke, 2006). However, safety practitioner, and other researchers such as Mearns & Reader, (2008) tend to use the term safety performance as the level of occupational injuries.

Personality and safety performance

Mistakes as negligent carelessly while performing work also influence the safety performance and increases the rate of accidents in the workplace (Tharaldsen *et al*., 2010). Based on a study carried out by Wallace & Chen, (2006) discover personality traits such conscientiousness has a relationship with the individual safety performance.

Their findings also emphasize the importance of conscientiousness over safety achievement. This was supported by Clarke & Robertson, (2005) which states personality traits such as low level in conscientiousness and agreeableness tend to be involved in an accident.

A study by Postlethwaite *et al*., (2009) was conducted to investigate the level of cognitive ability in moderating the effects of the Big Five personality dimensions of conscientiousness in our expectations on the behavior of safety in the workplace. A total of 219 respondents were selected for this study among the various organizations and industries. The study found people with high levels of cognitive ability tend to have high safety behavior based on personality dimensions in Big Five conscientiousness.

In addition, the study by Wallace & Vodanovich, (2003) also found when unsafe behavior is at a high level so low conscientiousness will. In which there is a negative relationship between unsafe behaviors with the Big Five personality dimensions conscientiousness.

In fact, according Fadzli *et al*., (2003) factor personality traits played by employers and supervisors also contributed to the work environment unsafe and inappropriate. For example, employers are less concerned with the safety aspect and ignore the design or layout of ergonomic office equipment or machinery will create problems or high accident in case of fire or unwanted things happen.

In the study Khdair *et al*., (2012) has shown conscientiousness (one of the Big Five dimensions of personality) to act as a moderator in the relationship between management practices in safety performance. This is because according to Khdair *et al*., (2012) employees who are conscientiousness characterized as responsible, reliable, and comply with management tend to have better safety performance. Moreover, they are more likely to find the hidden information to ensure high performance, and they see the collection of information as part of the process to the success of preventing accidents and injuries in the workplace.

Furthermore, the study by Hogan & Foster, (2013) also showed that personality can consistently predict the safety performance in the workplace. Reason, (2008) agree that there are people working less safe than others, and recognized it related to the personality of a less careful. Most managers understand the importance of individual characteristics as they explain about "unsafe acts" and recognized as a component of the humanitarian and safety systems model (Reason, 2008; Hogan & Foster, 2013).

Personality has long been used as a predictor of performance (Wallace & Vodanovich, 2003). Especially the Big Five personality containing conscientiousness, agreeableness, extroversion, openness to experience and emotional stability (Costa & McCrae, 1992; Goldberg, 1992). For example, conscientiousness is used to predict performance in a variety of jobs. This is because the individual conscientiousness are individuals who can be trusted, loyal, efficient and achievement-oriented (Barrick & Mount, 1991). According Khdair et al., (2012) stated that occupational accidents and injuries in the workplace can be reduced if the employee has the right personality.

There are a number of previous studies using the Big Five personality for predicting the safety performance such as Cellar *et al*., (2001); Thoresen et al., (2004); Christian *et al*., (2009); Hogan & Foster, (2013). The study conducted by Hogan & Foster, (2013), found the individual who does not give full attention and ignore of the rules are more prone to accidents and injuries in the workplace. Studies show that individuals who are easily depressed (low levels of Neuroticism), difficult to collaborate with others (low levels of Agreeableness), always looking for the public's attention (high levels of extraversion) and is easy to feel tired and need a boost (high levels of Openness) is included in unsafe behavior and very prone to accidents and injuries in the workplace and this will have an impact on safety performance (Hogan & Foster, 2013).

According to Christian *et al*. (2009) stated personality to be able to predict the overall safety performance. For example, individuals with high levels of conscientiousness tend to give careful attention and try to avoid risk. Usually liable and be careful. From observation, this individual will provide good safety performance and less involved in accidents at work (Hogan & Foster, 2013).

Conclusion

After review number of previous studies using the Big Five personality for predicting the safety performance such as Cellar *et al*., (2001); Thoresen *et al*., (2004); Christian *et al*., (2009); Hogan & Foster, (2013) author make conclusion that all dimension of Big Five Personality (Openness to Experiences, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) have contributed to the safety performance. But for this concept paper its limited to the Model of Big Five.

Future should explore other personality like Myers Briggs Personality and Holland Personality. The authors also recommended that organization need to design test of personality special for safety and health and use it on the interview session in order to select the right candidate to work in organization for enhancing safety performance. This concept paper also offers a set of interesting lessons for organization by providing the positive personality that must be apply by employees based on Big Five Personality model that will assist to improve safety performance in organization.

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A Review on Conceptualization and Dimensions of Safety Culture

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Abstract

Recent development in industrialization and global economy has contributed to the increased number of workplace injuries and accidents. Safety culture has been seen as a central medium to curb the worrying trend of workplace accidents. The term of safety culture has emerged from the Chernobyl nuclear disaster in 1986 and the concept has been widely used until today. However, the conceptualization of safety culture suffers from several major drawbacks such as no definite understanding of how safety culture is being defined and measured. This paper hypothesized that higher levels of safety culture in the workplace will display lower numbers of accidents. Due to this concern, this paper seeks to provide a clear conceptualization of safety culture, dimensions used to measure it and common research methodology used in the previous safety research.

Keywords: Safety Culture, Workplace Accidents, Safety

Introduction

Safety culture is a term that first appeared after the Chernobyl nuclear disaster in 1986 (Cox and Flin, 1998, Cooper, 2002, Garcí-Herrero *et al.*, 2013). The importance of safety culture as well as the impact of the managerial and human factors on accidents was highlighted in the report of Chernobyl disaster, rather than merely technical failures (Flin *et al.*, 2000). Thus, numerous studies have attempted to investigate and define the term "safety culture"; trying to discuss its dimensions as well as the method to analyze it since it has been widely recognized from 1986 (Pidgeon, 1998; Carroll, 1998; Clarke, 1998; Cooper, 2002; Cai, 2005; Bentley and Tappin, 2010; Edwards *et al.*, 2013). This paper will proceed by reviewing the literature in aspect of safety culture, looking into its definitions and dimensions; discussing the methodology adopted by existing studies and lastly discussing the impact of safety culture on reducing the number of accidents in organizations.

Nowadays, safety culture has been recognized and become prevalent as the key aspect closely linked to safety management in many industries (Hå old, 2010; Mearns v *et al*., 2013). To lower the number of safety failures, Edwards and Jabs (2009) believed that the employees should create safety culture by speaking out their concerns and challenge authorities in the organization. However, it cannot be assumed that proactive communication about safety issues can always exist within the organization (Ismail *et al*., 2012a).

Definitions, Dimensions and Method to Measure Safety Culture

Except for the Chernobyl nuclear reactor accident, a series of major disasters such as King Cross fire, Piper Alpha explosion, Clapham junction train crash were due to the lack of safety culture in the organization (Gadd and Collins, 2002). Unfortunately, the scarcity of safety culture has led to 235 men being killed in these accidents.

There is a large volume of published studies describing the concept of safety culture (Teo and Feng, 2009; Filho *et al.*, 2010; Wu *et al.*, 2010; Mariscal *et al*., 2012; Edwards *et al.*, 2013; Fang and Wu, 2013; Pumar-Mé z *et al*., 2014; Atchley *et al*., 2014). However, the concept of safety culture is still remaining vague and implicit, and it does not have a universal definition for it (Frazier *et al.*, 2013; Boughaba *et al.*, 2014; Reiman *et al*., 2014). In other words, there is no mutual way to define and measure safety culture (Guldenmund, 2000; Hale, 2000; Garcí-Herrero *et al.*, 2013).

Meanwhile, the concept of safety culture and safety climate has discovered having a considerable overlap in terms of definition (Fruhen *et al*., 2013). Guldenmund (2000) has reviewed existing studies and listed out 18 different definitions of safety culture as well as for safety climate which he claimed that both concepts have not much consensus in term of cause, content and consequences (Hå , 2010). Table 1.1 has listed down seven definitions of vold safety culture that proposed by different researchers from 1991 until 2014.

The multifaceted nature of safety culture brings the lack of consent about how it is defined and to measured (Mearns *et al.*, 2013). In order to conceptualize the term of safety culture, many researchers have proposed

Table 1.1: Definition of safety culture in previous studies

References	Definition
Cox & Cox (1991)	Attitudes, beliefs, perceptions and values that employees share in relation to safety, has gained acceptance due to its critical role for accident prevention.
Cox & Flin (1998)	System which indicates to the workforce what is important and legitimate for their action in relation to safety culture.
Wu *et al.* (2010)	Employees' imaging of safety conditions in the workplace; which images then affect organizational safety activities.
Mannan *et al.* (2013)	Organization shared attitudes, values, norms and beliefs about safety, including attitudes about danger, risks, and the proper conduct of hazardous operation.
Frazier *et al.* (2013)	The values, attitudes, beliefs, risk-perceptions and behaviours as they relate to employee safety.
dos Santos Grecco *et al.* (2014)	Personal attitudes and habits of thought to the style of organization
Morrow *et al.* (2014)	Employees' beliefs about the importance of safety are shaped by the safety culture of the organization, which then influences their attitudes toward safety, perceived norms over safe working behaviours for working safely, and perceptions of control over safe working behaviours.

different kind of attributes and measuring methods of safety culture in their studies. Wu *et al.* (2010) believed that safety culture consists of three dimensions which are employee safety participation, perceived risk and emergency response. Mannan *et al.* (2013) conducted a case study on creating a Best-in-Class safety culture framework and indentified four attributes of safety culture, namely, leadership, culture and value, goals, policies and initiatives, and organization and structure.

In their research using quantitative analysis, both Garcí-Herrero *et al.* (2013) and Frazier *et al.* (2013), addressed their own dimensions of safety culture. Garcí- Herrero *et al.* (2013) proposed five attributes of safety culture in their research which are, safety is a clearly recognized value, accountability for safety is clear, safety is integrated into all the activities in the organization, leadership for safety is clear, and safety is learning driven. Meanwhile, Frazier *et al.* (2013) identified three dimensions of safety culture included in their 92-items questionnaire; management concern, personal responsibility, and peer support for safety.

In recent years, the argument on the development of safety culture's dimension is still carrying on. Dos Santos Grecco *et al.* (2014) in their exploratory case study has proposed that safety culture consists of six dimensions that include top-level commitment to safety, organizational learning, organizational flexibility, awareness, just culture, and emergency preparedness. Meanwhile, Morrow *et al.* (2014) believed that, management, commitment to safety, willingness to raise safety concern, decision making, supervisor's responsibility for safety, questioning attitude, safety communication, personal responsibility for safety, prioritizing safety, and safety training, total ten should be the dimensions of safety culture.

Conclusion

According to Ismail *et al.* (2012b), organizations with positive safety culture become reflective of safety practices by bringing the workforce together to learn how to work more safely at the workplace. In short, fostering a positive safety culture has become a strong and critical fundamental of improving safety performance within the organization (Fang and Wu, 2013). This paper hypothesized that higher levels of safety culture in the workplace will display lower numbers of accidents rate at the workplace.

Figure 1.1: Safety culture framework

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Conceptualization of Safety Leadership in Malaysia's Manufacturing Companies.

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Abstract

In the new global economy, workplace safety has become a central issue among companies all over the world. It is becoming difficult to ignore that this trend has also been happening in Malaysia especially the manufacturing sector. The worrying trend can be seen from the increasing number of workplace accidents reported by Department of Occupational Safety and Health (DOSH), Malaysia in manufacturing companies. In recent years, researchers have shown an interest in studying the role of safety leadership to reduce workplace accidents. It is found that safety leadership plays a significant role in ensuring a safe and sound workplace. Due to this concern, this paper attempts to provide a conceptualization of safety leadership from the perspective of Malaysia's manufacturing sector. It is proposed that positive safety leadership lead to a reduction of workplace accidents. In response to this matter, it is hypothesized that the higher level of safety leadership will positively affect the lower level of workplace accidents. A questionnaire from Wu *et al.* (2008) will be adopted to explain the conceptualization of safety leadership, where it is expected that the concept of safety leadership practised in Malaysia's manufacturing sector has a similar meaning from the perspective of western researchers.

Keywords: Safety leadership; Workplace accidents, Malaysia's Manufacturing Sector

Introduction

In this era of globalization, almost all of the world's countries are in pursuit of development (Tharaldsen *et al.*, 2010). The advancement of technologies all over the world has led to the raising awareness of peoples towards safety issues (Li *et al.*, 2009), and as a result, has made workplace safety issues headline news all over the world (Wameedh *et al.*, 2011). For example, accident statistics have reported as many as 591000 cases of non-fatal injuries in the years 2011/2012 in the United Kingdom (Health and Safety Executive, 2012a). In addition, the United States recorded 760000 workplace accidents during 2011 (U.S. Bureau of Labor Statistics, 2012). Based on Health and Safety Executive (2012b), there is a decreasing trend in workplace accidents in United Kingdom. However, the total number of reported cases of workplace accidents is not reassuring. In light of these numbers, issues concerning safety have become a central issue for many safety researchers (Choudhry *et al.*, 2009; Wameed *et al.*, 2011; Shang and Lu, 2009).

Overview of Safety

Accidents have been defined as the events which are unwanted, unplanned and unforeseen, resulting in the loss of cost, and even life (Alicia, 2009). Efforts to overcome workplace accidents taken to inhibit accidents from happening and improve workplace safety (Wu *et al.*, 2007). A number of studies have been conducted on safety, beginning from 1990s (Kennedy and Kirwan, 1998; Hofmann and Morgeson, 1999) until 2000s (Wu *et al.*, 2007; Wu *et al.*,, 2008; Fernandez-Muniz *et al.* 2007;Cooper and Phillip, 2004 ; Tam *et al.*, 2004), and finally, 2010s (Kapp, 2012; Lu and Yang, 2010). In this paper, safety leadership shall be discussed as it was proposed by Griffin and Hu (2013) that there is a lack of studies on specific actions required of leadership for their contribution in workplace safety.

Workplace Accidents in Malaysia

Years by years, Malaysia has developed and climbed to its robust position in the new global economy despite the challenges regarding safety issues (Ministry of Human Resources Malaysia, 2009). In reference to Figure 1, the accident rate was actually experiencing a downward trend from year 2000 to year 2011 (2000= 98281 cases; 2003= 81003 cases; 2006= 68008 cases; 2008= 56095 cases; 2011= 24290 cases) (Department of Safety and Health, 2012; Social Security Organization, 2011). Nevertheless, total accidents from year 2011 to year 2012 experienced an upturn trend, boosted from 24290 cases to 61552 cases (Department of Safety and Health, 2013).

While the total accident cases in Malaysia illustrated a downturn trend, there is a controversy when the focus

swift to the sector of manufacturing. Based on the evidences, manufacturing sector reported an increased number of accidents from 2002 until 2012 (2000= 43.67%; 2003= 41.85%; 2006= 39.80%; 2008= 33.94% ; 2011=67.89%; 2012= 27.1%). Referring to Figure 1, it can be clearly seen that among all of the sectors, manufacturing sector recorded the highest numbers of accidents compared to the other sectors in Malaysia (Department of Safety and Health, 2013). Therefore, there is a need to identify the problems of safety issues within manufacturing sector in Malaysia (Social Security Organization, 2011).

Safety Leadership and Its Relations to Workplace Accidents

Safety leadership can be defined as the process through which the leaders exert their influence on employees' daily routine work via communication to achieve a low accident rate and a positive safety performance (Lu and Yang, 2010; Wu *et al.*, 2007). Previous studies (Barling *et al.*, 2002; Zohar, 2002; Hofmann *et al.*, 2003) showed that leadership practice is a vital factor influencing the accident rates. It has become the centre of attention for studies in numerous industries especially in energy and manufacturing sectors (Flin and Yule, 2004; Rowley, 2009). Cooper (2010) concluded that safety leadership is a necessity for top performing companies in shaping commitment towards safety issues as safety leadership plays a vital role in maintaining the behavioural safety process. According to Mullen et al. (2011), safety leadership is far more effective in shaping positive safety behaviour and attitudes through inspiring and promoting. Thus, it is hypothesized that the higher is the safety leadership in the organization, the lower is the accident rate in the organization.

Previous studies have investigated the relationship between safety leadership and safety performance and have reported that there is significant influence of safety leadership on safety performance (Lingard et al., 2012; Yang et al., 2010; Zohar, 2002; Rowley, 2009). Wu (2005) proposed that, leaders with efforts to coach and trained their employees regarding safety issues formed a great safety performance. Thus, it was recommended that safety caring and safety controlling be included in safety leadership. Wiegand (2007) explained that safety coaching refers to the efforts of leaders in managing the safety performance and that these efforts involve interpersonal interactions and communication. Safety caring refers to the level of concern and attention amongst leaders towards safety issues and involves efforts to ensure the quality of safety in the workplace (Wu et al., 2010; Cooper, 1998). Both Wu et al. (2008) and Cooper (1998) proposed that safety controlling is the use of power in outlining the safety rules and regulations to be complied with by the employees in order to achieve safe performance.

Throughout the years, it can be seen that safety leadership has always been based on transformational and transactional leadership model in engaging the dimensions. For example, Cooper (1998), in initiating the dimensions of safety leadership, chose to build the dimensions from the foundation of transformational and transactional leadership. Ultimately, primary dimensions of safety leadership, safety caring (transformational) and safety controlling (transactional) had been proposed. Extending from Cooper's (1998) dimensions, Wu (2005) introduced an additional dimension under transformational leadership, safety coaching, without abandoning the original dimensions initiated by Cooper (1998). Nonetheless, while Wu (2005) named her safety dimensions as safety caring, safety coaching,

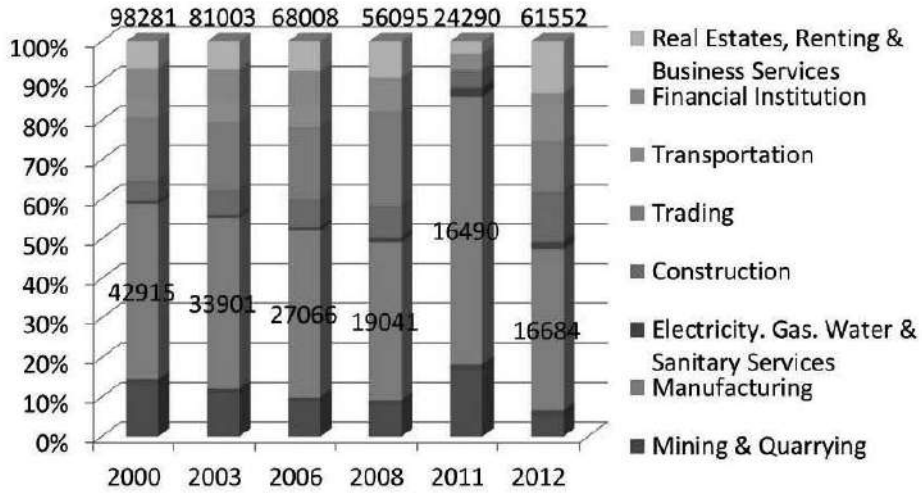

Figure 1: Workplace Accidents in Malaysia, 2000 to 2012 (Department of Safety and Health, Malaysia, 2013

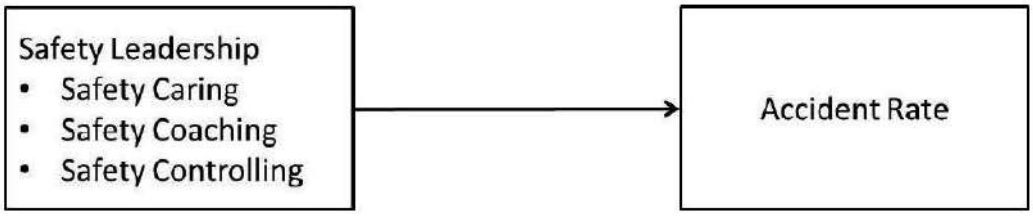

Figure 2: Framework

H1: the higher level of safety leadership will affect the lower level of workplace accidents.

and safety controlling, there had been some situations when other scholars would have revised the names of such dimensions to other labels while retaining the meanings of each dimension at the same time. There situations occurred when Lu and Yang (2010) and Du and Sun (2012) renamed Wu's (2005) safety caring as safety motivation and active management respectively, and Wu's safety coaching as safety policy and safety monitoring respectively.

Subsequently to the review of dimensions, Wu's (2005) versions of safety caring, safety coaching, and safety controlling were chosen in this study as it could be generalized to most of the industries (Shah Rollah Abdul Wahab, 2011). Thus, the conceptual framework of this study was developed.

Research Methodology

This research shall be a quantitative type. According to Creswell (2002), a quantitative research refers to research that measures causal relationships, hypothesis testing, and theoretical testing using survey as data collection instrument. Creswell (2002) further proposed that quantitative research should be used in research which contains a large amount of statistical data. Furthermore, the design of this research is descriptive and correlational in nature. Elifson (1998) proposed that descriptive study describes the characteristics of the desired trends or situations. Descriptive study helps the researcher understand the phenomena and inter-correlation between the variables (Sekaran and Bougie, 2009). Correlational study has been defined as a technique that is able to describe and measure the links and relationships between two variables statistically (Gravetter and Wallnau, 2002).

Respondents of this study will be employees from the iron and steel based manufacturing companies chosen from the Federation of Malaysian Manufacturers (FMM) directory. The main reason for selecting these industries is that the number of accidents which occur in these industries is the highest among all the other manufacturing industries, with an accident occurring every two working hours in Malaysia in 2011 (Social Security Organization, 2011).

In this research, it is apparent that the questionnaire is an adaptation of questionnaires by Wu *et al.* (2008). In order to measure safety leadership, the Safety Leadership Scale developed by Wu *et al.* (2008) shall be adopted. Meanwhile, adoption of Wu *et al*.'s (2008) Safety Performance Scale shall be adopted to explore the findings. The adoption of Wu et al.'s questionnaires in the measurements of independent variables, dependent variable, and also mediation is due to the proven high reliability of the questionnaires (Alpha Cronbach: 0.84 to 0.97) (Shah Rollah, 2011; Wu *et al*., 2008).

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The Redesign of Nurse Break Hour based on Physical Fatigue (a Case Study in Hospital X)

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Abstract

Variations in a nursing job is not only related to the tasks to be performed, but also related to the working hour In this paper the results of a study of nurses in the hospital X will be presented. A sample size of 75 nurses (from a total of 95 nurses) working in hospital X was selected for the purpose of the study. Measurements of physical factors including heart rate, temperature, and sleepiness of these nurses were made. Results were obtained from the physical body measurement of the nursed' working patterns at work. The study recommends break time based on the results of measurements.

Keywords: Nurse breaks hour; heart rate; the sleepiness; body temperature.

Introduction

The need for hospital service quality increases along with the increasing awareness about the importance of health. The increased need for community hospitals for services is reflected in the high growth in the number of hospitals in Indonesia. According to data from the Ministry of Health, during 2003-2008, the number of hospitals recorded in Indonesia increased from 1234 units (2003) to 1320 units (2008), an increase by 86 units or 6.97%. This has led to an intense competition among the hospitals prompting them to always strive to provide a better service quality for customers' satisfaction.

Nursing is a profession in the hospital with important roles to provide services to the patients. Nurses need to be available round the clock caring for the patients. Therefore, the performance of nurses is a vital factor in supporting the quality of health care in hospitals. In other words, the quality of hospital services is highly dependent on the quality services of the nurses. Thus, improving the quality of nursing should be done. Physical workload experienced by nurses in the hospitals includes lifting of patients, bathing them, helping them to the bathroom, making beds for them, pushing medical equipment, replacing the infusion, administering medications, and going on the ward rounds with the doctors.

The problems that often arise in hospitals are that the timing of nurses' rest breaks does not appropriately suit them and that they do not have enough rest due to working in shifts and task demands even while at rest. This does not only risk the quality of services provided by nurses but also the health care itself. With the increasing level of fatigue, the nursing performance in providing care to patients will be affected. In addition, having to work in shifts affects the rhythm of one's work performance. Therefore it is necessary for the determination of suitable rest break times for the nurses, taking into consideration the fatigue factor to be measured physically in this study.

The Study Objectives

Based on the background above, the purposes of the study are as follows:

- To perform physical measurements of health related to fatigue on nurses working in the space In-patient treatment of disease in the physical locations to determine their workload in each shift.
- To determine appropriate rest break times based on the results of fatigue evaluation on the selected nurses working in the In-patient internal medicine ward of Hospital "X".

Limitation and Assumptions

To focus on the study, limitations were imposed as follows:

- Determination of nurses who work with restricted hours of break rest was based on the fatigue factor physically measured.
- Research was conducted only on the nursing units with continuous shift work and with the hardest tasks according to the nurses working in Hospital "X". Based on the observations of researchers and interviews with the hospital health care unit, In-patient nursing units were selected.
- Measurements are limited only to nurses who are not pregnant, not sick during the research period and have worked at least for a year.

The assumptions used in this study were as follows :

- The nurses work normally and naturally.
- The nurses are not currently experiencing health problems both physically and mentally.

Method, Data, and Result

The methods of measurement used to measure the fatigue factors in Hospital "X" are as follows:

- Measurement of heart rate by counting the nurses'pulse, performed manually, and recorded as pulse per minute. Data collection was performed every hour until completion of each shift.
- Measurement of levels of sleepiness using Stamford Sleepiness Scale. Data collection was done once in every hour until completion of each shift.
- Measurement of circadian rhythms patterns by measuring the nurses' body temperature using a thermometer. Data collection was performed every hour until completion of each shift.
- Subjective measurement by providing questionnaires and conducting interviews with the nurses on matters related to fatigue experience. Data collection was done once every shift.

Selection of Job Characteristics

Characteristics of the selected job in the current study is for the work that needs constant surveillance for 24 hours and service users who are not volatile. In addition, of the distribution of questionnaires, the hardest tasks handled by nurses working in Hospital "X" is a disease in treated patients. Hence, the nursing units selected were ones whose nurses care for patients hospitalized in internal medicine.

Sample

The populations in this study were all nurses working in the inpatient Hospital "X" with the following criteria: not pregnant, mentally and physically healthy, not sick during this research and have worked at least for one year. There were a total of 95 respondents meeting the criteria. The sample size taken was 76, based on the determination of sample size tables created by Kracjie and Morgan [1].

Heart rate measurement

From the measurement results of the calculation the average heart rate per time interval, the release of the energy expenditure can be calculated by summing up the data of the heart rate at the ith and hour to-(i +1), divided by 2. Calculations are performed with the energy expenditure using the formula by Kamalakannan [2], as in

E-Cost = - 1967 + 8:58 + HR + HT 25.1 4:50 A - 7:47 RHR+ 67.8 G

Where:

E-Cost = energy expenditure (watts)

HR = heart rate (bpm)

RHR = resting heart rate (bpm)

HT = height (inc.)

A = age (years)

G = gender (0 = male, 1 = female)

1 Watt = 0.0143 kcal / min

Having obtained the value of energy expenditure, this value can be compared with the maximum energy expenditure. According to Pulat [3], the maximum energy expenditure needed to do duty for the average age is 5 kcal / min (male) and 4 kcal / min (women). The value of the calculated energy expenditure can be compared with these data. Table 1 is a recapitulation of the average heart rate and energy issued by the nurses.

Ratings on average heart rate per interval of time for the nurses are useful to quantify the difference between an interval scale of measurement in the same. Differences in heart rate values at each time interval was made into a particular scale so as to facilitate the comparison and decision making of the data. The following is the process of ranking the average heart rate per interval time:

Step 1: Calculate the average heart rate per interval of time. In this study, the time interval used is the interval of one hour. The average rate heart per time interval can be calculated by summing up the data on heart rate hour to and hour-i-(i +1), divided by 2.

Step 2: Perform a line so that sorting can be ranked. Rating 1 is given to the lowest scale and ranked on a scale of 8 is given the highest scale (the highest ranking is adjusted with the number of intervals contained in the shift). If at the time of sequencing the same two numbers, the average is calculated by summing the i-th order with the order to (i +1), divided by two. Similarly, for three numbers or more, the same order of summation is performed, divided by the same number of points.

Step3: Calculate average ratings. The calculation of the average ratings is made by summing the ratings of heartbeat per time interval, divided by 76 (number of samples).

Table 1: Measurement results

Shift	Average of Heart Rate (bpm)	Expenditure Energy (kkal/min)	
		Man	Woman
Morning	80.9 (10:00 - 12:00)	0.9	1.2
Afternoon	83.7 (17:00 - 19:00)	1.1	1.6
Night	82.7 (01:00 - 02:00)	1.1	1.4

Sleepiness Level Measurement

The nurses in the inpatient nursing unit were required to give ratings to the level of sleepiness. The process of data recording was performed every hour. Measurements were done in subjective sleepiness levels, using Stanford Sleepiness Scale, from 1 for best fit condition until 7 for really sleepy and sleepy.

Table 2: Level of sleepiness

Shift	Working hours with the highest level of sleepiness
Morning	10:00 - 13:00 (rating : 6.74)
Afternoon	17:00 - 19:00 (rating : 5.95)
Night	02:00 - 07:00 (rating : 7.38)

Body Temperature

Body temperature data room nurse inpatient nursing unit in the disease obtained by measuring the body temperature approaches the temperature of nurses with maxilla using a digital thermometer from work to complete. Process data recording is carried out once every hour. Measurements were performed with nurse put a thermometer into the armpit for a minute. The measurement of armpit temperature, done by first adding 0.9 for conversion into the ear temperature, was calculated using the average temperature per interval of time. Having obtained the calculation of average body temperature per time interval, grading process to quantify difference between the time interval measurements in the same scale could be done. Steps the provision of equal rank with the steps performed on the ratings on the level of heart rate and sleepiness.

Table 3: Working hour with the peak of body temperature

Shift	Working hours with the highest level of body temperature
Morning	10:00 - 12:00
Afternoon	14:00 - 15:00 and 17:00 - 18:00
Night	23:00 - 24:00

Conclusion

Fatigue was measured physically by measuring heart rate level, the level of sleepiness and body temperature of each nurse. From measurements of the heart rate, it was found that the nurses had the highest fatigue at 11:00 to 12:00 for the morning shift, at 18:00 to 19:00 for the afternoon shift, and at 01:00 to 02:00 for night shift.

From measurements of the level of sleepiness, it was found that nurses experienced highest fatigue at 11:00 to 12:00 for the morning shift, at 21:00 to 21:20 for afternoon shift and at 03:00 to 04:00 for night shift. As for the body temperature measurement, it was found that the nurses had the highest fatigue at 13:00 to 14:00 for morning shift, at 18:00 to 19:00 for the afternoon shift, and 2:00 to 3:00 pm for night shift.

The design of the proposed schedule nurses, based on the results of measurements of resting heart rate, the level of sleepiness, body temperature, and the questionnaire is as follows:

- Morning shift: 11.00 - 11.30/11.30 - 12.00
- Afternoon shift: 18.00 - 18.30/18.30 - 19.00
- Night shift: 3:00 a.m. to 4:00 a.m.

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Assessment of Physical Fatigue for Train Drivers

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Abstract

The light train (LRT) is one of the important public transportation modes in the congested city of Kuala Lumpur. Train drivers drive the trains within their shift time on similar routes every day. This job activity may lead to stress. Physical fatigue is one of the health problems commonly experienced by the train drivers. There were three methods applied in this study, namely, Nordic Questionnaire, NASA-TLX and observations. There were a total of 52 respondents, consisting of the train drivers from Rapid Rail Sdn Bhd, a subsidiary company of Prasarana Malaysia Berhad. The questionnaires were analyzed using Statistical Software for the Social Science (SPSS) with a suitable statistical analysis. It was found that, the train drivers experienced pain on their necks, shoulders and lower backs. The main causes of physical fatigue that affect the performance of a train driver are sleep disorder and uncomfortable seating. Moreover, other effects of physical fatigue also prevent the drivers from carrying out activities at home. The industry has improved the drivers' workstations such as their seats to reduce the rate of physical fatigue. However, more improvements are expected to be done.

Keywords: Physical fatigue; NASA-TLX; Observation; Driver workstation

Introduction

The progress of a nation can be measured by its public transportation system. Transportation plays an important role in the coordination of the development plan of the country. Public transportation may be referred to as a form of transportation that has an enormous capacity to carry passengers at any one time, different from private vehicles with a small cxapacity. Light train (LRT) services are peoples' choices because of its convenience. It eases them to avoid traffic congestion in the city centre. When discussing the role of public utility services, especially trains, the physical factors of the train drivers themselves should be emphasized as well. The performance of the train drivers will have an impact on the driving mode and the passengers.

Literature Review

Physical Fatigue

Fatigue or tiredness may refer to the lack of energy and lethargy, and it describes the physical or mental conditions. Although physical fatigue and mental fatigue are different, the two often coexist. If a person is physically tired for long enough, he will also be mentally tired as well. When a person suffers from physical fatigue, he cannot continue to do his normal activities. Fatigue is a symptom and not a sign. Symptoms are pains which can be explained to doctors, such as headaches or dizziness, while a sign is something that doctors can detect without having to ask the patients. There are 5 main causes of physical fatigue on drivers such as, insufficient sleep, the internal body clock, prolonged tasks, repetitive work and individual characteristics including health conditions. Fatigue can severely affect a person's ability to carry out his normal activities

Train Driver's Seat Design

The train drivers' seats are their workstations associated with the physical fatigue suffered by the train drivers. They are correlated with whole-body vibration (WBV) and lower back pain (LBP) related to physical fatigue caused to the drivers. Train drivers are among the groups of employees who have been widely reported to be in the high risk groups exposed to the risk of back pain. They spend hours sitting on their seats every day driving the trains. Their comfort is an important thing to be considered to ensure a safe driving and a safe ride for the passengers.

Driver Posture

Driver Posture while driving should be seriously considered to ensure that all activities are performed

smoothly and comfortably. The posture of the drivers can be explained as the position of their bodies and limbs while driving. This posture will depend on drivers' behaviour themselves, the design of the driver's seats and their work or activities. In general, the drivers experience discomfort in their bodies as a result of the ongoing effects of sitting while driving. Most drivers sit upright while driving or sitting is bending and twisting sit to the left or right to operate the ticket machine and give tickets to passengers for the bus driver case. For train drivers, they will rotate the body or head to either the left or right for rear view mirror available at each station.

Anthropometric Data

Anthropometric measurement refers to the science of the body, including the physical form, the nature of the mass and strength of the body's ability. Use of anthropometric data is to ensure that employees are in a comfortable and efficient while handling and performing activities and the use of equipment. Anthropometric data can be used for the design of personal protective equipment, work space design, improved quality of life, and prevention of harm. Now, anthropometric data play a very important role in various areas, especially in the engineering industry.

Biomechanical Jobs

Place of driving a work space for train drivers associated with the control and operation of the train. Biomechanical employment is defined as an interdisciplinary field in which information from both the biological sciences and mechanical engineering is used to specify the quantity present in the human body during made a job. Provide a workplace with good biomechanical is a need for workers. Thus, there are various factors that influence the comfort of the driver when driving such as design driver seats, sitting posture, vibration, noise, visual impact and moisture. These factors will impact directly and indirectly to the employee's work performance.

Methodology

Questionnaire

This method was intended to obtain practical data which the actual situation occurred. The method was performed in a single stage, which a detailed study in which a set of questionnaires was prepared and distributed to train drivers in cities around Kuala Lumpur and the Klang Valley. The results of the questionnaire as used as a basis to fulfill the objectives of this study. The questionnaire used Nordic questionnaire for musculoskeletal symptoms. There are 3 sections and 44 questions in this questionnaire. Part A was the demographics of the respondents. Part B was a problem with the locomotive organs. Part C was a problem with back pain.

NASA-TLX

The NASA - TLX method has been widely used to study workload experienced by employees in the course of their work and have been proven as well as having high validity compared with the measurement of other workloads. Workload assessment is a matter of referring to the range of tasks and jobs. The goal of the NASA-TLX method study is to develop a workload rating scale also provides a summary of the sensitivity of the sensitive workload variations. NASA TLX used to measure the workload of train drivers. Respondents will be evaluated using an application on the website and will have results in quick time. A total of 4 respondents was assessed using this method. Evaluators will assess respondents after completion of driving a train.

Observation

Observation methods used throughout this study was the method of video observation. All driver activities were recorded using the camera model hero1 GoPro mounted to the left of the driver while driving the train. Video recorded and then analyzed using simple task analysis. Limbs that involved in the drive train identified and analyzed. The number of respondents involved in video observation is 4. Recording duration for each respondent estimated that within 30 minutes. Analysis of the work done within the duration of 10 minutes for each respondent. Abbreviation for type of relative motion between the driver used k-tkd (control-push front), k-tkb (control-pull back), k-tb (control-press button) and k-pcb (control-rear view mirror).

Result and Discussion

Physical fatigue was identified through Nordic questionnaire. Their driving activities also were observed and verified through observation video installed during the driving. From the results, they experienced pain on their neck, shoulders and lower back as found through the survey; with percentage of 67.3% (35), 65.4% (34) and 73.1% (38) respectively. Fatigue on the neck was caused by repetitive tasks of looking at rear view mirror at each of the station.

The location of the mirror and driver's sitting position required them to lower their head in order to look at the mirror. This forced the driver to position themselves on awkward posture. Therefore, this repetitive driving activity caused physical fatigue to the driver (Brown 1994). They also complained fatigue on their shoulders. Left hand was used consistently to control the speed knob throughout the journey while right hand operated the control panel, for door opening, public announcement (PA) system and other related buttons. Results from both methods were compared and it was found that, usage of hands, wrist and shoulders repetitively during the driving activities caused fatigue to the driver especially on their hands. At the same time, the driver was required to sit while driving. Prolonged sitting throughout the shift also

caused lower back pain and extensive usage of hip. From observed video, the driver was oscillate on their seat. Its shows that, they were experiencing vibration. However, no whole body vibration testing was conducted to measure the effect of vibration on the performance of the train driver.

Figure 1 explained fatigue faced by train drivers are caused by not getting enough sleep and uncomfortable seats with percentage of 38.5% (20) and 34.6% (18) respectively, and proved by previous studies (Brown 1994), a state of fatigue factor are not getting enough sleep. Beside from not enough sleep and uncomfortable seating respondents also felt sitting too long, the repetition of work and other factors such as vibration, emotional, mental fatigue and so also caused by physical fatigue. Physical exhaustion experienced by the train driver causes the effect on their daily activities either indoors or outdoors. The physical exhaustion suffered by the train driver is from 1 to 7 days with a percentage of 63.5% (33). Some train drivers suffering from fatigue in the lower back and had to receive treatment in the hospital with a percentage of 36.5% (19).

Workload was measured on train drivers using the NASA-TLX from Figure 2 showed mental workload faced by train drivers is higher than their physical workload. During driving the train, other than the physical movement to operate trains at the same time for the driver to use their mental and physical coupled to achieve the task

Conclusion

The industry has improved the workstations of the drivers such as their seats to reduce the rate of physical exhaustion caused to them. However, more improvements can be done. Based on the results of the analysis, all the objectives of this study were achieved. The first objective of the study was to identify the types of physical fatigue on the train drivers. The study conducted by the Nordic Questionnaire method identified the types of physical

Figure 1: Frequency for causes of fatigue

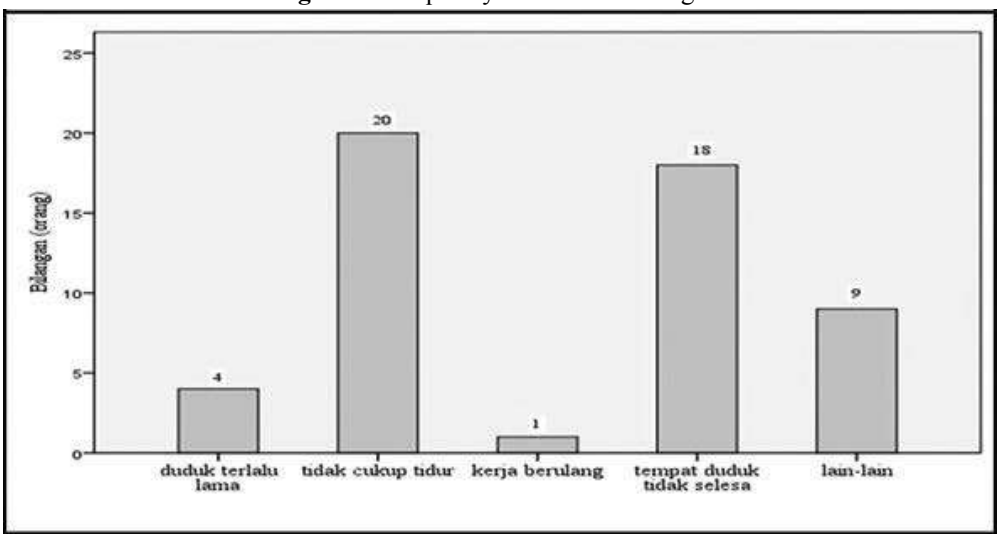
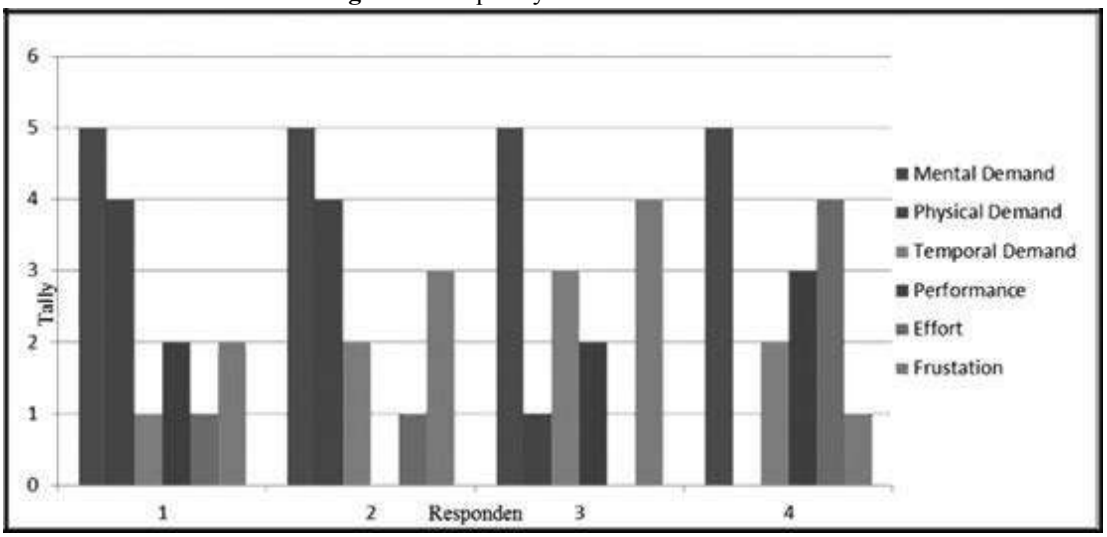


Figure 2: Frequency of NASA TLX Scale



fatigue caused to the train drivers, namely, pain in the necks, shoulders and lower backs. Frequency of body posture drivers who causing physical fatigue can be seen from the video observations. These three types of fatigue will lead to physical fatigue causes.

The next objective of the study was to determine the causes of physical fatigue on train driver and the effects of physical fatigue on train driver. Through the Nordic Questionnaire, found that the main causes of physical fatigue that goes over the train driver is not getting enough sleep, the seats are uncomfortable, repetitive movements and other factors such as vibration, stress, mental fatigue and the workstation itself. As a result of NASA-TLX method finds the highest workload that experienced by the train driver is mental and physical workload. Workload and frequency of use of a body in time will cause physical fatigue.

The effects of physical fatigue on a train driver are identified by the Nordic Questionnaire. The results of the analysis showed that the driver will have limited activity at home because of fatigue experienced by their workload. The fatigue experienced by train drivers are 1 to 7 days, and some drivers had to get hospital treatment for fatigue in the lower back.

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Appendices

Figure 3: Train driving posture

Figure 4: Position of camera

Figure 5: Real view from camera

Figure 6: Relative motion against time

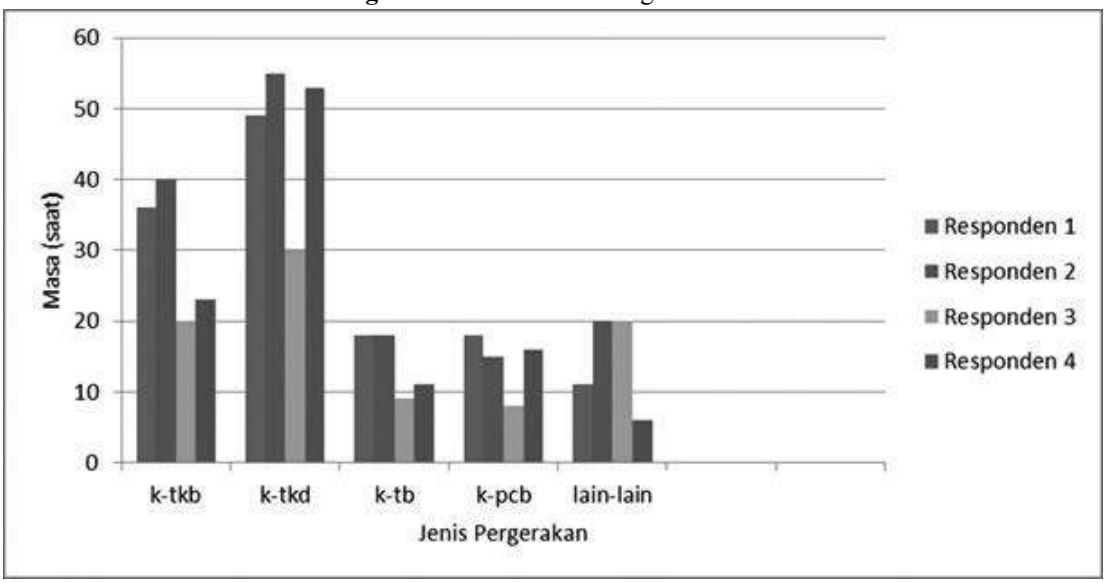

Table 1 : Summary of parts of the body that are experiencing fatigue

Tubuh Badan	**Mengalami sakit pada bahagian badan dalam tempoh 12 bulan lepas**				**Sakit yang dialami dalam tempoh 12 bulan menghalang melakukan kerja**			
	Kekerapan		Peratus		Kekerapan		Peratus	
	Ya	Tiada	Ya	Tiada	Ya	Tiada	Ya	Tiada
Leher	35	17	67.3	32.7	35	17	67.3	32.7
Bahu	34	18	65.4	34.6	28	24	53.8	46.2
Siku	2	50	3.8	96.2	2	50	3.8	96.2
Pergelangan Tangan/Tapak Tangan	17	35	32.7	67.3	15	37	28.8	71.2
Belakang	28	24	53.8	46.2	23	29	44.2	55.8
Bahagian Bawah Belakang	38	14	73.1	26.9	37	15	71.2	28.8
Pinggul/Paha	11	41	21.2	78.8	11	41	21.2	78.8
Lutut	10	42	19.2	80.8	8	44	15.4	84.6
Buku Lali/Kaki	9	43	17.3	82.7	10	42	19.2	80.8

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The Impact Of Green Compound Catalyst On Health And Work Environment In Production Environment.

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Abstract

Two EU directives which are RoHS and WEEE have restricted the usage of certain hazardous substances in electrical and electronic equipment. This has led to the introduction of green compound which is halogen free. The non-halogenated molding compound with different recipes was developed by compound manufacturers without compromising the reliability performance of electronic packages. The focus, often, has been on product reliability performance while qualifying new materials which overlook relevant safety and health concerns that might incur during the production stage. This paper is intended to study the forming of crystalline deposits which are found at the exhaust inlet of the Post Mold Cure Oven (PMC) arising from the usage of this green compound. The writers will investigate the underlying reasons and the impact on the work environment and the potential risk on health. From the initial evaluation result, the writers have indentified Compound A as the cause of this deposition. Data analyzed from the Thermo-Gravimetric Analysis (TGA) revealed higher weight loss which was 0.26% for compound A compared to other green compounds which are also used. Differential Scanning Calorimetric (DSC) test shows melting temperature of crystallized particle at 139°C while cold crystallization temperature at 80°C. The temperature in the interior of the oven is 180°C while the temperature at the exhaust inlet which is exposed to room temperature, and thus, providing the opportunity for this deposition. Further study carried out using Fourier Transform Infrared (FTIR) spectroscopy on one of the ingredient of the green compound (material C) observed a 95% spectrum matching compared to the crystallized particle. Material C is a catalyst added to the mold compound for epoxy-phenolic reaction. It is also considered to have the capability to enhance flame retardation. This paper will discuss in detail the characteristics of Compound A green compound and its impact on human and environment.

Keywords: Crystallize mold compound waste.

Introduction

Crystalline deposit (whitish to brownish) deposits were found occurring at Post Mold Cure Ovens (Refer to Figure 1). This raised health concerns since the deposits blocked the heat exhaust inlets, thus preventing the extraction of other thermal decomposition gases i.e. Benzene, and other VOCs are released out from the work environment during the compound curing process. The crystallization deposits were also found on ceiling, lights fittings, and air-condition grilles. The source and hazard properties of the crystallization particles were not known, hence raising anxieties and uneasiness among workers. This also created 5s concern to the production floor. Hence, frequent cleaning of exhaust inlet, ceiling, air-condition grilles and light fittings were done and resulting in increased cleaning cost.

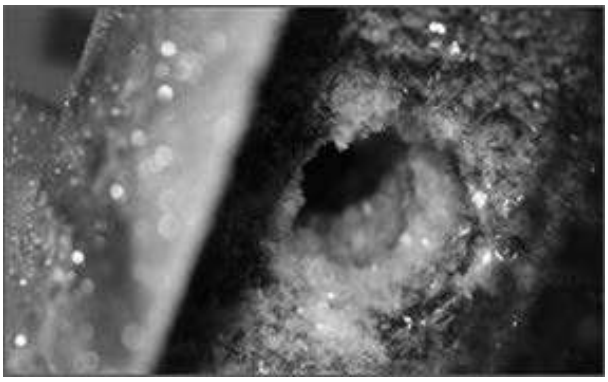

Figure 1: Crystallization formation choking exhaust inlet

Literature Review

Mold compounds are generally classified as harmful due to its properties of silica, carbon black, halogen, antimony and others [1]. Epoxy resin molding compounds are used to encapsulate semiconductor packages. Most molding compounds are composite materials that consist of epoxy resins, phenolic hardeners, silicas, catalysts, pigments, and mold release agents.

Two EU directives which are RoHS and WEEE led to the introduction of Green compound. The term green compound was subjected to halogen free mould compounds with the elimination of hazardous brominated and chlorinated flame retardants and replaced with other alternatives. Since then, the non-halogenated molding compound with different recipes was developed by compound manufacturers without compromising the reliability performance of electronic packages. Some of the green mold

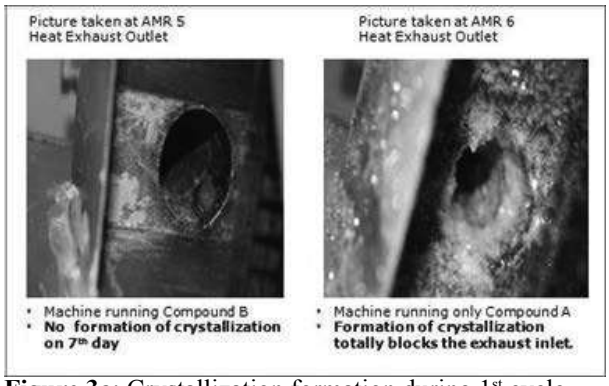

Figure 3a: Crystallization formation during 1st cycle assessment

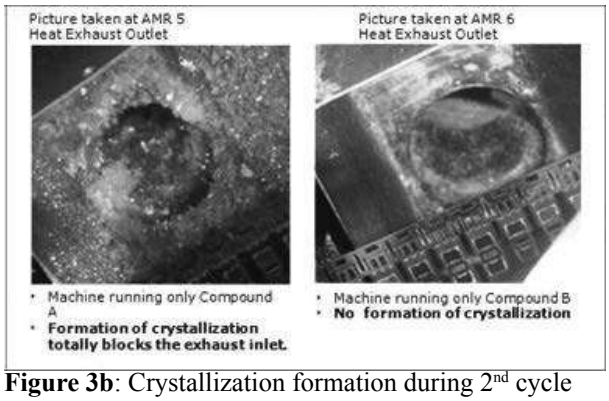

Figure 3b: Crystallization formation during 2nd cycle assessment with different oven

compounds also revealed some reliability concern as highlighted in the literature [2]. However, there were no studies conducted to look into the interrelationship of polymer structure and processing behaviour of some green compounds with safety of work environment in production line.

Methodology

Identification of compounds that causes crystallization was done by isolating the PMC ovens to cure packages with specific compounds. The isolated ovens were monitored daily to access the crystallization formation. Repeatability test was conducted by swapping the compounds with other ovens to confirm the influence of other factors such as equipment and exhaust flow rate. The exhaust flow rate and compound loading factor for all the ovens were also monitored. Samples of crystallization particle and different mold compounds used in the production line where the crystallization occurs were collected for TGA and DSC test to study the sample characteristics. Matching tests to confirm the properties of the compound with the crystal particle were carried out using the FTIR .

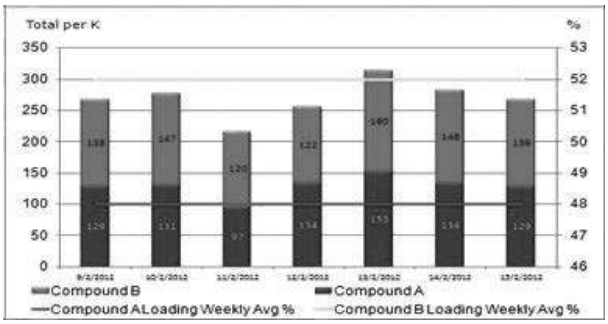

Figure 4 a: Oven loading Rate for 1st Cycle Assessment

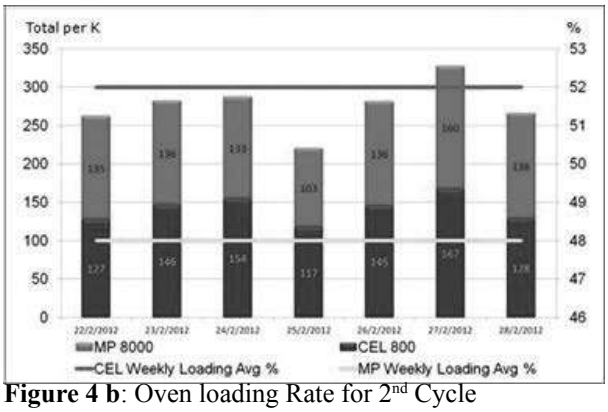

Figure 4 b: Oven loading Rate for 2nd Cycle Assessment

Results and Discussion

Referring to Figure 3a, daily assessment of crystallization formation in isolated ovens showed that the crystallization only occurred at Oven running packages with Compound A (Green Compound). Daily assessment was continued for 7 days. The experiment also showed that the exhaust inlet was fully choked within 7 days of running the curing activities. Repeatability test with the next cycle of assessment (7 days) was done by swapping the compounds with other ovens still

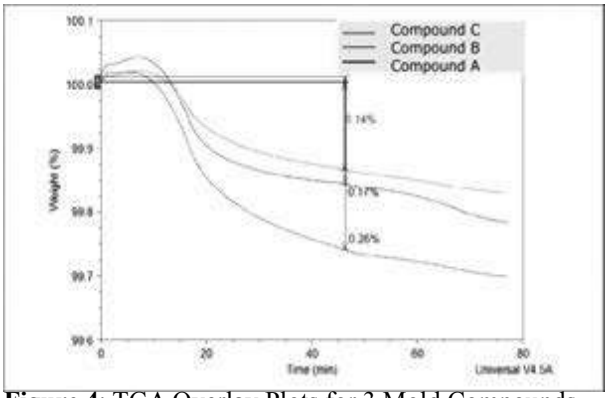

Figure 4: TGA Overlay Plots for 3 Mold Compounds

showing that only Compound A caused crystallization as compared to other compounds as shown in Figure 3b. Oven loading rates were also monitored to check the correlation of crystallization versus the loading factor. Loading rate for ovens running Compound A was 48% as compared to Compound B which was 52%. The next cycle of assessment showed Compound A with loading rate of 52% as compared to Compound B 48%. Although the loading rates of MP was higher (above 4%) during the 1st cycle, the crystallization was still found in oven exhaust running compound A. Hence, the loading factor

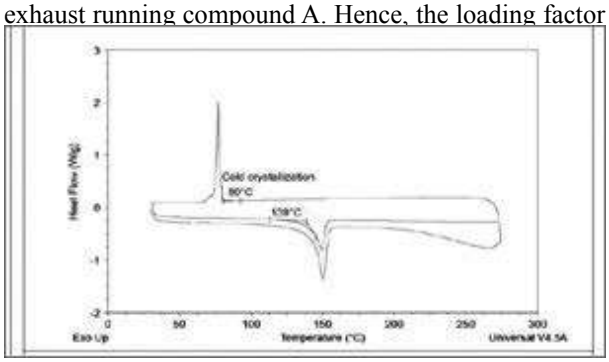

Figure 5: DSC Plots for Crystallized Material

was ruled out since the experiment shows no correlation referring to Figure 4a and Figure 4b. The exhaust flow rates for all other ovens were relatively comparable hence, this factor was also determined as non impact to the crystallization formation.

The related compounds were sent to for TGA analysis. Data analyzed from the Thermo-Gravimetric Analysis (TGA) revealed highest weight loss which was

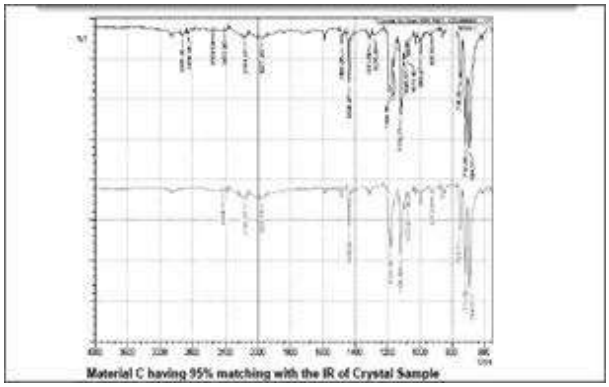

Figure 6: Material C having 95% matching IR of Crystallized Sample

0.26% for Compound A compared to other compounds which are also used. Weight loss for Compound B and Compound C were reported as 0.17% and 0.14% respectively. This supported our first visual observation whereby the crystallization only occurs in Compound A. Refer to Figure 4.

The Differential Scanning Calorimetric (DSC) test shows melting temperatures of crystallized particle at 139°C while the cold crystallization temperature at 80°C. The temperature in the interior of the oven was 180°C while the temperature at the exhaust inlet was exposed to room temperature, and thus, providing the opportunity for this deposition. This supports the finding whereby the crystallization only happens at the face of the exhaust and not on the entire exhaust ducting line. Refer to Figure 5.

Next a meeting with the supplier was organized to disclose our finding and to obtain information of the properties. A top confidential recipe was obtained by signing the NDA. Further studies were carried out using Fourier Transform Infrared (FTIR) spectroscopy on one of the ingredient of the green compound (Material C) which observed a 95% spectrum matching compared to the crystallized particle. Refer to Figure 6.

Material C is a catalyst added to the mold compound for epoxy-phenolic reaction. It is also considered to have the capability to enhance flame retardation. The hazard properties of the crystallization were further evaluated. The result shows that Material C possesses potential harmful characteristics. An immediate interim measure was released to staff and maintenance personnel to avoid exposure to the crystallization particles.

Conclusion

From the experiment, it is concluded that selection of catalyst mold compound formulation plays an important factor in ensuring the elimination of crystallization effect in work place environment. This is crucial in ensuring safe and healthy workplace. Stability of catalyst in the compound formulation has to be considered during the compound evaluation process. This project also triggered the development group to look into the compound formulation to prevent the occurrence of crystallization. It was agreed that a documented mold compound evaluation criterion will be put in during future compound evaluation to avoid recurrence in the future for other new compounds to be introduced.

Acknowledgments

The writers would like to acknowledge the management of Infineon Technologies Sdn. Bhd who has given full support to carry out detail analysis on the crystallization topic in molding work environment

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Development and Validation of Road Safety Index for Commercial Bus

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Abstract

This study develops a Road Safety Index (RSI) for commercial bus with the aim of determining whether the proposed index can be beneficial to the stakeholders for the purpose of mitigating road accident and promoting road safety. Five risk factors which include drivers, Vehicle, Task, Hazard/Risk and Road, where three critical factors out of these factors, were identified as high contributing factors (Drivers, Vehicle and Road) were selected for the construction of RSI. Drivers risk perceptions data were collected using survey instrument with sample size (n= 465) to test the model and the data fits the model perfectly. The main benefits of this approach and the subsequent development of RSI are: (1) Enable organisations to justify the investment on road safety by providing a measurement and evaluation mechanism. (2) The index provides a balanced view of the impact of the three critical (DVR) risk factors that the management can improve upon.

Keywords: Driver, Road, Vehicle, Index, Variables.

Introduction

Road safety has become a global issue of concern; this is due largely to the economic, social and human costs associated with road accidents and crashes. The purpose of this study is the validation of the developed Road Safety Index (RSI) with the aim to determine whether the proposed index is useful to the stakeholders with the intention of mitigating road accident and promoting road safety. Five major identified risk factors were considered as the model constructs for endogenous variables and one construct for exogenous variable which was derived from literature review and case studies. These major risk factors include Driver's factors, Road factors, Vehicle factors, Hazard/Risk factors, and Task. On the other hand, Road Safety Outcome efforts are used for the exogenous variable.

Findings from other related works include a confirmatory factor analysis of the behaviour of young novice drivers by Scott-Parker et al.,(2012) in which they developed a model to measure a risky behaviour of young novice drivers. They used Behaviour of Young Novice Drivers Scale (BYND) and found that crashes were associated with fixed violation, risky driving exposure and misjudgment. They equally revealed that road-rule compliance intentions were highly associated with transient violations while offences were moderately associated with risky driving exposure and transient violations, the model fits for the data that validate it. A major limitation of this work was lack of consideration for other humans and structure risk factors. El-Basyouny & El-Bassiouni, (2013) used Confirmatory Factor Analysis (CFA) and Structural Equation Analysis (SEM) to model and analyse traffic safety perceptions of drivers in application to speed limit reduction.

In the report, they used prior to project initiation (pre-pilot) and following the end of project (post-pilot) survey of six communities and concluded that the multivariate analysis has demonstrated that the pilot project was successful in improving the residents' perceptions on the traffic safety in their community. However, their studies lack the inclusion of the risk of human factors that are responsible for concerns related to speeding.

Safety propensity index for signalized intersections with seventeen factors was developed with SEM by Schorr & Hamdar, (2014). Similarities and differences of both types of intersections through model comparison were observed, at the same time, the limitation of this study was the lack of consideration for the risk factors. Logistic regression model was used on social-demographics, driving experience and yearly driving distance in relation to a tour bus driver's at –fault accident risk by Tseng, (2012) and concluded that driver's yearly driving distance and use of an Automatic Vehicle Location (AVL) system were significantly associated with a driver's at fault accident without consideration for the human risk factors influences that this present study aims at addressing.

A steady increase in vehicular movement over the past decades and its associated traffic problems which include road accidents has made road safety a major

policy area where safety index can serve as supportive policymaking tools. This study aims at quantifying and analyzing safety through identified risk factors by exploring comprehensive endogenous variables and considering the effects on exogenous variable on safety as well as on one another. One such arrangement and frame work that allows for the inclusion of these parameters is the SEM (Schorr & Hamdar, 2014).

The main benefit of this approach is the quantification of safety in terms of risk factors. The three major risk factors (Drivers factor, Vehicle factor and Road factor) form the endogenous that relate to the exogenous. This is to explain their contributions towards road safety among commercial bus drivers in Malaysia as a case study. In addition, the estimation of structural model for major commercial bus risk factors creates a powerful framework from which additional analyses can be conducted. This methodology has been employed by (Zakuan., 2009) to identify and develop a model to analyse the Total Quality Management (TQM) variables, ISO/TS16949 efforts and organisation performance measures for Malaysia and Thailand automotive industries.

Literature Review

Findings from other related work include a confirmatory factor analysis of the behaviour of young novice drivers by Scott-Parker *et al.*, (2012) in which they developed a model to measure a risky behaviour of young novice drivers in the Behaviour of Young Novice Drivers Scale (BYND) and found out that crashes were associated with fixed violation, risky driving exposure and misjudgment and road-rule compliance intentions were highly associated with transient violations, while offences were moderately associated with risky driving exposure and transient violations, the model fit for the data. A major limitation of this work was lack of consideration for other human and structure risk factors. El-Basyouny & El-Bassiouni, (2013) used CFA and SEM to model and analyse traffic safety perceptions of drivers in application to speed limit reduction, where they used prior to project initiation (pre-pilot) and following the end of project (post-pilot) survey of six communities and concluded that the multivariate analysis has demonstrated that the pilot project was successful in improving the residents' perceptions on the traffic safety in their community. Their study lacks the inclusion of the risk human factors responsible for concern on increases with speeding. Safety propensity index for signalized intersections with seventeen factors was developed with SEM by Schorr & Hamdar, (2014). Similarities and differences of both types of intersections through model comparison were observed at the same time. The limitation of this study was the lack of consideration for the risk factors. Logistic regression model was used on social-demographics, driving experience and yearly driving distance in relation to a tour bus driver's at fault accident risk by Tseng, (2012) and concluded that driver's yearly driving distance and use of an AVL system were significantly associated with a driver's at fault accident without consideration for the human risk factors influence that this present study aims at addressing. Therefore, research in this study aims at identifying critical risk factors and analyzing safety through identified risk factors. One such arrangement and frame work that allows for the inclusion of these parameters is the SEM (Schorr & Hamdar, 2014).

The main benefit of this approach is the identification and quantification of safety in terms of risk factors. In addition, the estimation of structural model for major commercial bus risk factors creates a powerful framework from which additional analysis can be conducted. This methodology has been employed by (Zakuan., 2009) to analyse the Total Quality Management (TQM) variables, ISO/TS16949 efforts and organisation performance measures for Malaysia and Thailand automotive industries.

This study has two major objectives, which are to systematically identify the risk factors that affect safety among commercial buses and to analyse the validated model through a drivers' perception survey obtained from a commercial bus station in Malaysia. The findings may be useful in providing understanding on how better safety measures can be obtained and improved among commercial bus drivers.

Methodology

Overview

A set of self-designed questionnaire was developed containing six major parts as follows:

i. Five endogenous variables: Driver's factors, Road factors, Vehicle factors, Hazard/Risk factors, and Task, and

ii. One exogenous variable: Road Safety Outcome efforts.

The total numbers of items in endogenous and exogenous variables are 46 items and 10 items respectively. The collected questionnaire was processed using Statistical Package for Social Science (SPSS 16) and Analysis of Moment Structures (AMOS 16) for necessary statistical analysis including reliability test that measure how reliable the items of the risk factors, regression analysis to establish the relationship of the constructs and factor analysis was conducted so as to group the items according to their respective constructs. Confirmatory analysis shows the degree of data fitness to the model and finally the structural model analysis was performed.

Participants

Participants were drawn from five commercial bus transport companies consisting of 465 licensed drivers who have involved in a long distance journey. Their ages range between 34 to 42 years old. Among them, 98.7%

were males and only 1.3% were females. Participant accident history shows that nearly half of the drivers (49%) never had accident since driving while the other half (51.3%) had accident experience ranging between 1 to 4 times occurrence during the period of their driving. 1.3% involved in severe and fatal accidents. From the survey, it was reported that about 21% of the participants have ten years driving experience while about 43% have 11 to 15 years driving experience. In terms of their driving shift, 83% drove between 4 to 6 days per week, all the 465 drivers were administered with the questionnaire which consists of five constructs to measure the perception of the drivers towards safety. Overall, it took a period of three months interval for recollection of the data to ensure no missing values for future analysis.

Instruments

The questionnaire consists of 56 questions and was designed based on the proposed framework (Arowolo *et al.*,2014). The initial draft was examined by two safety experts, one ergonomist, and a survey instrument quality expert for facial and content validity. Suggestions and amendments were made on the phrasing and arrangements of the questions. The questionnaire was then examined by three of the bus managers before being administered to the bus drivers. The final validated version consists of demographic information and questions that address some driving risk factors identified to be responsible for road accident among commercial bus drivers. 8 questions deal with perceived drivers factors that influence road accident, 6 questions deal with vehicle factors emanating from causes of accident as a result of factors associated with vehicles, 7 questions arise from road factors associated with bus accident, 8 questions deal with driving tasks that can affect bus accident, 7 questions concern wirth their hazard/risk perceptions that relate to road accident and 10 questions on road safety outcome and traffic accident. The remaining questions are on demographic information. Some of the questions were modified and improved from previous questionnaires in the literature (Cafiso *et al*.,2013, Chen *et al.*,2013, de Winter & Dodou, 2010, Edquist *et al*.,2011, Hermans *et al*.,2008)

In this initial Exploratory Factor Analysis (EFA), all the 46 categorical variables in the questionnaire were included. The factors were extracted based on Eigenvalues greater than 1 and variables with that is less than 0.5 were suppressed (Pearson, 2008). Five factors of driver's perception were extracted which have a Kaiser-Meyer-Olkin (KMO) measure sampling adequacy of 0.824 and Bartlett's test of Sphericity was significant ($\chi 2(630)=2873.401$, $p<0.05$). The communalities of the variables also exceeded the minimum value of 0.3 (Everitt, 2009). The fit of the model was however improved by a minimum diagonal value of 0.5 for each of the item in the anti-image correlation matrix.

The data collected in MIROS account for accident record from a secondary source with the purpose of having the knowledge and trend of commercial bus accident in Malaysia from 1993 to 2012. The second stage of the work was the distribution of questionnaire to capture drivers' perceptions of the identified risk factors. Out of 250 questionnaires given to Maju 150 were returned, followed by UTM bus 100 questionnaires given only 50 were returned, for Causeway Link out of 250 questionnaires 65 were returned, 200 were given to Transnational express 150 were returned and 100 were distributed to Transit Link, 50 were returned.

Table 3.1: Summary of questionnaire distribution and responses

Distribution for Pilot Studies				
S/N	Organisation/Company	Date	Submission	Response
1	MIMOS	October 29th,2013	50	30
Distribution for Full – Blown Questionnaire				
1	MAJU	January 8th, 2014	250	150
2	UTM	January 30th, 2014	100	50
3	CAUSEWAY LINK	February 24th,2014	250	65
4	TRANSNATIONALEXPRESS.	June 5th, 2014	200	150
5	TRANSIT LINK	June 5th, 2014	100	50
Total			**900**	**465**

Defining the Construct

Each of the construct was measured by its respective items as stated in Table 3.2

Table 3.2: Constructs and their defining items

Human Factor	Item
Driving Hazard	1. Long hour of driving causes fatigue & tiredness. 2. Traffic jam and hold up 3. Long hour of driving 4. Driving at high speed 5. Pressurefrom passengers while driving 6. Improvement in road technology
Driving Risk	1. Overconfident in driving is a powerful source of bias in the perception of risk 2. Subjective perception of risk. 3. Over speeding is an involvement in risk behaviour 4. Fixate more on stationary object is risk behaviour.
Driving Distraction	1. Eating/ Talking 2. Reading road bill board 3. Dialling/answering call 4. Taking off jacket 5. Wiping/looking at dash
Vehicle factors	1. Better vehicle interior design can reduce road accident. 2. Vehicle connected with speed regulators 3. Vehicle connected with forwardcollision warning 4. Installation of driver assisted system will aid road safety. 5. Old vehicles on highway are risk to the driver and other road users. 6. Installation of curve speed warning is essential in a vehicle.
Road safety outcome	1. Government and stakeholders should make road safety a top priority. 2. Driving safety is an important concern in Malaysia road 3. I am satisfied with the amount of emphasis placed on road safety 4. Road safety issue must be discussed among road users

Results

Measurement Model

The results show an adequate fit with GFI of 0.928 and AGFI of 0.901 which are within the recommended value, NNFI of 0.922, CFI of 0.937, RMSEA of 0.060 and CMIN of 2.677, which are still less than the recommended value of <3. There is a significant relationship between driving risk and driving hazard ($r=0.631, p<0.01$), relationship also exists between driving risk and driving distraction ($r=0.619, p<0.01$). In a similar manner driving hazard has a significant relationship with driving task ($r=0.631, p<0.01$), as well as driving hazard with driving distraction at ($r=0.579, p<0.01$).

Therefore, the hypothesis (H1,H2 & H3) that the three variables H1,H2 & H3 have a positive influence on road safety is accepted. Factor analysis of KMO and Bartlett's test of sphericity conducted on the three measuring variables shows task with KMO= 0.786. Hazard/Risk KMO- 0.827 and vehicle KMO= 0.721, while Reliability Cronbach's Alpha for the five variables is 0.824 higher than the minimum recommended value of 0.7. This finding is in good agreement to that of Abang and Von (2011) who established relationship between working relationship, schedule and accident with ($r=0.486, p<0.01$ and $r=0.601, p<0.01$).

Structural Model for Road Safety Index (RSI)

Road safety outcome has been a key issue of concern globally as a result of the human and economic cost associated with road safety crashes and fatalities. The objective of this part is to see the level of contribution of each of the three major drivers, vehicle and road identified risk factors towards building of road safety index.

Figure 4.1 shows a structural model of road safety outcome effort for the construction of the safety index. Driver, vehicle and road situations are three major factors that have the highest contributions. The highest contribution comes from drivers factor which has an index of 0.41, followed by vehicle factor of 0.39 and finally road factor of 0.13. From the statistical analysis, the results show that the model fits the data with GFI of 0.947, AGFI 0.920, NNFI 0.938, CFI 0.953, RMSEA 0.061 and CMIN of 2.728.

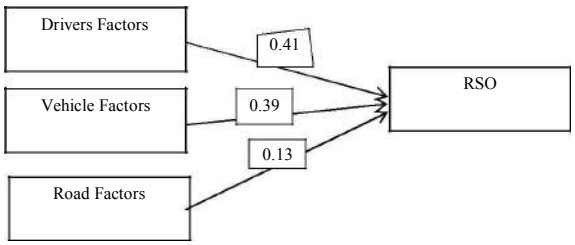

Figure 4.1 : Structural Model of the Constructs for Road Safety Index (RSI)

Drivers factor has the most contributing effect, human factor in the ergonomic literature generally refers to all human aspects involved in any activity, either be positive or negative activities since driving requires different activities. The human factor of accidents refers to the inadequacy of the variables characterizing the human component (like level of driving experience, fatigue, distractions, etc.) and which combines with the inadequacy of variables characterizing the other factors (road, vehicle, hazard/risk, task) to produce 'human errors'(Pierre Van elslande & Claire Naing, 2008).

Table 4.1 shows a structural equation in which driver factors (dr) has a positive contribution of 0.41, vehicle factors (vh) has 0.39 contribution and road factors (rd) with 0.13 contribution with 0.52 errors and their various endogenous measurement as stated in table 4.1. Drivers factor has five measurement items with drivers pain as a result of driving multiple task having the highest contribution of 1.05 and measurement error of 0.18, driving in hurry 0.9, maneuvering under traffic jam has 0.7 contribution and influence of policy makers (Plymk) 0.63 with a measurement error of 0.34. Vehicle has three items of measurement with drivers assistance (DrAs) having the highest contribution of 1.08 with 0.11 errors, vehicle connected with speed regulator (Srgu) has 1.00 contribution with 0.38 measurement error, while interior design (InDg) has 0.55 positive contribution.

Road measurement model produces a positive effect as accident rate on bad road (AcdRt) has 0.89 contribution to accident, road intersections (Ints) has the highest contribution of 1.64 with 3.37 measurement errors and roundabout design has 1.00 positive contributions with 0.44 measurement errors, with their respective R square values.

Conclusion

A lot of important implications in terms of practice and implementation emanate from the construction of Road Safety Index. First, road safety index may be a major method of making comparisons of road safety performance of any bus transportation company. Secondly, road safety index can be a good instrument of annual performance in the hand of managerial teams of any bus transportation company. In a similar manner, manager can try to improve Road Safety Outcomes (RSO) through the improvement of its Drivers factors. Driver's conditions can be improved through training and safety awareness campaign, and better vehicle interior design. Installation of speed warning and applications of decision support for drivers inside and outside the vehicle can be of great help (Drew & Hayes, 2012).

Table 4.1 : RSI model measurement equations.

Equation	Error variable	R^2 value
Structural model		
INDEX = 0.41dr + 0.39vh + 0.13rd + 0.52	1.00	0.52
Endogenous measurement model		
Measurement model for Drivers:		0.45
Hurry = 0.90dr + 0.11	0.23	
Pain = 1.05dr + 0.18	0.18	
Trfjm = 0.7dr + 0.55	0.55	
LgHr = 0.06dr + 0.51	0.51	
Plymk = 0.63dr + 0.34	0.34	
Measurement model for Vehicle:		0.37
DrAs – 1.08vh + 0.11	0.11	
Srgu = 1.00vh + 0.38	0.38	
InDg = 0.55vh + 3.52	3.52	
Measurement model for Road:		0.15
AcdRt = 0.89rd + 3.52	3.37	
Ints = 1.64rd + 3.37	1.00	
RdAb = 1.00rd + 0.44	0.44	
Exogenous measurement model		
RdUser	10.42	
Drsf	0.10	
SkHd	0.18	

Recommendation

The RSI Approach and Benefits are summarized as follows:

- Enable organisation to justify the investment on road safety by providing a measurement and evaluation mechanism.
- Provide a balanced view of the impact of RSI initiatives for a holistic evaluation by considering the three DVR measurable entities that form the index constructs.
- Increase the visibility of the results of the improvement for all stakeholders according to their safety needs.
- Reuse of same RSI model in evaluating a broad spectrum of safety across different bus companies.
- Create awareness for taking into consideration confounding factors that might affect safety evaluation.

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Egress Modeling In Performance Based Fire Engineering Design– Fire Safety Study At Niosh Tower.

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Abstract

Evacuation profile systems in high rise building are important to determine the safety level during any fire emergency. In relation to this, the study was conducted with its objective to develop the evacuation profile for NIOSH Tower. Evacnet-4 software was used to develop models for building evacuations using the building network descriptions and the initial content of the occupant at the beginning of the evacuation. The results show that it requires 390 seconds to evacuate NIOSH tower, with the highest number of bottlenecks recorded for the Third Floor. Identification of bottleneck is important to determine the evacuation periods. The information gained from the model may be used for the emergency response planning and for support material. The model should be tested in real time to have its reliability verified.

Keywords: Evacnet-4, Evacuation Profile, Fire emergency, Emergency response

Introduction

Evacuation profile systems in high rise building are important to determine the safety level during any fire emergency. The most important factor for developing evacuation profiles is by ensuring that occupants can evacuate the affected building safely and immediately. Fire in high rise buildings is the most common contributing factor which causes civilian fatality and injury as well as panic situations. Emergency plan deals with this situation to ensure that the best strategic and tactical measures are taken during the emergency situation.

Researchers have come out with various evacuation approaches to evaluate the efficiency of evacuation process through different reports and studies (Francis and sanders, 1982). The degree of route of exits and floor design play important roles in the emergency situation, while the distance between each room and exit routes or stairs will affect the process of emptying the rooms. Therefore, it is important for every room to have standard measured distance in order to accelerate the evacuation process of the evacuees. For that reason, travel distance and direct distance of the floor are considered important to determine the means of egress.

Not every civilian in the high rise buildings is alert and aware of the emergency inside the building. Mostly, emergency drills are not quite successful in creating the panic situation and people tend not to take it seriously. Sometimes, even properly planned emergency drills do not cover all the important aspects during evacuation process. Evacuation simulators are developed to overcome this problem. Evacuation models are used mainly as a pre-assessment test for the safety conditions of the building by taking every evacuation requirement into consideration. There are several dozens of evacuation simulators developed (Silva *et al*., 2013).

For this research, Evacnet-4 was used to develop an evacuation profile for NIOSH tower. Evacnet was developed by Kisko and Francis in 1984 as a public domain building evacuation programme. This model uses a set of network descriptions of the building and information about the initial placement of the occupants at the initial stage of the evacuation process. This information consists of a set of nodes and arc called Evacnet-4 network model. Nodes are any place or component inside the building where the people are moving out during the evacuation. Arc is any visible passageway between two defined nodes (Farooqui *et al*, 2011). Evacnet-4 has been designed to be flexible enough to model the evacuation of almost any conceivable structure represented as network including office building, hotels, skyscrapers, auditorium and stadiums (Kisko *et al*., 1998).

National Institute of Occupational Safety and Health (NIOSH) was established as a company with a warranty on June 24, 1992. Its functions include providing training and consultancy, dissemination of information and conducting research in the field of occupational safety and health in Malaysia. The construction of NIOSH Tower was completed in 2012. This study intended to evaluate safe travel distance during emergency evacuation from the design point of view. The assessment was conducted at NIOSH, Bandar Baru Bangi because of its role as

the main training and learning institution in Malaysia in the field of occupational, safety and health. The aim of the study was to develop an evacuation profile using Evacnet-4 evacuation simulator as a control for actual fire drill situation.

Methodology

The study was conducted in NIOSH Tower, with data collection taken from all occupied rooms from Level 1 to Level 8 of the building. This study was carried out for 18 months, from May 2012 until November 2013. The sampling frame for the study was developed based on the floor plan provided by the Administration and Facility Department of NIOSH. From the floor plan, the offices and training room were identified and a list was created as the sampling frame. Rooms not in use such as store and auditorium were excluded from the study. Data for simulation was collected during the training session with the classroom occupied.

The NIOSH tower with 652 occupants was modelled for Evacnet simulation, with a total of 84 arcs and 71 nodes. A total of 4 destination points (DS) were allotted to the building, two at the first level and two at the ground level. A time period of 10 seconds was fixed for all calculations with an average speed of 120 ft/minute at the stair area and 230 ft/minute at all other nodes for dynamic density calculation and transverse time.

Results and Discussion

The estimation of the moment time was done at the NIOSH Tower at Bandar Baru Bangi using Evacnet software. A summary of the output for main parameters are shown below:

1. A period of 390 seconds was required to successfully evacuate 652 people from the building.

2. A period of 180 seconds was required for the building evacuation when uncongested.

3. A total of 324 persons were evacuated through nodes Destination 2 and 303 persons were evacuated using Nodes Destination 1. Only 25 persons were evacuated through Nodes Destination 4 while Nodes Destination 3 were not utilized.

4. A total of 5 bottlenecks were identified, 3 from the first floor and 2 from the third floor of the building. The number of bottleneck will increase the evacuation time.

5. The averaged time for all the evacuees to evacuate the building was 237 seconds.

Based on the Evacnet analysis, two of the destination allocations were used during the evacuation process. Those exits will only be used if the evacuees were there. Normally only three exit routes were used during the evacuation.

Bottleneck identification is important to determine the evacuation time periods. The presence of bottleneck on every floor will increase the evacuation time periods. From the evacuation simulation, there were a total of 5 bottlenecks identified during the evacuation model. Level 3 has the highest potential for bottleneck to happen which can delay the evacuation time for 56 of the time periods. Level 3 is the intercept point for the evacuees from Level 4 to Level 8. All evacuees will gather at the intercept point at Level 3 to arrive at the allocated destinations.

The implementation of a facilitator system during evacuation process will increase the evacuation time with directions given for the evacuees to go to the assembly point. Understanding the requirement to remove bottlenecks in high rise building will reduce the required safe egress time during evacuation.

The time period for the evacuation of NIOSH tower was set at 600 seconds as the maximum time allowed for the evacuation process, a default value determined by the researchers. During the time period provided, it required only 390 seconds to evacuate 652 evacuees from the building. Most of the evacuees were evacuated from the building after 273 seconds.

Conclusion

The evacuation simulator can be used as a support material for the emergency response by providing the necessary additional insight into evacuation plan, building layout and building design for improvement critical situations. The results obtained during the simulation show that the evacuation time is below the permitted time set by the researchers. The very next step of this research includes the simulation process for fire drill in NIOSH tower to calculate the actual time for the evacuees to evacuate the building. Data gathered from the emergency drill will be compared with the data from evacuation simulator to see the difference in the time required for the evacuation process.

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Applying Sociotechnical Philosophy in Integrating Psychosocial and Physical Safety Climate to Predict Performance: A theoretical review

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Abstract

This paper is focusing on developing theoretical model on the effects of psychosocial and physical safety climate towards workers task performance. Psychosocial and physical safety climate can be defined as workers' perception on organizational policies, process, and procedures outline, specifically on psychosocial issues and physical safety aspect. This paper is based on sociotechnical philosophy by highlighting the integration of both psychosocial and physical safety climate in predicting task performance. According to the philosophy, workers working performance is dependent on both social and technical context in environment to accomplish the task and will influence both physical products and psychosocial outcomes. Thus, it is essential to investigate the integration of psychosocial and physical safety climate in predicting performance outcome.

Keywords: Psychosocial safety climate, physical safety climate, sociotechnical, job demand, safety behaviour and performance

Introduction

Safety is one of the crucial criteria in the design and operation of many technological systems (Basnyat, Palanque, Schupp, & Wright, 2007). According to DOSH (2013), workers' safety has become major concern as in Malaysia, the number of reported accidents especially in manufacturing industry keeps increasing. In, 2009, 34,376 cases had been reported and the number increased to 35,296 cases in 2012. The number was decreased slightly in 2011 with 35,088 cases (SOCSO, 2012). These took place probably due to both physical and psychosocial safety measures. A member of the Health Ministry's Mental Health Promotion Advisory Council and chairman of National Institute of Occupational Safety and Health (NIOSH); Tan Sri Lee Lam Thye, had strongly suggested the organization to amend policies on psychosocial aspectS instead of focusing on physical health issues only (DOSH, 2014). Besides, a study with daily collected data for 20 days revealed that psychosocial factors produce a stronger effect compared to work stress and musculoskeletal discomfort at workplace (Zakerian, & Subramaniam, 2009). The psychosocial factors used to be investigated were job demands, negative social interaction and computer-related problems (Zakerian, & Subramaniam, 2009).

Amending policies based on safety perspective is essential as previous studies reported that workers' perception on organizational outline of policies, process and procedures will affect workers' performance and behaviour (Schneider & Reichers 1983). By amending working policies, process and procedures, employers are able to create a climate that reflects their believe in relation to their workers' needs (Schneider, Brief, & Guzzo, 1996). In addition, there are development of climate's facets-specific concerning psychological safety and health issues among workers known as psychosocial safety climate (Dollard & Bekker) and facets-specific climate that relate to workers' physical health and safety called physical safety climate (Zohar, 1980). Previous studies attempted to understand the physical safety climate in organization (Grote & KuÈnzler, 2000). The physical safety climate is entrenched by assumptions based on interplay between people, technology, and organization in their relation to safety (Grote, & KuÈnzler, 2000). Nonetheless, research in determining the effects of psychosocial and physical safety climate and its importance is still limited. The argument is developed encompassing two aims: first, to expand and define the underlying motivation, principles, and theories behind sociotechnical systems theory and, second, to theoretically explore the linkages that exist between it and the emerging psychosocial and physical safety climate paradigm in order to determine performance enhancement. The prime purpose of this research is to explore the potential of sociotechnical systems theory in underlying the integration of psychosocial and physical safety climate.

Literature Review

Sociotechnical perspective

Previously, the sociotechnical theory was mostly applied in organizational design (Trist & Bamforth, 1951). Sociotechnical refers to the interrelated relation between 'social' and 'technical'. The two main principles support sociotechnical theory on the interaction between social and technical factors that determine the system performance (Walker, *et. al*., 2008). The classical sociotechnical theories of the 1950s defined it as an interface between human (social) and non-human (technological) systems (Petrina,

2003). On the other hand, it also can be defined as any practical instantiation of socio and technical elements engaged in purposeful goal-directed behaviour (Walker, *et. al*., 2008). These interactions bounded by linear 'cause and effect' relationships; relationships that are normally 'designed', and partly 'non-linear' complex; unpredictable and unexpected relationships (Walker, *et. al*., 2008). Nevertheless, it is expected that when 'socio' and technical' are combined, the result would be unpredictable as both react differently because of their obvious differences (Walker, *et. al*., 2008). From safety perspective, the consensus of psychosocial and physical safety climate presented an idea where people in working condition (socio) interact with machine and equipment in completing their work task (technical). Having a working environment based on safety demonstrates safety concern that is being pursued by the organization. It is because the environment created by the management reflects aspects that have been prioritized by the organization towards the workers (Schneider, *et. al*., 1996).

Sociotechnical systems theory is the widespread term to be used (Walker, *et. al*., 2008) to reflect certain specific methods that joint optimisation in order to design organisations that exhibit open systems properties, and thus, are able to cope better with environmental complexity, dynamism, new technology and competition. Current article reviews the extent of knowledge in this area. It argues that the implementation of psychosocial and physical safety climate is able to aid global manufacturers when experiencing organisational design challenges that sociotechnical systems theory was originally developed to answer except it should take place separately. Sociotechnical theory offers a theoretical basis that considers the advantages of psychosocial and physical safety climate implementation in designing an organisation. The fundamental principle in sociotechnical theory comes from Trist and Bamforth (1951) seminal research on coal mining plant. This research shows irrational finding as production decreased despite the advancement in machinery and equipment, higher payment and better facilities. Driven by the unexpected result, they suggested another aspect that had been ignored which was the social aspect. Physical constraints may prevent the task from being carried out sensibly, nevertheless, social structure elements such as occupational role also assist in determining the outcome (Trist and Bamforth, 1951). Consequently, the interaction between interactive technological and sociological allows technologies to be manipulated to suit people preference on technologies uses. Besides, people could be made to adapt to technologies and technologies are made to adjust to people. Hence, this will be able to promote psychological and social processes conducive to efficient, harmonious and productive relations (Petrina, 2003).

Based on the previous studies of sociotechnical application, sociotechnical model was widely used to develop a work system. Nevertheless, sociotechnical model is unable to raise and relate sociotechnical theory on safety perspective when the element of safety aspect was discussed. Nonetheless, the sociotechnical theory is feasible to assist the safety execution with the integration of facet-specific of climate based on safety named psychosocial and physical safety climate. In an organization, both product and services are found to be interacted among workers who work across organizational, geographical, cultural and temporal boundaries. This situation causes major implication on people and their working condition which may challenge how the system was designed. It is also widening the range of system elements and safety that can be considered. The designation of sociotechnical systems that involve work across multiple boundaries requires better integration between various sub-disciplines or components of people, and machinery and equipment. Other than that, collaboration with other disciplines that provide either expertise regarding the domain of application or expertise on its concepts can enrich the system design as well as the performance (Carayon, 2006).

Physical Safety Climate

In current study, the term for safety climate is used as physical safety climate to distinguish the differences between both facet-specific climates based on safety (Dollard & Karasek, 2010). The physical safety climate refers to workers' perceptions towards policy, practices and procedure attributes that take priority on safety (Zohar & Luria, 2005). Climate, for a specific facet, such as safety or service, reflects on employees' perceptions towards its importance in an organization (Zohar, 2000; Zohar & Luria, 2005) and affects facet-specific behaviors (Cheyne, Oliver, Tomas, & Cox, 2002). In discussing the physical safety climate in team level, Zohar and Luria (2005) have refined the dimension of physical safety climate view from Zohar (2000) and People subscale in the Dictionary of Occupational Titles (1991). Zohar and Luria (2005) delivered three dimensions of physical safety climate consisting of active practices, proactive practices and declarative practices. An active practice reflects on the monitoring and controlling commotion related to physical safety from management practices. Proactive practices can be defined as the instructing and guiding commotion related to physical safety from manager in promoting learning and improvement in safety activities. Thus, declarative practices present an action of declaring and informing safety management programmes that enhance physical safety (Zohar & Luria, 2005). It is similar with communication and information sharing which are found to be important aspects of physical safety climate (Pousette, Larsson, & Törner, 2008).

The dimension of physical safety climate indicates interaction between group members by which supervisors can indicate the importance of safety compared to competing goals such as production speed or schedules and offer a wider range of climate indicators relating to supervisory practice in the context of competing demands

(Zohar & Luria, 2005). Physical safety climate was significantly predicting self-reported safety behaviour which is workers behaviour with regard to safety (Pousette, *et. al*., 2008). The active practices (monitoring and controlling), proactive practices (instructing and guiding), and declarative practices (declaring and informing) determine the quality of environmental management systems and provide a general description of the managerial activities that comprise a benchmark physical safety programme (Zohar & Luria, 2005).

Psychosocial Safety Climate

The inference that workers draw on organizational climate is based on policies, practices and procedures, work task behaviour that are expected of them and lastly, rewards and support by an organization (Schneider, et. al., 1996). The expectation to improve workers performance is possible through organizational changes. However, the failure to cooperate changes will affect workers psychologically as well (Schneider, *et. al*., 1996). Like organizational climate, psychosocial safety climate is also being perceived as organization's property. It consists of workers' aggregated perceptions regarding management commitment in protecting their psychosocial health and safety by perceiving the policies, practices and procedures prior to their psychosocial safety (Dollard and Bakker, 2010). The interaction between management and workers are related to workers psychological development and their social environment which is known as psychosocial (Radzaz & Bahari, 2013). Thus, psychosocial safety climate construct stems largely from the belief that individuals ascribe meaning to their work environment based on their working conditions, management systems, salary, co-worker relationships, and treatment equity (James *et. al*., 2008). Prior consideration in developing psychosocial safety climate is from the perspective of work stress, psychosocial risk, and organizational climate literatures (Dollard, 2011). Psychosocial safety climate is a facet-specific component of organizational climate relating to freedom from psychosocial harm at work (Dollard and Bakker, 2010). It reflects management commitment towards their workers' psychological health and the priority they put in safeguarding workers' psychological health as opposed to production demands (Dollard and Bakker, 2010). Moreover, psychosocial safety climate can be achieved through establishing communication systems (e.g., for reporting poor psychological health at work) and actively involving every part of an organization in work stress prevention (Dollard and Bakker, 2010).

The criteria that determine psychosocial safety climate achievability might include management commitment on psychosocial safety, management priority on psychosocial safety, organizational communication on psychosocial safety issues, and lastly organizational participation in psychosocial safety matters (Law, *et. al*., 2011). A high level of psychosocial safety climate will reflect manager's awareness on their workers needs for adequate resources to complete work tasks. Hence, lack of enough resources will lead to decreasing levels of positive work emotions (Schaufeli and Bakker, 2004). High level of psychosocial safety climate will contribute to a higher procedural justice as managers have high value on positive well-being of its workforce (i.e., levels of satisfaction, engagement) shall lead to optimum working conditions. In addition, psychosocial safety climate also shows to have significant relation with psychosocial risk factors (e.g., job demands, job resources), worker engagement and health, and work related outcomes (Hall, Dollard & Coward, 2010). Therefore, with the existing of psychosocial safety climate, managers shall understand that insufficient resources may lead to negative reactions and counterproductive consequences (Spector *et al*., 2006), as well as indicate individual level of motivational processes that foster performance positive outcomes.

Integrating Psychosocial and Physical Safety Climate

The most prominent key question in organizational research is exploring ways to encourage employees' high performance. Organizations need to continuously motivate their employees to become more flexible, respond quickly, and produce reliable solutions in handling complex problems (Spink, 2000). Providing financial incentive (e.g., bonus plans or stock options) is a common approach to increase individual motivation and subsequent performance (Govindarajulu & Daily, 2004). Furthermore, research in organizational climate and work performance area are used to develop a framework for measuring perceptions on work safety to enhance performance. This framework helps to distinguish work environment perception from performance related to safety (Neal & Griffin, 2000). Based on a 40-year meta-analysis that consists of 9 meta-analyses review, findings from school, work, and physical domains indicates that intrinsic motivation is one of performance determinant (Cerasoli, Nicklin, & Ford, 2014). It is supported by the effect of intrinsic motivation to workers. Apart from extrinsic motivations such as reward and incentive, the intrinsic motivation is also able to boost and enhance workers' performance. This study proposed that physically and psychologically safe environment might enhance workers' performance. Psychosocial safety climate represents workers' collective perceptions regarding organizational policies, process, and procedure supporting psychosocial safety (Dollard & Bakker, 2010). On the other hand, physical safety climate signifies collective perceptions on organizational policies, process and procedure concern on avoiding physical risk (Zohar and Luria, 2003). Therefore, organizations should emphasize on safety aspects as workers' action and performance is dependent on the level of risk attached to them (Edmondson, 2003; Yagil & Luria, 2010). Nonetheless, the connection between work system safety-related characteristics and more general characteristics, such as work responsibilities, organizational designs, and technology usage, will lose its effects without the integration of psychosocial need in work system as proposed by previous sociotechnical

principle (Trist and Bamforth, 1951).

Conclusion

In conclusion, safety importance is not only about safety behaviour developed by workers while completing their task or the decrease of numbers on reported accidents and injuries. Therefore, it is belief that the integration of facet-specific climate safety of psychosocial and physical safety climate through the sociotechnical theory principles will solve concerns related to physical and psychosocial safety aspects through the workers' perception on organizational priority of safety in developing the organizational policies, process and procedures. It is belief that a positive psychosocial and physical safety climate is able to enhance workers' performance and help them to feel secure and confident in completing the work task (Baek & Frese, 2003). In measuring organizational performance, Baer and Frese (2003) found that a positive climate related to psychological safety is able to enhance organizational performance. It is essential for worker to have a positive perception regarding the safety aspect prioritized by the organization as workers' interpretation on organizational phenomenon varies with regard to their own worldview, perception biases and experience (Ostroff & Bowen, 2000). The current framework provides a link between workers perception on organizational policies, process, and procedure regarding physical and psychological safety. Kangis and Williams (2000) stated that the linkage is essential as workers' perceptions on their work environment (e.g., psychosocial and physical safety climate) have a parallel effect on their performance. Supported by Stetzer and Morgeson (1997), they suggested that organizations with high climates performance will not only be more effective, but are also able to avoid organizational ineffectiveness and lost productivity. Therefore, in line with organizational climate research view on safety and sociotechnical principle, this paper supports the association between the integration of psychosocial and physical safety climate and the workers' performance.

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A Survey On Safety Awareness Among Quarry Workers At East Cost Malaysia

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Abstract

Lack of safety awareness among quarry workers caused a number of accidents in quarry industries. The objective of this study is to gauge the awareness level towards safety among quarry workers. A questionnaire was distributed randomly among quarry workers in Pahang, Terengganu and Kelantan. The questionnaire consists of 6 questions regarding safety at workplace. Results revealed that 56.9% of the respondents agreed and totally agreed for the health and safety suggestions made to be given consideration and used. As many as 79.3% respondents admitted that they obeyed all the safety rules stated at the workplace and 86.3% respondents said that they always focused and gave full attention while completing their task. A high percentage of 88% of the respondents agreed for all accidents to be reported to responsible persons while 77.6% respondents agreed for all personal protective equipment to be used suitable with the task given and 86.2% respondents answered that they performed their task following the safe operation procedures provided by the company.

Keywords: safety awareness, quarry and mining workers.

Introduction

Over the past century, there have been rapid growths of development in every country around the world. Requirements on the quality, health, and safety have been increased by the governments in a number of occupations. In the new global economy, Occupational Safety and Health has become a central issue for quarry and mining industry in Malaysia. Recent evidences show that Malaysia has identified several types of mineral resources. In the 20th century, mineral production has played an important role in Malaysia's national economy. After many years of exploitation, such mineral has decreased significantly. In terms of its contribution to the country's economy, the mining and quarrying sector accounted for 7.0% of the Gross Domestic Product in 2010 (Department of Statistics, 2011).

The quarry and mining industry plays a very important role in the development of the country. The industry provides raw materials to the construction, building and manufacturing sectors. Quarrying and mining activities cause environmental and social impacts, such as those on land, water, air, wildlife, vegetation, supply and demand, revenues, employment and others, besides health and safety implications for both individuals and communities. Mining and Quarrying Safety and Health Act 1999 stated that quarry is a place on land where operations are carried on, continuously or from time to time, to produce construction or road building material. Meanwhile the meaning of mine is any of the following places; a place where operations are carried on, continuously or from time to time, within the boundaries of land the subject of a mining tenure, a place where operations are carried on, continuously or from time to time, on land adjoining, adjacent to, or contiguous with, the boundaries of land the subject of a mining tenure and within which is a place mentioned in paragraph, a place where operations are carried on, continuously or from time to time, unlawfully because land at the place is not the subject of a mining tenure, a place that was a mine while works are done to secure it after its abandonment, a place where tourism, education or research related to mining happens that is declared under a regulation to be a mine.

The failure by employers to provide a safe and conducive work environment, or the inability to use these facilities appropriately by employees, has cost implications on individuals, organizations, and the society (Pickvance,2003). The adoption of a health and safety management system demonstrates, in practical terms, the readiness of an organization to minimize the frequency and severity of work related accidents, ill health, and damage to property. This is because the provisions and requirements of health and safety management system encourage greater awareness of responsibilities and aspects of health and safety standards on the performance on organizations (Diugwu, 2008).

In practical terms, risk-awareness is developed in organizations through programmes that encourage workers to think of working safely and have the mind set of safety before they start their task (Hopkins, 2005a). It is an approach which not only involves the employees, but also the organization to create a safe environment at the workplace (Hopkins, 2005a, 2007). For example, supervisors may ask workers during the toolbox or other meetings to give their opinion on the safety

level in the organization and method of improvement. In turn, managers may ask supervisors to report the results of these meetings back to them according to the organization's safety reporting system.

Besides training or campaign provided by the management, common sense also plays roles in shaping safety culture and defining what it means to be risk-aware. For example, workers may use their common sense knowledge of what it means to work safely as a proxy for risk-awareness.

Hopkins (2002; 2005a; 2005b) identified that there are three reasons for promoting risk-awareness. The first reason is that, there are so many types of situations that could happen that need to cover to write a safety rule. Other than that, workers who are risk- aware will appreciate the limitations of safety rules and have their own efforts to work safely rather than mindlessly following the rules. The second reason is that workers who are risk-aware will be able to identify ways in which things might go wrong and know the actions to be taken instead of ignoring it (Hopkins, 2005a). Hopkins describes risk-awareness programmes as a "mini risk assessment" (Hopkins,2006)

Material and methods

Figure 1 shows the flow chart of the study. This academic undertaking research started with identification and random selection of quarry companies from Pahang, Terengganu and Kelantan as the study sites. The questionnaire used consisted of a set of Likert-type scales multiple choice items (Rodeghier, 1996). It was distributed to the subjects individually. The questionnaire comprised 43 questions divided into five parts : (1) demography, (2) safety awareness, (3) safety knowledge, (4) safety implementation, (5) safety attitude. However, this study looked only into part one, which contributes to the environmental factors. Each of the workers was asked to complete the questionnaire in a room at the site. The questionnaire was distributed to both employers and employees to answer questions about their personal information, their safety awareness, safety knowledge, safety implementation and safety attitude.

Personal information of the workers was analyzed and the level of safety awareness studied. After the analysis was carried out, the level of safety awareness was determined and all data was analyzed to achieve the objective of this study.

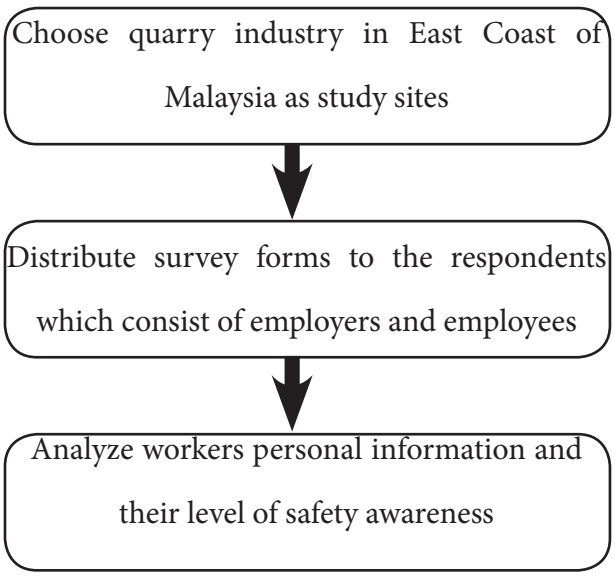

Figure 1 : Flow chart of the study

Results and discussion

Demographic data

A total of 58 workers were included in the study. Data gathered was classified as personal information of workers based on gender, age, education and position. Table 1 shows the detailed analysis of respondents' background. In this study, majority of respondents were males (72.4%). Based on the data acquired, age mode of workers is around 20 to 29 years old (51.7%) while their level of education is SPM level (48.3%). From the survey form, 72.4% of the respondents are employees and 27.6% are employers.

Reliability measures

Questionnaire reliability was tested using Cronbach's alpha (α) as shown in Table 2 derived from the average correlation of all the items on the scale (Rodeghier, 1996). Out of 4 reliability tests done, 3 had reliabilities above 0.7. One item had reliability measures of at least 0.4. The results indicated that the reliability measures were high for safety implementation which is 0.892. Reliability measures for level of safety awareness and attitude towards safety were also high at 0.829 and 0.882 respectively.

Study of level of safety awareness among quarry workers

Questions in part A focus on the level of safety awareness at the workplace. There were 6 variable of safety awareness studied and results from questionnaires were described in Table 3.

Analysis made on the level of safety awareness shows that there 56.9% of respondents agreed and totally agreed for health and safety suggestions made to be given

Table 1 : Characteristics of the sample

Characteristics	Category	Frequency	Percentage (%)	Mean±SD
Gender	Male	42	72.4	1.28±0.451
	Female	16	27.6	
Age	< 20	1	1.7	31.78±9.030
	20 – 29	30	51.7	
	30 – 39	14	24.1	
	40 – 49	11	18.97	
	>50	2	3.4	
Education	SPM	28	48.3	2.24±1.315
	Certificate	4	6.9	
	Diploma	10	17.2	
	Degree	16	27.6	
Position	Employer	16	27.6	1.72±0.451
	Employee	42	72.4	

Table 2 : Reliability measures using Cronbach's alpha for tested factor

Tested factors	Cronbach alpha (α)
The level of safety awareness at the quarry and mining	0.829
The perception of workers knowledge on safety and health at workplace	0.506
The perception of carrying out safety and health programme by workers at the workplace	0.892
The safety attitude of workers towards safety	0.882

consideration and used. As many as 79.3% respondents admitted that they obeyed all the safety rules stated at the workplace and 86.3% respondents said they always focused and gave full attention during completion of their task.

For variable from number 4, as many as 88% respondents agreed for all accidents to be reported to responsible persons. As many as 77.6% respondents agreed and totally agreed for all personal protective equipment to be used suitably with the task given and 86.2% respondents said they were doing their task following the safe operation procedures provided by the company.

From the results mentioned above, we can conclude that quarry workers have a high level of safety awareness when more than half of them agreed on those six different variables. However, Guo Wei-ci and Wu Chao (2011) stated that one of the causes of accident in quarry is lack of safety awareness among the workers. This different perception in different countries could be due to different educational backgrounds. Most of the workers in Malaysia completed their school education prior to employment. Furthermore, the results show that 79.3% respondents follow the rules at their workplace. Therefore the number of accident in this industry should be lower. However, based on statistics by SOCSO (2013) the number of accident in mining and quarry sector was 341 cases including 14 fatality accidents in 2012 compared to 305 accident cases and 8 fatality accidents in the previous year. This shows that even though the workers follow the rules and always report accidents to responsible authorities, and have high level of safety awareness, accidents can still happen since quarry is one of the more hazardous workplaces (Leger, 1991).

Overall, the maximum level of safety awareness is 88%, where the workers are aware that all accidents at the workplace must be reported to responsible persons.

Conclusion

Industrial development seems to be going towards further globalization, with mining industry requiring an increased flexibility of production to cater for continuous speedy changes in the future. Safety awareness, highly related with safety culture in this industry, besides good safety management is important. The findings of the study are useful for intervention programme on improving the level of safety awareness among quarry workers. The companies must play a particularly important role in establishing more safety programmes in order to improve safety awareness and induce good safety common sense among the workers.

Acknowledgement

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Table 3 : The Percentage of respondents distribution on safety awareness

	N	TD (%)	D (%)	NS (%)	A (%)	TA(%)	Mean	SD
Health and safety suggestion given consideration and used.	58	0.0	1.7	41.4	41.4	15.5	3.71	0.749
I obey all the safety rule stated at the workplace.	58	0.0	3.4	17.2	56.9	22.4	3.98	0.737
I am focused and I give full attention during completing my task.	58	0.0	0.0	13.8	46.6	39.7	4.26	0.690
All accidents will be reported to responsible persons	58	1.7	1.7	8.6	48.3	39.7	4.22	0.817
All PPE provided will be used suitably with the task given.	58	0.0	3.4	19.0	44.8	32.8	4.07	0.814
I do my work by following the safe operation procedure provided by the company.	58	0.0	1.7	12.1	56.9	29.3	4.14	0.687

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Survey on employers' commitment towards OSH and its implementation in the metalworking industry

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Abstract

The accident rate in metalworking industries does show a slight reduction over the years. However, it is still so much higher compared to those of the other industries. Despite the various incentives provided by the government of Malaysia to improve this situation, the problems still remain. Therefore, this paper aims to investigate the commitment and implementation of occupational safety and health (OSH) aspect in the metal working industries. A survey was carried out by posting a total of 550 questionnaires to metal manufacturing companies throughout Malaysia. As many as 131 questionnaires were returned and a statistical analysis was done. Results of the analysis show that the employers' commitment for safety operations is high but the implementation of OSH programmes is poor due to lack of resources and OSH knowledge.

Keywords: SME; OSH; metal working; survey; operational problems, continuous improvement.

Introduction

It is well accepted by many safety practitioners that "*poor*" occupational safety and health (OSH) performance within small and medium enterprises (SMEs) is associated with poor commitment to OSH, focus on productivity and limited resources (Surienty, 2012). These factors, in theory, make the occupational safety and health OSH aspect seriously compromised at the workplace. However, this is only an opinion which is not supported by proper research data. Therefore, this survey aims to investigate the commitment and implementation of OSH aspect in the metal working industries.

Research Methodology and Questionnaire Development

The assessment of OSH commitment and its implementation at the workplace can be done by the aid of a questionnaire survey. In this study, the questionnaires were constructed based on the research objectives. The contents of the questionnaire were discussed with academicians and senior safety professionals from the industries. The questionnaires were designed and developed to take into account the possible factors that might affect the OSH organization at work including confidence in OSH, commitment, involvement, training, quality and productivity. A good questionnaire should be carefully designed by considering among others the following criteria: (a) Questionnaire should be completed by respondents in around ten to fifteen minutes; (b) Use basic and easily understood words and sentences; (c) Design questions with positive and negative rankings, opinions, etc.; (d) Design questions related to what is to be learned from the sampling group.

In this research, respondents were asked to give their preference on a 4-point Likert scale in order to evaluate the their level of agreement with each item. Most of the items were phrased positively and a few items negatively so that strong agreement in the former and strong disagreement in the latter resulted in a higher score in favour of safety for the concerned item. A minimum of 550 sets of questionnaire were sent by post to metal manufacturing companies throughout Malaysia based on the SMIDEC database. According to sampling size given by Cochran (1963), for a large population, the minimum sample size for all SMEs in Malaysia is 400. Data collected from questionnaires was analyzed using the *Standard Package for Social Sciences (SPSS)* version 21.0 (Coakes & Steed, 2007)

Results and discussion

Out of 550 sets of questionnaire sent to the metal companies, about one third of them (185 sets) were returned to the senders because of wrong or not-up-to-date company address. It shows that SMIDEC data was out dated. Only about 131 respondents answered our survey giving 36% rate of return, acceptable for this kind of research. The respondents' answers were compiled and analyzed systematically. Large majority (67%) of the respondents are employers or employers' representatives and most of the companies (59%) are classified as small size industry with the number of employees around 6 to 40 persons.

Employers' belief in OSH Commitment

This section discusses the findings of employers' belief and commitment towards OSH. A total of ten (10) OSH aspects related to policy development, accidents prevention and the importance of a safe working environment were questioned. Figure 1 shows that, large majority (81%) of respondents agree that by implementing proper OSH, the workers' awareness, productivity and quality of work will increase. In practice, OSH is their top priority and good for the business. This finding is in agreement with the normal perception of the safety practitioners in SME. The finding also gives hope to the government agencies such as DOSH, SOCSO and SMEDEC that SMEs accepted the concept and pillar of OSH for the safe operation and sustainability of the business. Through this OSH believes, proactive action plans for continuous improvement of OSH in the metal working industry could be enhanced.

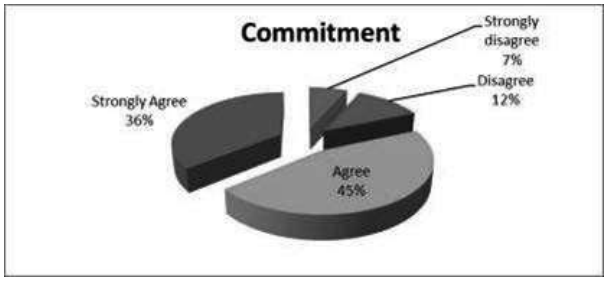

Figure 1: Employers' confidence in OSH Commitment

Employers' involvement in OSH

In this section, a total of 10 questions were developed to measure the involvement of employers in OSH aspects in their companies. Questions are related to OSH programmes at the workplace such as hazard identification, risk assessment and risk control of the hazard; safe operating procedure (SOP) and others. Figure 2 shows that 73% of respondents agreed for the management be involved actively in OSH programmes. However, based on the specific questions on OSH elements, the quality of OSH programmes or activities implemented is substandard. For example, a company has a safety and health policy, but it is not signed, a non-compliance to the minimum requirement stated in the OSHA 1994. In this situation, the level of OSH knowledge and exposure of the SMEs is questionable. Majority of the respondents declared that their OSH implementation is simple, not well planned and properly organized. Further study on this aspect is needed.

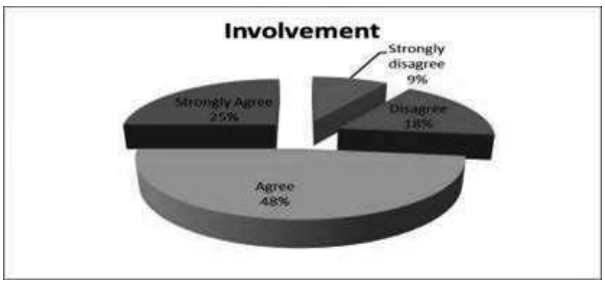

Figure 2: Employers' involvement in OSH

OSH Training

Well planned training and dissemination of OSH information to the employees are very important to support the OSH implementation in the metalworking industry. Therefore, six questions were developed to measure the OSH training implementation at the workplace. Figure 3 shows that about 73% of respondents agree that their employees are well trained and competent to perform their work safely. However, majority of the training sessions are done "*verbally*". No specific or formal training is given on OSH although the focus of the training is very practical, based on "*learn by doing*". In practice, new employees undergo a minimum of ten days of basic training i.e. on-the-job training with close monitoring by the seniors. Normally, new comers work as helpers for several months before they are allowed to handle metalworking machines alone. In summary, the finding provides a clearer picture what really happens in the SMEs and generates a better understanding on the weaknesses of OSH implementation in this sector. Proper OSH plan could be created to overcome these weaknesses.

Figure 3: OSH Training

Quality

This section gives the findings of the survey on the relationship of working environment quality to OSH performance. Seven questions about quality of working environment were developed especially on machine layout and positioning as well as a safe distance. Figure 4 shows that, 87% of respondents agree that their current

working environment is well designed. Majority of employers believe that good working environments are the best way to prevent accidents. It will increase the moral of the workers, which will result in high compliance to OSH requirements. However, some OSH aspects can still be improved further such as the quality of maintenance, repair works, planning and work scheduling. At the moment, most of the machines lack OSH documentation and written record keeping. This aspect is crucial for product quality and productivity as well as work planning.

Figure 4: Quality

Productivity

In this section, seven questions were developed to identify the relationships between productivity and OSH implementation in the metalworking industry. Figure 5 shows that, 87% of respondents agree that practising good OSH will boost the company productivity. However, it required proper work scheduling and planning. Poor planning and support system such as preventive maintenance and safe system of work will produce low product quality and affect the machine availability for production.

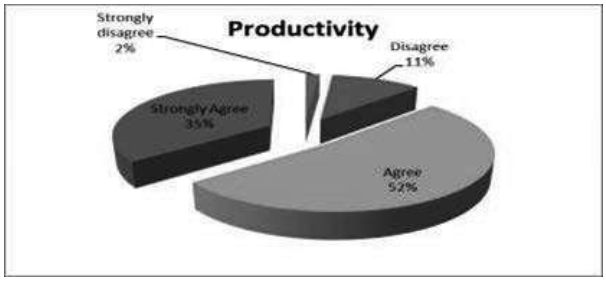

Figure 5: Productivity

Results and Conclusion

The questionnaire survey on the OSH commitment and its implementation among employer in the metalworking industry was successfully carried out. The focus of the survey was to measure the commitment, involvement, training, quality, productivity and belief in OSH. Clear relationships of these five elements with OSH performance were established. As shown in Figure 6, all respondents provided a positive response to the questionnaire. Majority of respondents (i.e. factory owners) are committed to OSH. In average, 80.2% of respondents believe that a good OSH implementation is needed for safe operations. This shows that the perception of safety practitioners that "*poor*" OSH performace within SMEs is associated with poor commitment to OSH is not true. Employers' confidence in OSH commitment is very important as an approach for accident prevention. Therefore, the accident rate in the metalworking sector can be reduced in the future.

The result of the analysis also confirms that the SMEs give more focus to quality and productivity (both 87%) as compared to OSH involvement and training (both 73%). Unbalanced approach in daily SMEs operation, indirectly affects the time and resources allocated for OSH. As a result, poor quality of OSH program is implemented on site.

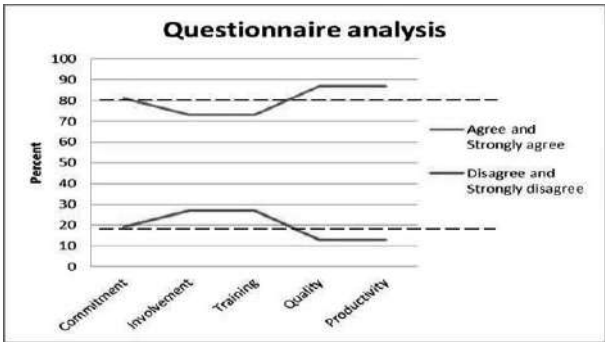

Figure 6: Questionnaire analysis

In conclusion, the survey confirms the factory owners' belief and commitment to OSH. However their main focus is still on product quality and productivity that compromise the OSH implementation on site. Due to lack of OSH knowledge, exposure and resources, poor OSH implementation has been recorded in the SMEs. These weaknesses can be corrected by developing a simple yet practical total OSH management system specifically for SMEs.

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Pendekatan Dalam Mempromosikan KKP Di Kalangan Pekerja Sektor Penanaman Padi Di Selangor.

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Abstrak

Pemprosesan padi adalah salah satu daripada sektor pertanian yang terbesar di Malaysia. Kekerapan kemalangan di tempat kerja yang berlaku dalam sektor ini berpunca daripada pelbagai faktor. Antara faktor utama ialah tahap pengetahuan dan kemahiran tentang keselamatan dan kesihatan pekerjaan (KKP) yang rendah. Objektif kajian ini adalah untuk menilai tahap pengetahuan KKP dan hubung kait antara tahap pengetahuan dan amalan pekerja berkaitan KKP dalam sektor ini. Seramai 300 orang responden yang terdiri daripada petani dan pemilik sawah padi di Sungai Besar, Selangor dipilih untuk menyertai kajian ini. Penyelidik menggunakan pendekatan soal selidik dalam mengumpulkan data kajian. Nilai Cronbach Alpha didapati daripada ujian kebolehpercayaan menggunakan perisian SPSS 20.0. Hasil kajian nenunjukkan bahawa jumlah responden tertinggi adalah seramai 138 orang yang bertugas membaja dan meracun. Selain itu, seramai 254 responden mengetahui cara bekerja dengan betul dan selamat. Manakala, seramai 242 responden mengetahui bahawa bahan kimia boleh meresap ke dalam kulit, mulut, sistem pernafasan dan seterusnya mata. Hasil kajian mendapati responden yang terlibat mempunyai tahap pengetahuan memuaskan tentang pendedahan risiko fizikal dan pendedahan risiko kimia terhadap tubuh badan mereka serta peralatan perlindungan diri yang diperlukan. Walau bagaimanapun, terdapat segelintir responden yang tidak peka untuk meletakkan amaran semasa proses menyembur racun dan membaja.

Pengenalan

Kemalangan di tempat kerja sering kali menjadi isu utama yang sering kali dilaporkan. Walau bagaimanapun, isu ini hanya diberi tumpuan dalam sektor perkilangan dan pembinaan. Industri pertanian juga merupakan penyumbang terbesar kepada ekonomi negara. Dalam penyelidikan kali ini, penekanan lebih ditumpukan kepada sektor pertanian kerana sektor pertanian merupakan sektor yang penting bagi negara membangun seperti Malaysia. Berdasarkan statistik kemalangan yang dikeluarkan oleh PERKESO pada tahun 2009, sektor pertanian, perhutanan dan perikanan menyumbang sebanyak 5 peratus dan merupakan sektor keenam tertinggi daripada sebelas sektor di Malaysia. Sektor pertanian juga tertakluk kepada Akta Keselamatan dan Kesihatan Pekerjaan, 1994.

Walaupun secara relatifnya bilangan kemalangan dalam sektor ini masih kecil, namun sektor pertanian merupakan antara sektor yang mempunyai bilangan tenaga pekerja paling ramai iaitu 1.5 juta orang *(Labour Force Survey Report Q2, 2008)*. Kajian ini dijalankan bagi mengkaji kaedah yang lebih signifikan dan efektif bagi mempromosikan KKP dikalangan pekerja khususnya dalam pemprosesan padi. Pengenalan terhadap KKP perlu dilakukan dan ditekankan kepada pekerja di sektor pertanian padi supaya kemalangan di tempat kerja dapat dielakkan.

Kaedah Kajian

Lokasi Dan Reka Bentuk Kajian

Kajian pendekatan dalam mempromosi KKP di kalangan pekerja sektor penanaman padi di Selangor telah dijalankan selama 2 bulan setengah bermula pada awal September 2012 sehingga pertengahan November 2012. Peserta kajian ini terdiri daripada petani-petani dan pemilik sawah padi yang bekerja dalam sektor penanaman padi di Sungai Besar, Selangor. Pengumpulan data telah dilakukan dengan menemuramah peserta mengunakan borang soal selidik. Seramai 300 responden berjaya dipilih untuk menyertai kajian ini.

Instrumen Kajian

Data yang dikumpul berpandukan kepada borang soal selidik dalam mempromosikan KKP di kalangan pekerja sektor penanaman padi. Borang soal selidik ini terbahagi kepada 6 bahagian iaitu data dermografi, pendedahan risiko fizikal, pendedahan risiko kimia, peralatan perlindungan diri dan kaedah mempromosi. Untuk menentukan sama ada borang soal selidik yang telah direkabentuk adalah sahih dan konsisten, nilai *cronbach alpha* dikira menggunakan *reliability test*

melalui perisian SPSS. Pilot study telah dijalankan dan responden yang dipilih terdiri daripada kakitangan NIOSH. Setelah dianalisis, nilai *cronbach alpha* untuk borang soal selidik pendekatan dalam mempromosikan KKP dikalangan pekerja sektor penanaman padi adalah sahih dan konsisten iaitu r = 0.76 .

Hasil Dan Perbincangan

Data Demografi

Item bagi maklumat dermografi termasuk jantina, umur, taraf pendidikan, pengalaman bekerja dan pekerjaan. Profil bagi setiap item dianalisis dalam bentuk jadual di bawah. Merujuk pada Jadual 1, responden lelaki adalah seramai 285 orang manakala responden perempuan pula seramai 25 orang. Hasil analisis menunjukkan jumlah responden paling ramai terdiri daripada golongan yang berumur 50 tahun keatas iaitu seramai 97 responden. Jumlah responden paling sedikit berumur antara 20-30 tahun seramai 64 orang. Merujuk pada Jadual 1, jumlah responden paling tinggi terdiri daripada golongan yang berpendidikan sekolah menengah. Golongan ini diwakili oleh 192 responden. Selain itu, majoriti responden terdiri daripada golongan yang berpengalaman bekerja 8 tahun keatas. Golongan ini diwakili oleh 183 responden. Seramai 66 responden bekerja antara 2-4 tahun manakala golongan yang berpengalaman bekerja antara 5-7 tahun, adalah seramai 61 orang. Data menunjukkan jumlah responden yang paling tinggi seramai 138 orang iaitu yang bertugas membaja dan meracun. Jumlah responden paling sedikit adalah seramai 2 orang, yang melakukan kerja meracun dan mengendalikan mesin.

Pendedahan Risiko Fizikal

Carta bar di bawah menunjukkan taburan kekerapan responden mengikut kaedah pendedahan risiko fizikal melalui 8 soalan yang berlainan. Objektif kajian adalah untuk mengenalpasti tahap pengetahuan KKP pekerja disektor pemprosesan padi. Analisis ini di selidik melalui 4 skala, iaitu sangat tahu, tahu, tidak pasti dan tidak tahu. Berdasarkan 8 soalan, soalan C1 merupakan cara bekerja dengan selamat iaitu seramai 254 responden. Manakala soalan C8 menunjukkan responden yang paling rendah iaitu seramai 191 responden yang mengetahui bahawa mereka perlu mendapatkan latihan dan kemahiran yang betul dalam mengendalikan mesin serta alatan.

Pendedahan Risiko Kimia

Carta bar di bawah menunjukkan taburan kekerapan responden mengikut kaedah pendedahan risiko kimia melalui 10 soalan yang berlainan. Soalan D9 menunjukkan tahap pengetahuan responden yang paling tinggi iaitu seramai 242 responden. Ini menunjukkan responden mengetahui bahawa bahan kimia boleh meresap kedalam kulit seterusnya penyebaran bahan kimia di udara boleh meresap kebahagian mulut, hidung dan mata. Manakala soalan D5 menunjukkan seramai 121 responden yang paling sedikit mengetahui bahawa mereka perlu meletakkan tanda amaran semasa proses penyemburan racun.

Peralatan Perlindungan Diri

Carta bar dibawah menunjukkan taburan kekerapan responden peralatan perlindungan diri melalui 3 soalan yang berlainan. Seramai 253 responden mengetahui tentang pemakaian penutup hidung dan goggle semasa

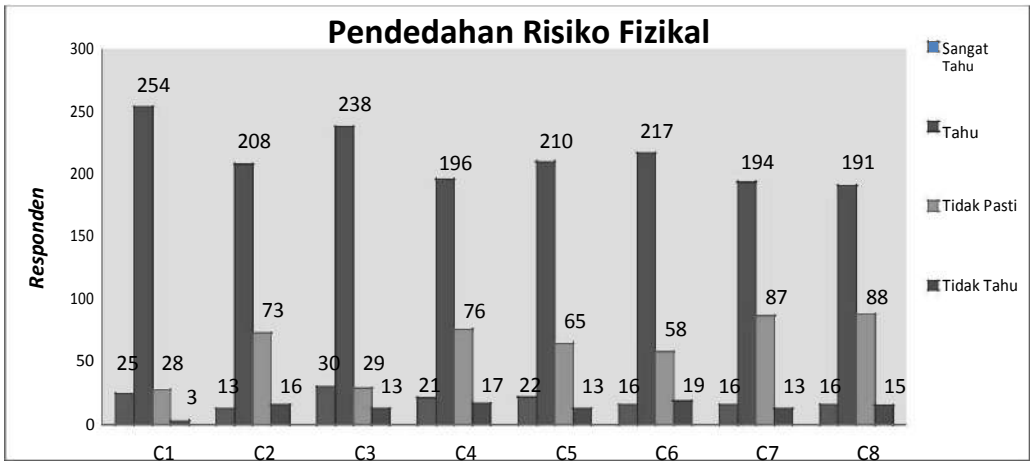
Kriteria	Kriteria Demografi	Bilangan
Jantina	Lelaki	285
	Perempuan	25
Umur	20 – 30 tahun	64
	30 – 40 tahun	76
	40 – 50 tahun	73
	50 >	97
Taraf Pendidikan	Tidak Bersekolah	14
	Sekolah Rendah / UPSR	72
	Sekolah Menengah	192
	Institut / Kolej / Universiti	32
Pengalaman Bekerja	2 – 4 tahun	66
	5 – 7 tahun	61
	8 tahun ke atas	183
Bidang Tugas	Membaja	32
	Meracun	11
	Mengendali Mesin	17
	Membaja / Racun	138
	Baja / Racun / Mesin	95
	Meracun / Mengendali Mesin	2
	Lain – lain	15

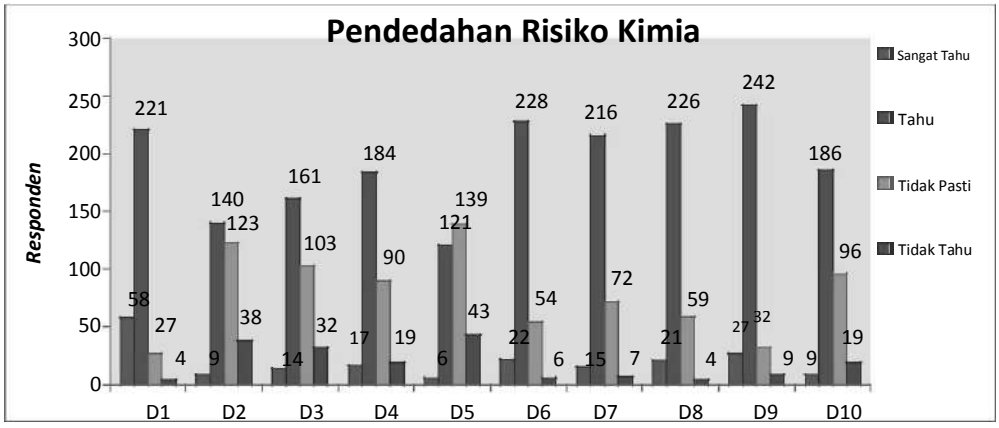
Jadual 1: Bilangan data demografi.

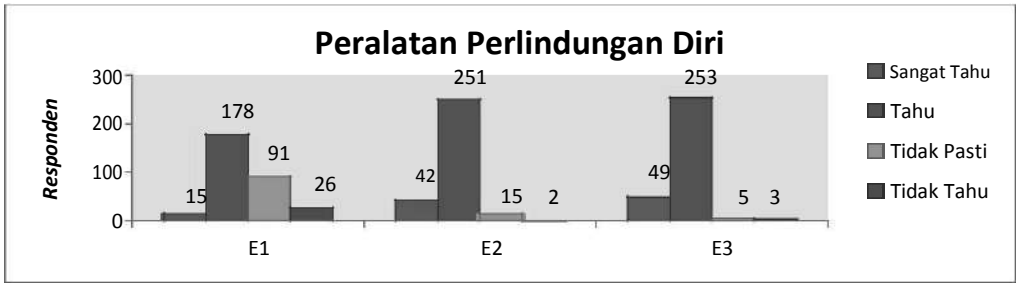
meracun dan membaja. Walau bagaimanapun, jumlah responden yang mengetahui tentang penggunaan pelindung telinga semasa mengendalikan mesin yang mengeluarkan bunyi kuat hanya 178 orang.

Hubungan antara KKP dan Sosio demografi

Ujian Pearson Chi-Square telah dijalankan bagi mengetahui nilai signifikan bagi setiap perhubungan antara pengetahuan kesihatan dan keselamatan pekerjaan (KKP) terhadap sosio demografi. Perhubungan antara pendedahan risiko fizikal dan pendidikan menunjukkan perhubungan statistik yang signifikan iaitu nilai p lebih kecil daripada 0.05. Ini menunjukkan bahawa tahap pengetahuan responden terhadap pendedahan risiko fizikal adalah baik. Berdasarkan analisis yang dijalankan, kesemua soalan bagi perhubungan antara pendedahan risiko fizikal dan tugasan kerja mempunyai perhubungan statistik yang signifikan. Ini menunjukkan bahawa tugasan kerja yang dilakukan pada setiap hari dapat memberi pendedahan risiko fizikal terhadap diri mereka. Perhubungan antara pendedahan risiko fizikal







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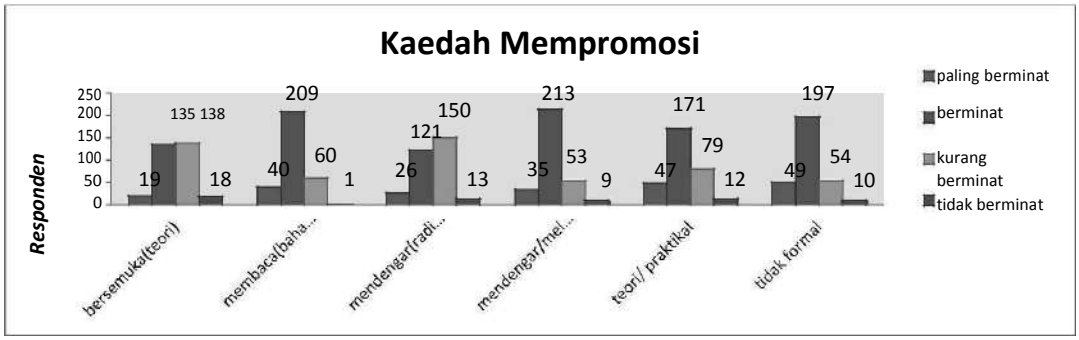

dan tahun bekerja menunjukkan hanya 4 daripada 8 soalan mempunyai perhubungan statistik yang signifikan. Walaupun responden telah lama berkhidmat dalam bidang ini, mereka tidak mengetahui tentang risiko fizikal terhadap diri mereka sendiri. Berdasarkan perhubungan antara pendedahan risiko kimia dan pendidikan, hanya 6 daripada 10 soalan yang mempunyai perhubungan statistik yang signifikan iaitu nilai p lebih kecil daripada 0.05. Hasil kajian menunjukkan bahawa responden mengetahui tentang tahap pengetahuan pendedahan risiko kimia terhadap diri mereka sendiri. Perhubungan antara pendedahan risiko kimia dan tugasan kerja menunjukkan hanya separuh daripada soalan mempunyai perhubungan statistik yang signifikan. Hasil kajian mendapati walaupun responden bekerja setiap hari, tetapi mereka tidak mengetahui tentang pendedahan risiko kimia. Berdasarkan perhubungan antara pendedahan risiko kimia dan tahun bekerja, hanya 3 daripada 10 soalan sahaja yang mempunyai perhubungan statistik yang signifikan. Kajian mendapati responden tidak didedahkan tentang risiko bahan kimia terhadap diri mereka. Perhubungan antara peralatan perlindungan diri dan pendidikan kerja menunjukkan kesemua soalan mempunyai perhubungan statistik yang signifikan. Kajian mendapati kesemua responden mengetahui cara menggunakan peralatan perlindungan diri dengan betul. Selain daripada itu, perhubungan antara peralatan perlindungan diri dan tugasan kerja menunjukkan perhubungan statistik yang signifikan iaitu nilai p lebih kecil daripada 0.05. Hasil kajian mendapati responden mengetahui teknik menggunakan peralatan perlindungan diri semasa menjalankan tugasan kerja mereka. Di samping itu, perhubungan antara peralatan perlindungan diri dan tugasan kerja mendapati terdapat 2 daripada 3 soalan mempunyai perhubungan statistik yang signifikan.

Kaedah mempromosi terbaik di kalangan pekerja penanaman padi

Carta bar diatas menunjukkan taburan kekerapan responden berdasarkan kaedah mempromosi mengikut kaedah bersemuka, membaca, mendengar, melihat, teori/ praktikal dan tidak formal. Analisis ini di selidik melalui 4 skala, iaitu paling berminat, berminat, kurang berminat dan tidak berminat. Kaedah yang diminati oleh responden ialah kaedah secara mendengar dan melihat iaitu seramai 248 responden. Manakala, kaedah membaca adalah seramai 249 responden dan kaedah secara tidak formal meliputi 246 responden. Kaedah yang kurang diminati oleh responden ialah kaedah secara mendengar iaitu seramai 163 responden dan kaedah secara bersemuka seramai 156 responden.

Kesimpulan

Daripada hasil analisis, objektif dalam menilai tahap pengetahuan pekerja terhadap pendedahan risiko fizikal, pendedahan risiko kimia dan peralatan perlindungan diri mendapati bahawa peratusan responden melebihi 50 %. Ini menunjukkan bahawa responden mempunyai pengetahuan yang bagus tentang pendedahan risiko fizikal, pendedahan risiko kimia dan peralatan perlindungan diri terhadap tubuh badan mereka. Walaubagaimanapun untuk pendedahan risiko kimia, masih ada responden yang tidak tahu bahawa mereka perlu meletakkan tanda amaran semasa proses menyembur racun/membaja.

Bagi objektif untuk menentukan perhubungan antara pendedahan risiko kimia/peralatan perlindungan diri dengan tahun bekerja, hasil ujian Pearson Chi-square tidak menunjukkan perhubungan statistik yang signifikan. Ini menunjukkan walaupun responden sudah lama bekerja, mereka masih tidak tahu tentang pendedahan risiko kimia dan cara penggunaan peralatan perlindungan diri.

Daripada hasil analisis yang dijalankan terhadap kaedah mempromosi, kaedah yang diminati oleh responden ialah kaedah secara mendengar/melihat iaitu seramai 248 responden dan kaedah membaca adalah seramai 249 responden. Ini menunjukkan kaedah mendengar, melihat dan membaca merupakan kaedah yang terbaik bagi mempromosikan keselamatan dan kesihatan pekerjaan dikalangan pekerja sektor penanaman padi di Selangor.

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Perception Study On Compliance Of Noise Exposure Control In Quarrying Industry In East Coast Of Malaysia

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Abstract

This study focused on noise exposure in quarrying industry. Quarry is one of the industries that have an exposure of noise in particular processes. The quarries machinery noise is produced when the machines are running, but the noise generated by the machines in the production environment includes both process-generated and machinery-generated noise. Survey method was used by distributing questionnaires comprising five parts which are, demography, safety and health awareness, safety and health knowledge, safety and health compliances and compliances toward noise exposure. However, the study emphasized only on the compliances toward noise exposure in quarrying industry. Cronbach alpha (α) was used for the reliability of questionnaires. The study found that the mean value for the perception of workers to noise control method compliances is 3.09 which indicates moderate compliances. It was shown that, the total number of NIHL cases reported is related to the compliances of noise exposure control measures. Compliance is one of the main factors to reduce NIHL among workers. For further development of methods for controlling noise exposure, other studies can be done to find other information or methods on how to ensure that the related organizations in quarrying industry give their commitment in compliance to noise control methods.

Keywords: quarrying industry, noise exposure, compliances

Introduction

Noise as an unpleasant sound which disturbs the human being physically and physiologically and cause environmental pollution by destroying environmental properties (Atmaca *et al*., 2005). Noise is also defined as unwanted sound and it is one of the most common occupational and environmental hazards but it is usually under estimated (Humeda and Saeed, 2008). Noise is one of the more widely and frequently experienced problems of the industrial working environment (Salman, 2003). From the exposure of excessive noise it will lead to several effects to workers. There are adverse health effects of noise on humans and there are hearing impairment, interference with spoken communication, sleep disturbances, cardiovascular disturbances, disturbances in mental health, impairment task performance, and negative social behaviour and annoyance reactions (Ouis, 1982). Noise has interferences with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps, and behavioral changes. These include problems with concentration, fatigue, uncertainty, lack of self-confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships, and stress reactions (Goines and Hagler, 2007). Besides, noise also affects human judgment and performance (Langdon, 1976). Occupational disease reported to Department Safety and Health (DOSH) from 2009 until 2013 is as shown in Table 1. From the table, Noise Induced Hearing Loss (NIHL) reported in 2010 is the highest (14 cases). It dropped to only one case in 2011, increased again to seven cases in 2012, and dropped to three cases in 2013, all totalled to 26 cases of NIHL for the last five years. Furthermore, in the last 5 years, NIHL is the highest occupational disease that has been reported. Therefore, it can be concluded that noise exposure in quarrying industry is high and it needs to be controlled.

In industry, quarry is one of the industries that have an exposure of noise. Some researchers found that quarries machinery emitted noise when the machines are running but the noise generated by machines in the production environment includes both process-generated and machinery-generated noise (Roy *et al*., 2007). Noise and vibration are normally related with processes in quarry such as rock drilling. In this process, redesigning has been made on compressors and drills, but the exposures may still exceed 90 dBA (Burgess, 1995). The health and safety issues involved in such operation include noise, vibration, heat and dust (Burns *et al.*, 1962). Some machineries such as jack hammers, obviously generate a high level of noise caused to the workers or operators (Vardhan et al., 2006). Previous studies stated that, some types of crushers are cone and jaw. Primary crushers break large rock into smaller sizes, while secondary and tertiary crushers are used to break aggregates into smaller aggregates. The crusher is

Table 1: Statistics of Occupational Disease in Mining and Quarrying Sectors From 2009 To November 2013

No.	Year	2009	2010	2011	2012	2013	
	Sector	Quarrying/ Mining	Quarrying/ Mining	Quarrying/ Mining	Quarrying/ Mining	Quarrying/ Mining	TOTAL
	Diagnosis						
1	Occupational Lung Disease (OLD)	1	3	2	2		**8**
2	Occupational Skin Disease (OSD)						
3	Occupational Noise Induced Hearing Loss (NIHL)		14	1	7	4	**26**
4	Occupational Muscular – Skeletal Disorder (OMD)						
5	Occupational Poisoning						
6	Disease Caused By Physical Agent						
7	Disease Cause By Biological Agent						
8	Occupational Cancer						
9	Psychosocial Problem						
10	Other Types Of Occupational Disease						
11	Non Occupational disease						
TOTAL		**1**	**17**	**3**	**9**	**4**	**34**

Source: Occupational Disease Department, Department of Occupational Safety and Health, Ministry Of Human Resource

run by a crusher operator who usually stays inside the operator's booth. The process produced a high level of noise (Mutlu, 2010). Channel burner used in quarry to cut the rock, produces the maximum noise exposure, between 118 dBA to 112 dBA when cutting is started. The minimum noise exposure produced is between 114 dBA to 116 dBA. Although, with a 20 dBA reduction with ear muff, the workers still have an exposure above 100 dBA (Burgess, 1995). The study was conducted to know the perception of workers towards noise exposure in quarrying industries and to know the management support to control the exposure.

Materials & Methods

The study involved 12 companies selected in East Coast of Malaysia which covered Kelantan, Terengganu and Pahang based on random selection. The respondents consisted of 58 males and females. Survey method was used to gain the data from respondents and questionnaires were distributed. The survey consists of five parts. (1) demography, (2) safety awareness, (3) safety knowledge, (4) safety compliances, (5) noise exposure. However, this study focused only on part five related to noise exposure. Demographic data was obtained consisting of respondents' name, age, gender, level of education, position, task of position, duration of working experience, salary and basic knowledge of occupational safety and health. The respondents were interviewed to answer all the questions. For survey design, Likert –type scales multiple choice items were used (Rodeghier, 1996). The questionnaires focused on the compliances of management toward noise exposure The data was analyzed by computing the mean of each answer question by using Statistical Package for Social Science (SPSS).

The computed mean from respondents' answers were categorized into the categorizing framework as in Table 2. The range of means that form the categorizing framework was calculated based on mid – point method (Teh and Tan, 2003).

Table 2 : range of means of safety practice

Scale	Lower range	Upper range	Range of mean	Level of practice
1	0	— + 1 = 1.5	0 – 1.5	Very low
2	— - 2 = 1.5	— + 2 =2.5	1.6 – 2.5	Low
3	— - 3 = 2.5	— + 3 = 3.5	2.6 – 3.5	Moderate
4	— - 4 = 3.5	— + 4 = 4.5	3.6 – 4.5	High
5	— - 5 = 4.5	5	4.6 – 5.0	Very high

Reliability test was conducted to ensure the validity of results, using Cronbach's alpha (α) value and the score must be more than 0.7.

Results

In this phase the characteristic of samples were characterized based on the demographic data. Table 4 shows the characteristic of samples.

The reliability of the survey questions were analyzed by Cronbach's alpha (α) derived from the average correlations of all the items on the scale. Reliability test is based on three parts of questions which are knowledge, awareness and compliances of safety practices on noise exposure. Results of the reliability test are shown in Table 5.

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Table 6 shows the means value of safety and health practices in quarry that have been studied in quarry industry. Based on the Table 6, the overall safety and health awareness level among quarry workers is at 3.37 which is at the moderate level, indicating that the safety awareness in this industry has not achieved the satisfactory level. Lack of safety awareness among the quarry workers can cause unwanted occurrence to happen (Guo Wei Ci and Wu Chap, 2010). This finding on the awareness level among quarry workers indicated that the management should improve the safety and health programmes to ensure that the awareness among workers is at the optimum level.

Besides, safety and health knowledge level among workers is at 3.31 (moderate level), failing to achieve the satisfactory level. Knowledge of safety is very important in order to create a safe working environment and increase the awareness of safety. Insufficient knowledge will cause accidents (Joy, 1999). Many accidents occur in quarry industry because the workers were unaware of the rules, having misunderstanding about the safety

Table 4: Characteristics of Samples

Characteristics	Category	Frequency	Percentage (%)	Mean±SD
Gender	Male	42	72.4	1.28±0.451
	Female	16	27.6	
Age	< 20	1	1.7	31.78±9.030
	20 – 29	30	51.7	
	30 – 39	14	24.1	
	40 – 49	11	18.97	
	>50	2	3.4	
Education	SPM	28	48.3	2.24±1.315
	Certificate	4	6.9	
	Diploma	10	17.2	
	Bachelor Degree	16	27.6	
Position	Employer	16	27.6	1.72±0.451
	Employee	42	72.4	

Table 5 : Reliability of questions based on Cronbach's alpha (α) value

Tested factors	Cronbach alpha (α)
Safety and health awareness	0.829
Safety and health knowledge	0.506
Safety and health compliance	0.791
Compliances toward noise exposure	0.883

Table 6 : Mean value for each part of questions

Questions	Means
Safety and health awareness	3.37
Safety and health knowledge	3.31
Safety and health compliance	3.18
Compliance toward noise exposure	3.09

operation procedure, not knowing the consequences if an accident happened and lack of education and training. Neal *et al*. (2000) in their study, believed that safety knowledge is the mediating factor which contributes to creating good safety environment at the workplace.

Meanwhile for safety implementation in this industry, the mean is at 3.18 which shows that element has been implemented as made compulsory in OSHA 1994. These results reflect their level of compliance towards OSHA 1994 since the questions asked in this section of implementation were referred to OSHA 1994. Mekos (2010) in his study in Thessaloniki stated that insufficient rules and regulations keep contributing towards accidents which happen at the workplace. Besides, good safety implementation starts with complying with acts and regulations (James *et al*,. 2013).

The mean value for compliances of management to control the exposure of noise in quarrying industry is 3.09 (moderate level). The level of compliances of noise exposure control did not achieve a satisfactory level. The management must take responsibility to ensure the workers are not exposed to high level of noise exceeding 90 dB (A). They must ensure that the noise from its sources must be reduced, adequate PPE and training must be provided to workers, noise monitoring must be conducted and audiometric test must be done to ensure the workers are protected and are not affected by high level of noise exposure such as hearing loss.

Table 7 shows only 17.2 % of the respondents totally agreed and 36.2 % agreed that noise assessments had been carried out by competent persons. While, only 17.2 % of the respondents totally agreed and 32.8 % agreed that hearing protectors were supplied and correctly worn by workers exposed to a high level of noise. Besides, only 3.4 % of the respondents totally agreed and 13.8 % just agreed. Only 8.6 % of the respondents totally agreed and 31 % agreed that all the information and training on noise hazards, effect and control were provided. For audiometric test programme for workers in quarrying industry, only 5.2 % totally agreed and 29.3 % agreed that audiometric tests for workers had been conducted. Furthermore, only 6.9 % totally agreed and 34.5 % agreed that there were appropriate actions taken when hearing loss happened. For raising of medical report, only 1.7 % among respondents totally agreed and 31 % agreed. Lastly, 10.3 % totally agreed while 37.9 % agreed that training were provided to develop awareness to noise hazards, effects and controls.

Conclusion

The industrial development will cause the quarrying industry to go further and there are improvements to be made in terms of production and safety and health as well. From this study, it can be concluded that the perception of workers toward safety and health awareness, basic knowledge and compliances are still at the moderate levels. The compliances towards noise exposure control

Table 7: The percentage of respondents' distribution on compliances to control noise

Questions	n	TD (%)	D (%)	NS (%)	A (%)	TA(%)	Mean	SD
Have noise assessments been carried out by competent persons	58	10.3	13.8	22.4	36.2	17.2	3.36	1.224
Hearing protectors supplied and correctly worn by workers who may be exposed to exceeded noise	58	5.2	13.8	31.0	32.8	17.2	3.43	1.094
There are complaints about insufficient hearing protectors	58	15.5	29.3	37.9	13.8	3.4	2.6	1.025
Information and training on noise hazards, effects and controls are provided	58	12.1	12.1	36.2	31.0	8.6	3.12	1.125
Audiometric test programmes for workers exposed to noise which exceeded the standards	58	13.8	13.8	37.9	29.3	5.2	2.98	1.100
Appropriate action taken when hearing loss happened	58	8.6	13.8	36.2	34.5	6.9	3.17	1.045
Medical report regarding hearing loss raised	58	15.5	10.3	41.4	31.0	1.7	2.93	1.057
Training provided to develop awareness to noise hazards, effects and controls	58	13.8	13.8	24.1	37.9	10.3	3.17	1.216

TD: Totally disagree; D: Disagree; NS: Not sure; A: Agree; TA: Totally agree

in this industry is also still at the moderate level. It was shown that, the total number of NIHL cases reported is related to the compliances of noise exposure control measures. Compliances are one of the main factors to reduce NIHL among workers. For further development of method for controlling noise exposure, other studies can be done to find other information or methods on how to ensure that related organizations in quarrying industry give their commitment in compliance with noise control methods.

Acknowledgement

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A Study of Occupational Noise Exposure Among Public Transportation Workers in Malaysia

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Abstract

Working for a minimum of 8 hours, 6 days a week might have exposed the workers of public transportation to high noise risks. However, occupational exposures in their workplace have not been adequately characterized and identified. Assessment of occupational noise exposure among workers at five public transportation stations was made using Sound Level Meter and through questionnaire survey. The data obtained was combined to estimate the work shift exposure level and health impacts to the workers by using statistical analysis. The respondents participated in the survey to identify the symptoms of noise-induced hearing loss and other health-related problems. Results of the study indicated that occupational noise exposure among workers for Mean Continuous Equivalent Level, Leq= 76.17 dB(A) presents small risks of developing a hearing disability. Some of the workers show symptoms of noise-induced hearing loss and are annoyed by the sources of noise present at the public transportation.

Keywords: Occupational noise exposures, public transportation workers, Mean Continuous Equivalent Level

Introduction

Sound is a sensory perception while noise corresponds to undesired sound. By extension, noise is any unwarranted disturbance within a useful frequency band (NIOSH, 1991). [1] Noise is present in every human activity, and when assessing its impact on human well-being it is usually classified either as occupational noise (i.e. noise in the workplace), or as environmental noise, which includes noise in all other settings, whether at the community, residential, or domestic level (e.g. traffic, playgrounds, sports, music). [1]

Noise could annoy people to have their normal healthy daily routine in life which life. Activities such as, studying, driving, communicating, playing, eating, sleeping and most importantly, working might cause the stress level of a person to increase. Noise is one of the most important occupational risk factors both in industry and transportation. [2] Exposure to continuous noise above the 85 dBA may lead to hearing loss. This loss is different from person to person and depends on the frequency of the noise and the duration of exposure. [3] People who work around the public transportation place could be facing a high risk of noise exposure. Listening to the sound of aero planes taking off, the sounds of buses coming in and going out of the stations and the sounds of the train arriving and departing from the train station, every day, almost 50 hours per week could be a factor of hearing loss which jeopardizes their healthy life.

Literature Review

Referring to the act applicable in Malaysia, the Factories and Machinery Act (FMA), 1967 and Occupational Safety and Health Act (OSHA 1994) the workers' exposures at the public transportation place were regulated. The National Institute of Occupational Safety and Health (NIOSH) recommended exposure limit (REL) of 85 dB (A) for occupational noise exposure for 8 hours average sound pressure level. The American Conference of Government Industrial Hygienists (ACGIH) also has recommended threshold limit values (TLV) for occupational noise. The TLV is exceeded when the dose is more than 100% or sound level of 85 dB (A) for 8 hours exposure.[4][5]

High noise levels can cause high blood pressure, high pulse rates, enhanced muscle reflexes and sleep disturbances. [6] The effect of high noise levels on hearing depends on factors such as noise levels, exposure time, noise frequency, individual sensitivity, environmental factors and physiological factors. The frequencies between 500 kHz to 4000 kHz are important for understanding human speech and high noise levels in these frequencies interrupt speech. [7]

Methodology

Place Selection

The aim of taking a measurement with a sound level meter is to evaluate the average exposure of workers to noise. There were five public transportation stations selected for the study, namely, KTM station, KLIA Express, LCCT Airport, Jalan Duta Bus Station, and Subang Skypark Airport.

Instrument: Sound Level Meter

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The instrument used in this study is Sound Level Meter. The configurations of the sound level meter are as follows:

- Measuring range: 30-130dBA
- Accuracy: ±1.5dB
- Frequency range: 31.5Hz to 8.5KHz
- Frequency weighting: A
- Digital display: 4 digits Resolution: 0.1dB .
- Sample rate: 2 times/second

Results and Discussion

Figure 1 shows a scatter diagram of Jalan Duta Bus station. The average of the data noise at Jalan Duta bus station is 74.5 dB (A). It presents small risks of developing a hearing disability.

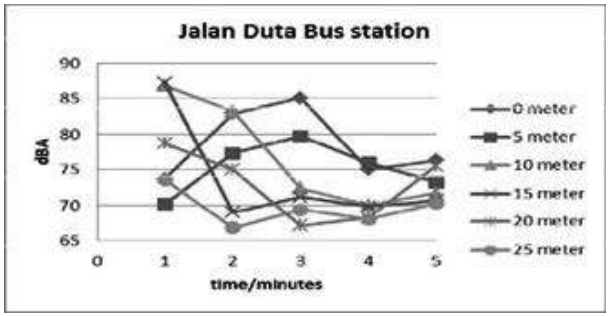

Figure 1: Scatter Diagram of Jalan Duta Bus station

Figure 2 shows a scatter diagram of LCCT Airport. The average of the data noise at LCCT Airport is 78 dB (A). It presents small risks of developing a hearing disability.

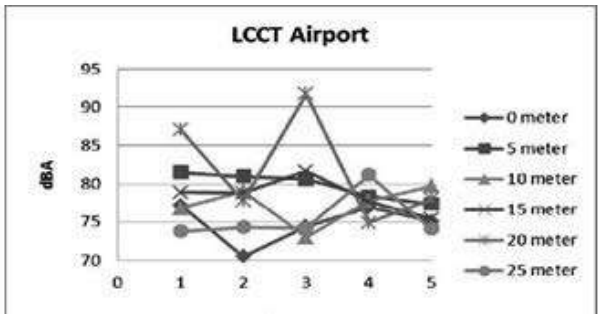

Figure 2: Scatter Diagram of LCCT Airport

Figure 3 shows a scatter diagram of KTM Bandar Tasik Selatan. The average of the data noise at KTM Bandar Tasik Selatan is 68.2 dB (A). It presents small risks of developing a hearing disability.

Figure 3: Scatter Diagram of KTM Bandar Tasik Selatan

Figure 4 shows a scatter diagram of KLIA Express Bandar Tasik Selatan. The average of the data noise at KLIA Express Bandar Tasik Selatan is 70.4 dB (A). It presents small risks of developing a hearing disability.

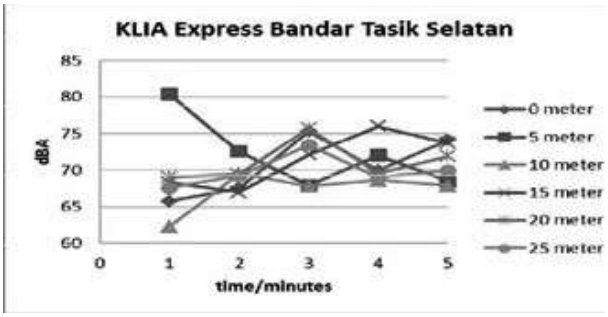

Figure 4: Scatter Diagram of KLIA Express Bandar Tasik Selatan

Figure 5 shows a scatter diagram of Subang Skypark Airport. The average of the data noise at Subang Skypark Airport is 89.79 dB(A). It presents considerably greater risks of developing a hearing disability.

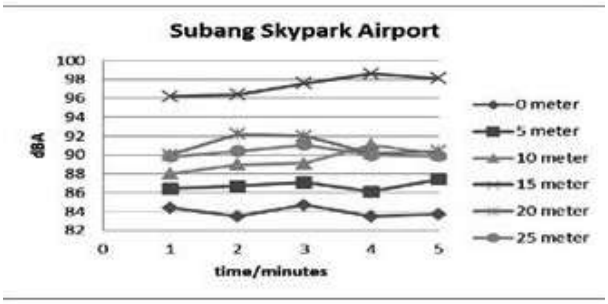

Figure 5: Scatter Diagram of Subang Skypark Airport

Conclusion

From the study it can be concluded that the highest sources of noise are emitted at the public transportation surrounding at the Subang Skypark Airport which is 89.79 dB(A).

Workers at public transportation appear to have substantial over exposure to noise. The most critical exposure was the peak level of sound emitted from the vehicles such as buses, taxi and construction area. Over exposure to noise will affect the health (hearing loss), while the level of noise was reported to cause significant

annoyance and disturbance to the task of workers. Based on the questionnaire results, majority of toll tellers experiences symptoms of NIHL. The controls of noise at the public transportation and construction area are highly recommended through the implementation of engineering or administrative noise control or the use of hearing protection that suitable with the tasks performed. Hearing Conservation Programmes should be established to prevent the risks of NIHL.

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Indoor Air Quality: Microbe and its relationship toward temperature, relative humidity and carbon dioxide concentration.

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Abstract

Indoor air quality is a term which refers to the air quality in and around buildings and structures, in which it is related to the health and comfort of those who are in the building. The study aims to identify the relationship between environmental factors with microbe growth by investigating the concentration of airborne bacteria and fungi at National Institute of Occupational Safety and Health (NIOSH) and to determine whether indoor bacteria and fungi concentration were associated with environmental factors such as temperature relative humidity and carbon dioxide concentration. This research was conducted concurrently with indoor air quality sampling as per requirement under the Malaysian Code of Practice of Indoor Air Quality (COP IAQ). The COP IAQ requires minimum of one sample to be taken from each area. If an area consists of a few separated rooms, each room is sampled and measured independently. Also this approach was used to determine whether there is a difference of indoor bacteria and fungi in different microenvironments. Results show that there is a significant correlation between humidity and bacteria concentration and fungi concentration; and between temperature and bacteria concentration. However, there is no significant correlation between temperature and fungi concentration. This study has also established significant difference on bacteria concentration and fungi concentration between microenvironments.

Keywords: Indoor Air Quality (IAQ), Microbe, Workplace, Microenvironment

Introduction

There is great concern about the potential health hazards of biological components in airborne particulate matter, particularly about the levels of allergenic of toxigenic fungi and their association with indoor air quality (Park et al. 2011). The quality of indoor air is considered to be very important since an average individual spends up to 85% - 90% of time indoors (ASHRAE 1992). According to Alsmo et al. (2007), inhalation is the major route of entry for airborne particulate, which may cause discomfort or disease to the occupant. People inhale approximately 10,000 liters of air in 24 hours, in consequences; we also inhale large quantities of airborne particulate matter including bacteria and fungi.

One of the indoor air major contaminants is microbe and it can be subgrouped into bacteria, fungi, dander, mites and virus. It can be inhaled by occupants and at later stage will cause health problems such as rashes, allergies and infection. The most common indication of building related infection is contagious disease which is spread through indoor air, especially in crowded environments (Ezeonu et al.1994). Common contagious disease which can easily spread in indoor air are influenza, common cold and tuberculosis. The growth of microbiology agents such as fungi and bacteria requires oxygen, which is generally found in damp environments. Water leakage, condensation on cold surfaces, poorly maintained drain pan, and wet foundation can easily become reservoir for microbe (Burge et al., 1998). Microbe can be brought into the indoor air from outside environment by human activity. Humans themselves can be the source of microbe if they carry airborne transmitted diseases such as tuberculosis, flue or fever. Small quantity of microbe in indoor air is a normal scenario, however if microbes are allowed to multiply and grow, they might cause nuisance odours and health problems to most of the occupants. Microbe growth such as bacteria and mold may also cause serious damage to building structure (Chern, 2005).

Most Malaysians spend most of their working time in indoor environment and basically building offices are equipped with air conditioning system to compensate hot, humid and contaminated outdoor condition. Poor maintenance of air-conditioning and ventilation system will cause accumulation of the contaminant in indoor environment. As concern about thermal comfort rather than ventilation, issue on ventilation of indoor air will not be addressed until the recirculation process that triggers complaints among the workers. Indoor contaminants such as microbe agent, dust and carbon

dioxide are generally generated from human activities. Some contaminants such as Volatile Organic Compound (VOC), ozone and formaldehyde are generated from building material and furniture. These contaminants if not controlled may cause indoor air quality problem and finally lead to Sick Building Syndrome (SBS) or Building Related Illnesses (BRI).

In the last decade, many studies have been conducted on microbe growth in indoor air environment. However, most of these studies were conducted in foreign countries, which have different climates than Malaysia. Many of these studies were able to find correlation between humidity and temperature with microbe growth in indoor environment but findings were not conclusive since few other researchers did not find correlation among the variables. Some researchers were more focused on the differences of microbe growth in microenvironment or on the identification of the bacteria. All these studies even though very well informed, cannot be directly used to infer local setting.

Hot and humid Malaysia's indoor air becomes an ideal environment of microbe growth; and as well as a great reservoir for transmission and spreading of contagious diseases. This contagious agent if brought into indoor environment might be easily proliferated and accumulated due to limited ventilation. Knowledge on microbe interaction with environmental factors such as temperature and relative humidity is very important in assisting building management to manage microbe in indoor air as well as sustaining pleasant and healthy environment for the occupants. Department of Occupational Safety and Health (DOSH) had published a Code of Practice of Indoor Air Quality (COP IAQ). This code emphasizes the need for employer to assess the risk arising from the indoor air quality at the workplace to the health of his employees (DOSH, 2005). Even though microbe has not been listed as one of the parameters to be measured in the COP IAQ, microbes are clearly listed as one of the parameters that need to be considered in indicating indoor air quality. Even though not compulsory, most of indoor air quality registered assessor voluntarily including microbe as one of the parameters measured in the indoor air quality assessment. This code of practice has become the primary reference for employer to perform indoor air quality assessment.

Literature Review

Health Effect Associated with Microbe

Generally, microbe in indoor air is associated with sick building syndrome or building related illnesses. Sick building syndrome is used to describe situations in which building occupants experience acute health effects or discomfort that appear to be linked to time spent in the building, but cause of the illness cannot be identified. Symptoms of sick building syndrome might include headache, eyes, nose, and throat irritation, dry cough, itchy skin, dizziness, nausea, difficulty in concentrating, fatigue as well as sensitive to odour. Basically, cause of the symptom is not known and symptom will be relief soon after leaving the building (EPA,1991).

Exposure to indoor fungi and their metabolites may occur through three main routes of entries: inhalation, dermal contact and ingestion. Among these three, inhalation plays the main role of transmission in indoor air environment. Some bacteria such as Streptococcus Pyogenes, Neisseria Meningitis, Corynebacterium Diphtheria and Mycobacterium Tuberculosis are known to be transmitted predominantly by droplet from infected people; and they may cause airborne nasocomial or respiratory infection (Sarica *et al*., 2002). Patients who are infected by this bacteria can easily be agents of tranmission once they entre indoor environment. Besides, some airborne bacteria were carried by dust which are introduced into the area by occupant shoes, through window opening or building works (Sarica *et al*., 2002, Schaal 1991; Hu *et al*., 2002). However, how readily a piece of fungi or spore becomes airborne depends on a degree of its size. The sizes of particle in most bioaerasol including spore are between 0.3 to 100 mm (Aydogdu *et al*., 2005). Since the microbeare are relatively very small they are generally very light in terms of aerodymanic density (AED) and very easy to become airbone; therefore increasing the possibility to be inhaled by occupants. In many areas, bioaerosol level is relatively high indoor where there are children, older people whose immunity are weaker than the general population (Kim *et al.*, 2001, Schall, 1991; Li *et al*., 1994). Due to this characteristic, inhalation is considered as a major route of entry for exposure to microbe.

Effect of Temperature and Humidity with Microbe Growth

Humidity is the water vapour within a given space or atmospheric moisture (Pearsal, 1998). In other words, reducing of temperature up to certain level will reduce formation of water vapour. Water in liquid form is introduced in bathroom, kitchen, and accidently by leaks and spill. Some of the water evaporates and enriches the vapour. The water content is also enriched by exhalation of building occupants. Since microbes require moisture to multiply; reducing humidity indirectly inhibits microbe growth in indoor air.

Most people in the office are comfortable when air temperature is about 22^{o}C and relative humidity level range between 30% to 60% (WorkSafe, 2009). Building management must compensate comfort requirement, in addition of controlling indoor air hazard. Arundel et al. (1986) recommended that relative humidity range from 40% to 60% as appropriate to control growth of viruses, fungi and mites. This range was established based on his studies which showed that most health effects increased severity either above 60% or below 40%. His finding was suported by Alsmo et al (2007) who found that the critical relative humidity necessary for microbe growth is more than 67%. According to Alsmo, the range of

relative humidity is more than 67%, which was also suggested by Johansson *et al*. (2005) and Grinbergs (1992). Furthermore, research conducted by Singh (1994) indicated that a relative humidity of within 75% to 85% is sufficient for microbe growth. He also claimed that bacteria do not multiply aggressively until the humidity is very high around 95% or if standing water is present. According to ASHRAE 1992:1999, several international standard identify an upper limit on relative humidity in building such range between 60% to 80% (Moon, 2003).

Microbe Growth in Microenviroment

Area for microbe sampling in this studies can be divided into three main microenvironment. The microenvironment includes accommodation rooms, training rooms and offices. The differences among the setting were anticipated; and to find the differences on the microbe growth in each microenvironment, Jo and Seo (2005) conducted a study on three microenvironments such as bars, internet cafe and elementary classroom. His finding indicated that indoor bacteria and fungi are higher in classroom compared with other two microenvironments. Higher activity in classroom might cause higher bacteria and fungi concentration in the area. His point of view is supported by Scheff *et al*. (2000) who found that human occupancy to be closely related to indoor microbial level.

Kim *et al*. (2007) in their study on bioaerasol conducted at seven building including hospital, kindergarten and senior care centre. They did find a positive correlation between bacteria and fungi growth with human activities. They also found correlation between bacteria and fungi growth with carbon dioxide level. Carbon dioxide is a byproduct of human metabolism, which can be one of the indicators of human activities. Besides, Kim's result showed that kindergarten, represents the highest reading of fungi followed by hospital and old care centre. Again due to intense activity conducted at kindergarten, resulting in high number of microbes in the air. Beside that, they did mention that cleanliness activity at old care centre indirectly contributes to the lowest reading. Studies conducted by Aydogdu et al. (2005) primary schools areas indicated that the level of microbe is higher at the canteen compared with classrooms and corridors. School settings are normally very pack in terms of activities but canteen contained more microbes due to plenty of breeding materials such as food and water. This result might be worsened by poor hygiene practice among the students and canteen operators. Increased level of activities among occupants will increase the possibility of microbe to be transmitted into the indoor air. Moreover, occupant movement will bring in more microbes especially bacteria from outside environment; or cause settled microbes to became airborne or suspended.

This study tries to find difference on the microbe concentration (bacteria and fungi) with different microenvironments. Microenvironment sets for this study are training rooms, offices and accommodation rooms. Considering activities conducted in each microenvironment, it is anticipated that training rooms might have the highest bacteria and fungi concentration compared with offices and accommodation rooms.

Legal Requirement on Microbe Growth

Malaysia does not enforce any regulation or provide guidelines on permissible airborne concentration or recommend maximum concentration of bacteria and fungi in indoor air. A guideline or regulation set by authority is needed as a reference for the public. Korean Ministry of environment announced the Indoor Air Quality Management Act in 2004. The act established a total air borne bacteria threshold limit value of 800cfu/m^3 for hospital, kindergarten, senior care centre and post partum nursing centre. The Act came into force on September 2004 and allowed imposition of a fine when the level is violated (Kim. *et al*., 2001).

Singapore on the other hand, imposed guidelines for good indoor air quality in office building. The guideline was established in October 1996 to complement the engineering specification set out by the Singapore Standard Code of Practice of Mechanical Ventilation and Air-conditioning in Building (SSCP13), According to this guideline, recommended maximum concentration for total bacteria and total fungi is at 500 cfu/m^3. Relative humidity is less than 70% and temperature ranges between 22.5^{o}C to 25.5^{o}C (Institute of Environmental Epidemiology, 1996). Robertson (1997); Zorman *et al.* 2008) suggested that indoor air which is the same with microbial concentration can be accepted or considered as normal while indoor air microbial concentration is lower than 300 cfu/m^3. Concentration more than 300 cfu/m^3 can be considered as unacceptable and requires further investigation.

National Institute of Occupational Safety and Health (NIOSH, USA) did establish 1000 cfu/m^3 as a total bioaerasol particle limit. But these recommended limit is referring to general bioaerasol without specific recommendation limit for bacteria or fungi while American Conference of Governmental Industrial Hygiene (ACGIH) also set 1000 cfu/m^3 as recommended limit for bioaerasol, with 500 cfu/m^3 for total bacteria concentration (Kalogerakis *et al*., 2005). Since Malaysia has yet to set airborne standard for total fungi and total bacteria in office setting, this research applies the standard recommended by the Singapore guidelines due to similarity of environmental condition. Any samples counted more than 500 cfu/m^3 are considered unacceptable and require further remedial programmes.

Materials and Methods

Sampling Location

NIOSH was selected as sample for this study for its nature of a typical office setting in Malaysia (N 2º

56' 05.8'' E 101º 46'07.9''). The NIOSH headquarters consists of one main block of three-storey building and one block of two-storey building. Most activities are confined in the main block while the other block is solely used for accommodation rooms. The whole area in NIOSH Headquarters Bandar Baru Bangi was sampled in the research except for cafeteria, stores and laboratories. Laboratory was not included in this study since laboratory was not covered under the Code of Practice of Indoor Air Quality (COP IAQ, 2005). Figure 1 shows the sampling location for this study.

Sampling Procedures

Generally there are two (2) methods of indoor air quality sampling and measurement which are direct-reading or real-time sampling, and integrated sampling. The real time sampling provides immediate and fast feedback in terms of sampling result, while the integrated sampling involves drawing of air through a sample collector for specific sampling time. The sampled media is then taken to a laboratory for analysis to determine the amount of contaminants present. For this research, temperature and humidity are measured by direct reading instrument but microbiological sampling uses applied integrated sampling technique.

A total of 147 sampling points were selected from all departments in the building. 11 samples were collected from training room, 61 samples from the offices, and 76 samples were taken from accommodation rooms.

Measurements of Indoor Bacteria and Fungi

Bioaerasol concentration was measured using SKC Standard Biostage Impactor. SKC Biostage Single-stage impactor is operated on the principle of initial impaction. The sampler meets NIOSH Method 0800 requirement

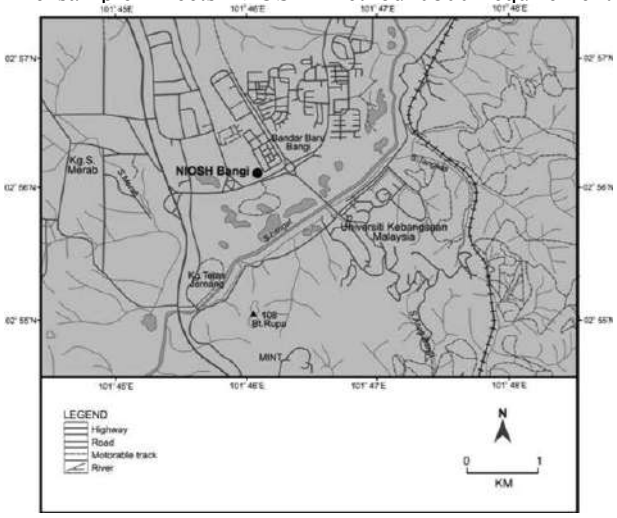

Figure 1 : Sampling station

and meets ACGIH recommendation for sampling viable microorganism including bacteria and fungi. The sampling head is made of autoclavable aluminum. Air is drawn through the impactor where the particle is impacted onto the agar collection media. The sampler pump flow rate is set and calibrated at 28.3 l/min.

Agar media is prepared a few days before sampling. Two types of agar are applied. Sabouraud Dextrose Agar (SDA) is used to sample air bone fungi and Tryptone Soya Agar (TSA) is used for airborne bacteria. The selection of agar is based on manufacturer recommendation.

TSA are prepared by mixing 40 gram of TSA powder with 1litre of deionised water. The mixture is boiled until it has dissolved properly. pH of the mixture is measured with pH metre and adjusted at pH 5.6 for SDA. After pH adjustment, the mixture is autoclaved for sterilization for 15 minutes at 121 degree Celsius. After autoclaved, the mixture is cooled for a few minutes and later poured into sterile petri dish and covered with lid. The agar is left hardened and stored in chiller until used. Similar process is applied with 65 gram of SDA with pH set at and pH 7.3 for TSA. Preparation of agar media is strictly following the media manual of Industrial Hygiene Analytical Laboratory (IHAL), NIOSH.

During the sampling, the agar plate is placed on the media holder and properly secured under impactor head. The Impactor head is assembled with sampler pump, which is already calibrated at 28.3 $Lmin^{-1}$. The sampling duration is set at 5 minutes. The manufacturer recommended duration is within 2 to 5 minutes but 5 minute is selected based on previous studies conducted by Cooley *et al*. (1998). The sampling head must be autoclaved and sterile with ethyl alcohol before each batch. The operator wears sterile gloves and sampling head must be wiped with alcohol prior and after placement of each media. After each sampling, the media is secured with the lid and sealed with microfilm tape and placed in sealable bag. The bag later is carried in icebox and immediately sends to laboratory.

At laboratory, the media is kept in incubator for 2 days for bacteria and 5 days for fungi. This duration is set to allow bacteria colony to grow and form visible colony. If the agar is left more than the required time, the colony might merge with each other and make counting impossible. During the counting session, the agar plate is mounted on colony counter and microbiologist counts the colonies manually. The total number of bacteria or fungus counted for every plate is noted and divided with the total volume of air drawn by sample.

The calculation is as follows:

COLONY FORM UNIT/CUBIC METER (cfu/m^3)

$$= \frac{\text{NUMBER OF BACTERIA OR FUNGI COUNT ON AGAR PLATE}}{\text{VOLUME}}$$

$$\text{Volume } (m^3) = \frac{\text{Duration(Min)} \times \text{Flow Rate(L/Min)}}{1000}$$

Manufacturer clean procedure is applied throughout the procedure in line with the requirement of NIOSH

sampling Method 0800, and Code of Practice of Indoor Air Quality (COP IAQ). The laboratory procedure includes agar preparation, incubation period, and counting is performed by IEC ISO 17025 accredited laboratories.

Measurements of Relative Humidity and Temperature

159 sampling points were measured for relative humidity and temperature data. Measurement of humidity and temperature are conducted by Q-Track Plus Indoor Air Quality Meter, TSI Model 8554. The equipment is well maintained and calibrated.

Results and Discussion

There are 147 sampling points measured on all parameters. The results for the parameters have been shown in Table 4.1. The results show that the lowest relative humidity recorded is 39.8%, while the highest relative humidity is 87.6%. The average of relative humidity for all sampling location is 62.6% where Training room recorded the lowest relative humidity readings compared with the General Office and Accommodation Room. Meanwhile, the lowest temperature recorded is 20.4°C while the highest temperature is 29°C. Average of temperature measurement is at 29.7°C. Training room has recorded the lowest temperature readings compared with the General Office and Accommodation Room.

Samplings of airborne bacteria and fungi are conducted using SKC Biostage Single-stage Impactor. Average of bacteria concentration is 472.75 cfu/m^3, with a range between 35 cfu/m^3 to 2780 cfu/m^3. Meanwhile, the average of fungi concentration is 237.39 cfu/m^3, with range between 7 cfu/m^3 to 1333 cfu/m^3. As for CO concentration, the lowest reading is 0.02 ppm while the highest reading is 5.8 ppm. General Office recorded the highest concentration of CO followed by the Training Room and Accommodation Room. The concentration of CO_2 recorded in this study is between 0.02 ppm to 2538 ppm where the highest concentration is in the Training Room followed by General Office and Accommodation Room. Descriptive data of the variables are shown in Table 4.1.

This study suggests that bacteria concentration is higher than fungi concentration. These findings are consistent with Jo and Seo (2005) and Patuszka *et al.* (2000). The research indicates there is significant difference between bacteria and fungi concentration between Training Rooms, General Office and Accommodation Rooms. The high concentration of airborne bacteria in accommodation rooms might be due to the application of the split unit air-conditioner in each room. Air conditioning systems are mainly to provide comfort to the occupants, but if poorly maintained air conditioning system can be a perfect reservoir for microbe to proliferate. However, if the air-conditioning systems are well operated and maintained, the system will help in reducing microbe growth. Previous studies conducted by Mui *et al*. (2007) indicate that bacteria concentration in indoor air was reduced after some time after the activation of the air-conditioning systems.

Air-conditioning helps in reducing microbe concentration by diluting the airborne concentration. Beside that, since this research indicates increased of temperature will result in increasing of bacteria concentration, that air-conditioning system might help in inhibiting microbe growth by reducing the environment temperature. Research done by Pasanen *et al*. (1993) and Korpi *et al*. (1998) indicated that building which suffers from dampness or moisture problem have significantly higher level of microorganism. Similarly, since microrganism needs water to grow, the present of

Table 4.1 : Descriptivedata of temperature, relative humidity, bacteria concentration and fungi concentration

Parameter	Sampling Location		
	Training Room	**General Office**	**Accommodation Room**
Temperature (^{0}C)	22.91 ± 1.20 (22.00 - 23.90)	24.28 ± 1.70 (20.40 - 28.90)	24.54 ± 1.94 (20.50 - 29.70)
Relative Humidity (%)	56.69± 14.21 (39.80 - 77.90)	59.46 ± 7.55 (43.40 - 79.90)	71.67 ± 7.09 (53.90 - 87.60)
Bacteria Concentration (cfu/m^3)	537.00± 438.69 (35.00 - 1220.00)	361.57 ± 375.88 (0.00 - 2780.00)	579.69± 232.63 (184.00 - 1163.00)
Fungi Concentration (cfu/m^3)	285.46± 210.04 (99.00 - 794.00)	202.30 ± 257.19 (7.00 - 1511.00)	224.40± 152.30 (28.00 - 1333.00)
CO (ppm)	2.21± 0.70 (1.40 - 3.30)	2.62 ± 1.05 (0.00 - 5.50)	2.13± 1.16 (0.20 - 5.80)
CO_2 (ppm)	765.36± 631.08 (265.00 - 2538.00)	572.59 ± 187.45 (0.00 - 1093.00)	468.92± 305.94 (257.00 - 1758.00)

humidity which contributes to moisture plays a big role in many indoor air quality problems. According to Jo and Seo (2005), Ren *et al*. (1999) suggested that temperature and relative humidity are closely related to microbial growth. This statement is supported by Law *et al*. (2001) .

The exposure limit of 500 cfu/m^3 was selected for recommended maximum concentration for bacteria and fungi airborne concentration. This exposure limit is adopted from Singapore Guidelines for Good Indoor Air Quality in Office Building (1996). This recommended maximum concentration is adopted for this study after considering similar environmental and culture conditions between Malaysia and Singapore. There is no specific standard or guideline published by Malaysian authority on the assessment of airborne microbe, although microbe is considered as one of the major contributors to poor indoor air in the Malaysian COP IAQ.

Results gathered from this study indicates that 40.3% from bacteria samples are above the recommended maximum concentration. The maximum bacteria concentration during the sampling is 2780 cfu/m^3. Some of the concentration are very high above the standard. The maximum bacteria concentration reaches up to more than five (5) times above the recommended maximum concentration. For fungi concentration, only 3.8% of fungi concentration is above the recommended maximum concentration. The maximum fungi concentration during the sampling was 1511 cfu/m^3.

Some of the rooms might be left empty for many days without activation of air-conditioning systems. This condition allows the microbe to continue proliferating. Besides, the high reading of bacteria in Accommodation Room might be due to old furniture and building materials. According to Yang *et al*. (1998) and Aydogdu et al. (2005), there is a positive correlation between bacteria concentration, relative humidity and age of building. The accommodation rooms main structure was built in 1998 and renovation activities were conducted in 2000. During this renovation, the carpet furnishings were replaced with tiles and the rooms were repainted and equipped with wood based furniture. No further upgrading was performed ever since. Furthermore, some of the rooms are slightly damaged due to water leakage from the roof and walls. The condition worsens with the present of toilets and shower in each room. Water reservoir in the toilet bowl and flooring can be the main reservoir for bacteria proliferation.

Correlation test indicates that there is a positive relation between relative humidity with bacteria growth. This finding affirms the result by Law (2001) who found that background bacteria concentration to be strongly correlated with indoor relative humidity. Similar finding was also concluded by Ayogdu *et al.* (2005) on bacteria and humidity. Findings in this research indicate that average of humidity is at 39.8% with maximum humidity up to 87.6%. This finding is similar with Alsmo *et al*. (2007), Johansson *et al*. (2005) and Grinberg (1992). They claimed that 67% is the critical relative humidity that favours microbe growth. Moreover, 42% of the samples show relative humidity which are above 67%, indicating that these areas are highly potential for microbe growth. The relative humidity in this area must be controlled and reduced to inhibit proliferation of bacteria and also indicate positive relation between temperature and bacteria concentration. This finding is supported by Corden *et al*. (2001) who indicated that concentration of microorganism is directly proportionate to the atmosphere temperature. However, there is no correlation between temperature and fungi concentration.

Sarica *et al*. (2002) conducted a study at a hospital and established that there are correlations between concentration of fungi and temperature. Higher temperature increases the risk of fungal and bacteria contamination. The finding was in line with other researches that suggest temperature induces fungal spore; and concentration of microorganism is directly propotionate to the atmosphere temperature (Sarica *et al*., 2002; Corden *et al*. 2001; Jazrawi *et al.* 1983).

Table 4.2 : Correlation table between microbe and indoor air parameters

Correlations

	Temperature	Relative Humidity	Total Bacteria	CO	CO_2	Total Fungi
Temperature	1					
Relative Humidity	0.197*	1				
Total Bacteria	0.101	0.266**	1			
CO	0.268**	-0.036	0.223**	1		
CO_2	-0.181*	-0.213**	-0.025	0.126	1	
Total Fungi	-0.043	0.063	0.067	0.070	-0.085	1

*** Correlation is significant at the 0.05 level (2-tailed)**
**** Correlation is significant at the 0.01 level (2-tailed)**

According to Mui *et al.* (2007), higher airborne fungi count levels (up to 2 to 6 times higher) were recorded in autumn than in winter and a result from a study in Taiwan indicates that airborne fungi in hot season is higher than those in winter.

Conclusion

This is a preliminary study at NIOSH in providing comprehensive baseline data on microbe concentration. There is a significant correlation between humidity and bacteria concentration. However, there is no significant correlation between temperature and fungi concentration. Apart from that, this study has also established significant difference on bacteria concentration and fungi concentration between training rooms, offices and accommodation rooms. Results obtained from statistical analysis that was used to test the hypotheses in the study prove that there is a significant positive correlation between temperature and bacteria concentration in indoor air. Other than that, there is a significant positive correlation between relative humidity and bacteria concentration in indoor air and significant difference on bacteria concentration between training rooms, offices and accommodation rooms in indoor air environment. Lastly, there is a significant difference on fungi concentration between training rooms, offices and accommodation rooms in indoor air environment.

Recommendation

Management is responsible for providing healthy workplace for the workers. In case of indoor air quality, many factors need to be considered. Among them are temperature, humidity, ventilation, workers' activities and others. If these entire factors are not well managed, they might induce contamination in indoor air and initiate proliferation of indoor bacteria and fungus. This condition later will cause serious indoor air quality problem to the workers. To ensure this, building management must ensure proper building construction and maintenance. Mold and bacteria prevention programmes must include three main plans: remediation programme, preventive maintenance programme and procedure for future renovation.

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Occupational Safety And Health Assessment In Metal Industry Within Small And Medium Enterprise

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Abstract

According to annual reports from the Social Security Organization (SOCSO), between years 2009 and 2011, metal industry has the highest reported number of accidents compared to the other manufacturing industry in small and medium enterprises (SMEs). Therefore, the aim of this study was to investigate the actual causes of problems that lead to the accidents involving metal industries within SMEs. In this study, a checklist through site visits was used to collect the data. The overall results revealed that the main causes of accidents are; organization failure, human factor, machine failure and surrounding environments.

Keywords: Social Security Organization (SOCSO), Small and Medium enterprises (SMEs), Metal Industry, Site Visit, Organization Failure

Introduction

Occupational safety and health (OSH) is basically focusing on safety, health and welfare of people in a workplace. There are various issues regarding occupational safety and health management and implementation in small and medium enterprises (SMEs) in Malaysia. The issues faced by the SMEs especially those related to OSH compliance have always become a major subject of discussions among researchers, employers, employees as well as the government. Among the typical problems faced by the SMEs related to OSH are lack of capital and qualified manpower, always made as excuses for poor safety management system. Size of the company also becomes a problem in implementing occupational safety and health.

In order to counter such problems, the government through agencies, such as Small and Medium Industries Development Corporation (SMIDEC) has provided many incentives to improve quality as well as productivity and also has offered grants for skills training. However, the same problems remain and are continuously being brought up by the SMEs when issues on OSH are discussed.

Surprisingly in the manufacturing sector, metal manufacturing industries showed the highest rate of accidents compared to the other manufacturing industries (SOCSO Annual Report, 2011).Therefore this research focused on OSH in metal industries within SMEs in Malaysia. The outcomes of this study are expected to be useful in improving the working condition in metal industries within SMEs. This will consequently enhance the productivities and competitiveness among the companies as well as contributing to the positive growth in the economy of the country.

Literature Review

SMEs Background

In Malaysia, SMEs are important contributors to the national economic growth and toward achieving the aim of becoming an industrial nation by the year 2020. In Malaysia, SMEs started in the 1970s when multinational companies (MNCs) began to operate in this country. In general, SMEs serve to strengthen economic linkages with MNCs. They make up more than four-fifths of all the manufacturing establishments in the country and contribute considerably to the national economy (Omar *et. al*., 2009).

It is noted that SME sector is the main driving force behind job creation, export earnings, poverty reduction, wealth creation, income distribution and income disparities reduction. The positive growth and development of this sector have the potential to transform

SMEs into the key of economic development and set them onto the path of sustained growth. There is no doubt that SMEs need to strengthen their linkages to large-scale enterprises as they are key players in supplying raw materials and distributing manufactured goods (Report of the Vision 2020; 2009). In the manufacturing sector, SMEs act as specialist suppliers of component, parts and sub-assemblies to larger companies (Gadenna and Sharma, 2009; Singh *et. al*., 2010) because these items can be produced at a cheaper price compared to the price larger companies must pay for in-house production of the same components (Singh *et. al.*, 2010).

Structure of the SMEs Sector

There are a number of definitions that constitutes the SME (Jafari *et. al*., 2007: Fathien *et al*., 2008). The definitions vary between countries depending on the number of employees or business capital. (Thassanabanjong *et. al*., 2009; Mirbargkar, 2009; Ghanatabadai, 2005). In Malaysia, a new definition of SMEs has been endorsed by the National SME Development Council (NSDC) on 11 July 2013. The new definition is expected to result in more firms being classified as SMEs especially from the service sector. The newly detailed definition by the three categories namely micro, small and medium are as summarized in Table 1 below.

Table 1: New definition of SMEs in Malaysia proposed by SMIDEC (SME Annual Report, 2013)

SME Category	Based on number of full-time employees		Based on annual sales turnover	
	Manufacturing	**Service and other sectors**	**Manufacturing**	**Service and other sectors**
Micro	Less than 5 employees	Less than 5 employees	Less than RM 300,000	Less than RM 300,000
Small	5 to less than 75 employees	5 to less than 30 employees	RM 300,000 to less than RM 15 million	RM 300,000 to less than RM 3 million
Medium	75 to 200 employees	30 to 75 employees	RM 15 million to RM 50 million	RM 3 million to RM 20 million

Methodology

The data was collected in selected metal companies throughout Malaysia. A total of 66 companies were selected involving four different states in Malaysia which are Johor, Malacca, Selangor and Penang. During the site visits, data was collected through interview and close ended checklists. The checklist consisted of 48 questions which emphasizes on several parts of the assessment which are the regulation of OSHA 1994, FMA 1967, hazards in the factory as well as suggestion made by the assessors to the companies based on the observation during the visit. In addition, specifically designed questionnaire which focuses more on the company's practices was also distributed to the management personnel. The data was analyzed using the Minitab16 statistical software. It involves basic calculation of data mean, range, percentages of response in each category of the questionnaire. Anderson-Darling Normality Test (confident interval 95%) was used to analyze the data.

Results

Basically, the actual condition of the visited companies was observed during the visits. The result of the site visits survey can be concluded based on several aspects of the company's commitment, employers' involvement and training given by the companies.

Based on the actual observation made during the visit, the commitment of the visited companies towards OSH is not satisfactory. Around 68% of them failed to comply with the OSHA 1994 requirements. Around 61% of them lack evidence to support their stated documents. A total of 66 companies were visited in this study. Based on the observation, most of the companies have safety and health policy that is not updated and not clear. Because of this, the employees did not understand the content of the policy. Some of the companies have written safety policies available but display only one copy, insufficient for the employees to have access to the policies. Findings from the site visits also showed that 37% of the companies failed to comply with the FMA 1967 regulations; only 48% of them claimed that they conducted noise monitoring programmes, 60% of them did not have any emergency lamps and 54% of them did not provide proper seating facility as prescribed under regulation 30 of the Factory and Machinery (Safety, Health and Welfare) Regulation, 1970.

Majority of the visited companies showed inadequate employers' involvement toward safety and health in the workplace. Based on the evidence observed during the site visits, 69% from the companies did not have SOP even for normal operations let alone for start-up, shut-down and emergency operations. Normally, the companies gave instructions to employees verbally without any documentation or SOP.

From the study, trainings provided for the employees were not satisfactory; 49% of the employers failed to show evidences of the training and information that have been given to the employees. This is because the trainings were mostly given verbally and informally without any documentation or record of them.

The frequency of OSH related hazards present in the companies was determined in this study. As shown in Figure 1, the most frequent hazard in majority of the companies is noise (55%), followed by physical hazard (50%), slip or fall (33%), ergonomic hazards (30%) and electrical hazards (23%).

The findings from the site visits also indicate that companies need to do the following (in the order of most significant) to improve the OSH in the workplace: development of SOP or work instruction (55%), hazards identification, assessment and control programmes (50%), safety management system (33%) and safety culture (24%) (see Figure 2).

Discussion

The findings of this study suggest that the causes of accidents in metal manufacturing industry are mainly due to organization failure (lack of commitment and involvement), human factor (lack of training), machine failure (no guarding and old machines) and surrounding environment (noise, physical hazards and others). Every company either small or medium needs to provide SOP and communicate the SOP to the employees. It is important to ensure that employees understand the working procedures properly in order to avoid any mistake that can lead to accidents.

Moreover, metal working companies particularly in Malaysia need to improve a lot more in the hazards identification, assessment and control programmes (HIRAC) since the hazards observed in this study are poorly identified, evaluated and understood by the workers. The site visit shows that none of the companies has documented reports on the hazards identification,

Figure 1: Frequencies of Hazards in the Visited Metal Companies

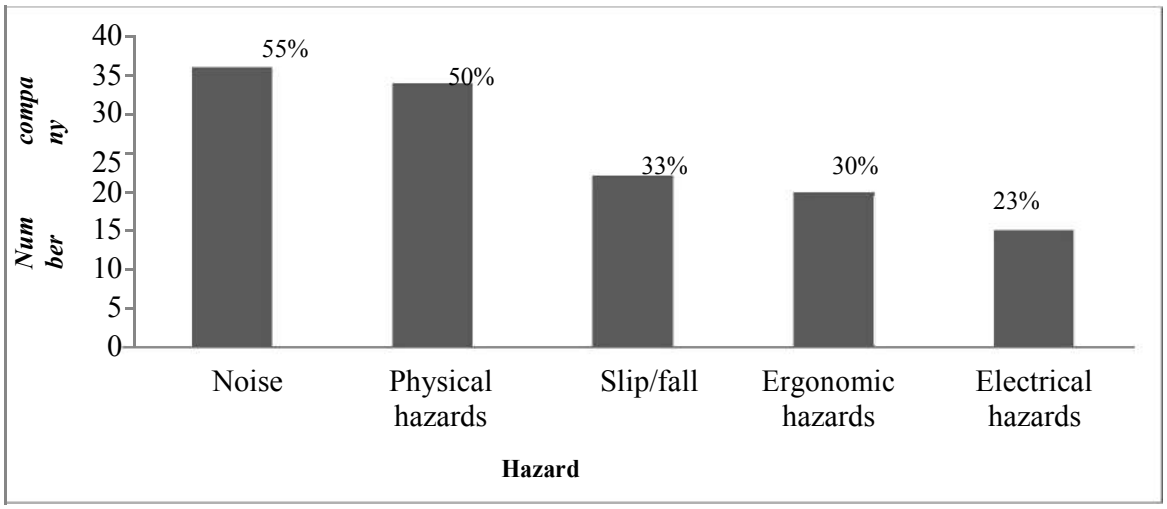
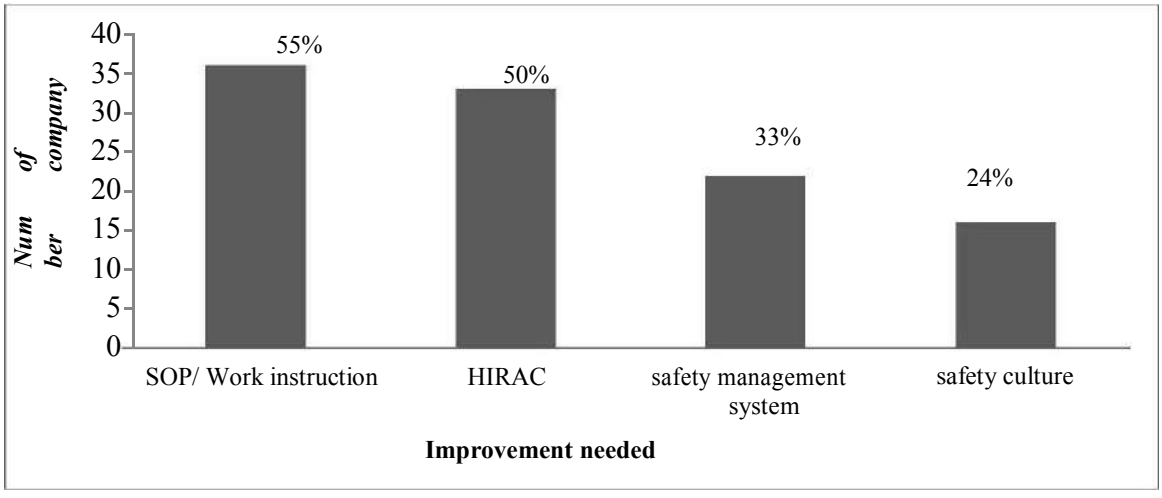


Figure 2: Improvement Suggestions for Metal Industry



assessment and control programmes that have been conducted. Also, the companies need to improve their safety management system as well as safety culture to ensure that employees are working in a safe environment.

Most of the companies (around 56% of them) showed poor commitment, involvement and training toward OSH in the workplace. By focusing on corrective actions such as development of SOP and HIRAC, a specific safety management system for micro, small and medium industry can enhance the readiness of SMEs to avoid accidents. It may also reduce 56% of problems currently faced by the metal industry within SMEs. A significant decrease in the rate of problems will consequently reduce the number of accidents in the metal industry within SMEs.

Conclusion

The result obtained from this study is hoped to be beneficial to all the relevant agencies including the DOSH in reducing the rate of accidents especially in metal industries within SMEs. Besides clear benefits on the reduction of the cost of compensation due to accidents, the productivities and qualities of the industries can be enhanced by implementing an excellent occupational safety and health system, hence contributing toward a positive growth of economy of the company as well as the country. Further empirical work is highly needed in order to develop detailed action plan and better working procedures to reduce the accident rate in metal manufacturing industry within SMEs.

Acknowledgements

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Medium Penyampaian Maklumat Sedia Ada Bagi Pekerja Asing Dalam Kursus Keselamatan Industri Pembinaan Malaysia : Satu Perbincangan

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Abstrak

Medium penyampaian maklumat merupakan media pengajaran utama yang digunakan dalam menyampaikan maklumat kepada pekerja tempatan dan juga asing dalam Kursus Induksi Keselamatan dan Kesihatan (KIKK). Justeru, kertas kerja ini menumpukan kepada perbincangan mengenai permasalahan serta hasil kajian lepas berkaitan penggunaan media penyampaian maklumat sedia ada oleh pekerja asing dalam KIKK. Kesimpulan hasil kajian perpustakaan mendapati terdapat beberapa masalah penggunaan media penyampaian maklumat sedia ada ini daripada aspek penggunaan bahasa, cara penyampaian dan medium penyampaian. Bahasa Melayu lazimnya digunakan sebagai bahasa pengantar semasa penyampaian maklumat dalam KIKK sama ada dalam bentuk teks mahupun penyampaian lisan. Namun, penggunaan Bahasa Melayu ini didapati tidak difahami oleh kebanyakan pekerja asing terutamanya pekerja asing bukan warga Indonesia. Cara penyampaian maklumat juga dilihat bersifat satu hala dan kurang difahami serta medium penyampaian yang digunakan kurang interaktif dan berbentuk presentasi. Malah, medium penyampaian maklumat seperti *PowerPoint* yang digunakan masih belum cukup kemas untuk memenuhi keperluan kerja pekerja asing di tapak bina yang mana teks bahasa Melayu terlalu panjang digunakan, susunan teks dan grafik tidak kemas, saiz teks tidak konsisten serta penggunaan grafik yang kurang jelas.

Kata kunci: Medium Penyampaian Maklumat, Kursus Keselamatan, Pekerja Asing, Industri Pembinaan, Malaysia

Latar Belakang Kajian

Industri pembinaan merupakan sebuah industri yang disenaraikan sebagai penyumbang utama kepada peningkatan pertumbuhan ekonomi negara dengan peranan penting kearah merealisasikan hasrat masyarakat sejagat dalam bentuk pembangunan fizikal seperti pembangunan prasarana, kediaman, perniagaan, pusat pendidikan dan sebagainya disamping menjadi enjin penggerak pembangunan ekonomi kepada sesebuah negara (Nurul Azita & Abdul Aziz 2007). Namun, kerancakan aktiviti pembinaan yang dijalankan bergantung kepada tenaga kerja yang dimiliki. Di Malaysia, fenomena kekurangan tenaga buruh telah menyebabkan Malaysia bergantung kepada tenaga buruh daripada luar dan pengambilan pekerja asing dalam sektor pembinaan Malaysia bukan satu isu baru (Haryati *et al*. 2009). Walau bagaimanapun, sebelum pekerja-pekerja ini memasuki atau melakukan kerja-kerja di tapak bina, mereka diwajibkan menghadiri Kursus Induksi Keselamatan dan Kesihatan (KIKK) agar mereka memperolehi kesedaran tentang bahaya di tapak bina, dapat mengurangkan kerosakan atau kecederaan terhadap pekerja lain, orang awam atau harta benda serta dapat mematuhi undang-undang dan peraturan keselamatan di tapak bina iaitu seperti yang termaktub di bawah objektif kursus yang telah ditetapkan oleh Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB). Kursus ini adalah merupakan perlaksanaan keselamatan awal berlandaskan Akta Keselamatan dan Kesihatan Pekerjaan 1994 (OSHA) yang mana turut mewajibkan pihak majikan mematuhi peraturan dengan memberikan atau menghantar pekerja asing menghadiri latihan atau kursus bagi mendapatkan maklumat keselamatan sebelum memulakan kerja di tapak bina. Bagi menyampaikan maklumat kepada pekerja tempatan dan juga asing di dalam kursus ini, maka lazimnya satu media penyampaian maklumat berbentuk *PowerPoint* telah digunakan.

Permasaalahan Kajian

Menurut Hola (2007), pekerjaan dalam industri pembinaan adalah merupakan salah satu pekerjaan yang kompleks dan merbahaya. Kemalangan yang berlaku dalam industri pembinaan ini dikatakan berpunca daripada kegagalan pembinaan (Cheng *et al*. 2004) di mana mempunyai hubungkait dengan kepincangan atau kegagalan pelaksanaan keselamatan yang dijalankan di tapak bina. Namun, terdapat beberapa kajian sebelum ini yang mendedahkan masalah-masalah yang dihadapi oleh pekerja asing dalam menerima maklumat keselamatan semasa pelaksanaan kursus yang wajib dihadiri oleh pekerja sebelum memasuki tapak bina atau semasa melaksanakan kerja di tapak bina.

Contohnya kajian yang dilaksanakan oleh Haryati *et al*. (2009) dan kajian Trajkovski dan Loosemore (2006) yang menyentuh mengenai isu masalah bahasa dalam KIKK, telah mendedahkan masalah komunikasi iaitu masalah bahasa yang wujud dalam kalangan pekerja asing dalam senario industri pembinaan di Malaysia. Kajian luar pula melihat kewujudan masalah bahasa dalam kalangan pekerja asing dalam industri pembinaan dilaksanakan oleh Bust *et al*. (2008) di United Kingdom (UK), Trajkovski dan Loosemore (2006) serta Loosemore dan Andonakis (2007) di Australia,

O'Connor *et al*. (2005) di United States (US) dan Wah (2000) di Singapura. Walaupun kajian terlibat kebanyakannya menumpukan kepada kewujudan masalah bahasa dalam kalangan pekerja asing di dalam industri pembinaan, namun kajian-kajian sebelum ini kurang membincangkan mengenai kebolehbantuan penggunaan media penyampaian maklumat sedia ada di dalam KIKK untuk memenuhi keperluan kerja pekerja asing di tapak bina. Sedangkan maklumat keselamatan yang disampaikan perlu difahami oleh pekerja asing agar mereka dapat menyedari bahaya-bahaya di tapak bina serta dapat melaksanakan kerja dengan lebih selamat dan berhati-hati.

Kajian yang telah dilaksanakan oleh Nurul Azita (2014) turut mendapati bahawa kebanyakan medium penyampaian maklumat sedia ada yang digunakan kepada pekerja asing di dalam KIKK adalah menggunakan bahasa Melayu. Bahasa Melayu digunakan bagi menyampaikan maklumat samada dalam bentuk teks mahupun bentuk lisan. Penggunaan bahasa Melayu tidak difahami oleh pekerja asing terutamanya pekerja asing bukan warga Indonesia. Dapatan kajian beliau juga mendedahkan bahawa medium yang digunakan juga adalah kurang interaktif serta berbentuk presentasi dan bersifat satu hala. Hal ini terjadi kerana pekerja asing hanya dapat menerima maklumat daripada media penyampaian maklumat semata-mata tanpa dapat memberi apa-apa maklum balas samada mereka memahami atau tidak memahami maklumat yang disampaikan. Malah, medium penyampaian maklumat yang digunakan juga masih belum cukup kemas untuk memenuhi keperluan kerja pekerja asing di tapak bina apabila media seperti *PowerPoint* di dapati menggunakan teks yang terlalu panjang dalam bahasa Melayu, susunan teks dan grafik yang tidak kemas, saiz teks yang tidak konsisten serta terdapat penggunaan grafik yang kurang jelas. Kajian Nurul Azita (2014) turut mendapati medium sedia ada yang digunakan di dalam KIKK adalah kurang berkesan untuk dilaksanakan kepada pekerja asing terutamanya pekerja asing bukan warganegara Indonesia. Ujian kefahaman terhadap maklumat keselamatan industri pembinaan Malaysia pekerja asing warga Myanmar menunjukkan hasil keputusan yang amat membimbangkan di mana mereka tidak memahami maklumat yang disampaikan di dalam kursus.

Perbincangan

Medium penyampaian maklumat atau media yang digunakan di dalam pengajaran adalah merupakan alat atau bahan berbentuk perisian yang dibangunkan bagi mengendalikan proses pengajaran dan pembelajaran (Yusup 1997). Media pengajaran ini juga bertindak sebagai media yang membawa mesej untuk tujuan pengajaran (Heinich 1993). Penggunaan media penyampaian maklumat ini memberikan kemudahan kepada tenaga pengajar untuk menyampaikan mesej kepada pelajar dengan lebih jelas, cepat dan mudah difahami. Hal ini kerana penggunaannya membantu tenaga pengajar menyampaikan maklumat dengan tepat tanpa ada kebocoran terutama dalam menyampaikan maklumat-maklumat penting. Penggunaan media penyampaian yang cekap adalah penting kerana ia menjadi kayu ukur kepada keberkesanan KIKK. Selain itu, medium penyampaian maklumat yang digunakan harus dapat memenuhi keperluan kerja pekerja asing. Ini kerana, maklumat keselamatan diri perlu difahami sepenuhnya oleh pekerja asing sebagai langkah menjamin pelaksanaan kerja yang lebih baik serta keselamatan diri yang lebih sempurna sepanjang bekerja di tapak bina. Namun begitu, medium penyampaian maklumat sedia ada yang digunakan di dalam KIKK mempunyai beberapa kelemahan (Nurul Azita 2014). Antara kelemahan yang telah dikenal pasti ialah:

a. Bahasa Melayu sebagai bahasa pengantar kurang berkesan digunakan kepada pekerja asing terutamanya pekerja asing bukan warganegara Indonesia. Ujian pencapaian yang telah dijalankan menunjukkan hasil keputusan yang amat membimbangkan di mana pekerja binaan warga Myanmar tidak memahami maklumat yang disampaikan menggunakan bahasa Melayu di dalam kursus. Walau bagaimanpun, di dapati ujian pencapaian pekerja binaan warga Myanmar yang menggunakan bahasa Myanmar menunjukkan pencapaian yang jauh lebih baik.

b. Penggunaan media pengajaran yang kurang bersesuaian tidak membantu pekerja asing

memahami maklumat. Kajian mendapati penggunaan perisian IM-SmartSAFETY yang menggunakan bahasa Myanmar telah menunjukkan hasil pencapaian yang jauh lebih baik berbanding sebelum menggunakan perisian ini. Dapatan ini menepati kenyataan Chu (2010) di mana sebarang alat yang digunakan dalam proses pengajaran dan pembelajaran dapat memberikan kesan kepada cara peserta berfikir.

c. Medium penyampaian yang belum cukup kemas untuk dilaksanakan di dalam kursus. Medium penyampaian maklumat iaitu *PowerPoint* sedia ada menggunakan teks yang terlalu panjang, susunan teks dan grafik yang tidak kemas, saiz teks yang tidak konsisten serta terdapat penggunaan grafik yang kurang jelas. Penggunaan teks yang terlalu panjang, susunan teks dan grafik yang tidak kemas, saiz teks yang tidak konsisten serta penggunaan grafik yang kurang jelas boleh mempengaruhi motivasi peserta. Robotham (2001) menyatakan bahawa orang dewasa paling bermotivasi untuk belajar atau menerima maklumat apabila bahan-bahan yang digunakan sepanjang pembelajaran atau kursus dapat memenuhi keperluan diri atau pekerjaan mereka. Selain itu, Kelly (2006) menyatakan bahan berbentuk visual yang digunakan perlulah sesuai dan jelas supaya peserta dapat melihat gambar dan membaca tulisan dengan mudah.

d. Pengambilan pekerja asing selain warga Indonesia mencatat jumlah yang tinggi (Jadual 1). Masalah kurang keberkesanan dan kelemahan-kelemahan pada medium penyampaian dalam KIKK sedia ada sebelum ini menunjukkan ianya perlu ditangani dengan segera agar dapat memenuhi keperluan kerja pekerja warganegara asing di tapak bina (Nurul Azita 2014). Selaras dengan pandangan Gupta (2008), perolehan pengetahuan merupakan pengumpulan pengetahuan daripada pelbagai sumber seperti surat khabar, artikel, program latihan, pembinaan pengetahuan melalui eksperimen dengan cara baru bagi pekerjaan serta perbincangan dengan rakan boleh diadakan untuk meningkatkan kefahaman pekerja asing bukan warga Indonesia terhadap keperluan kerja di tapak bina. Oleh itu tindakan segera perlu diambil untuk membina medium penyampaian maklumat secara lebih berkesan bagi memenuhi keperluan hampir 20% tenaga kerja bukan warga indonesia kerana bilangan mereka mungkin akan bertambah dari semasa ke semasa.

e. Penggunaan bahasa Melayu sebagai medium penyampaian maklumat dalam KIKK samada dalam bentuk teks mahupun lisan menyebabkan maklumat penting keselamatan semasa bekerja di tapak bina tidak sampai sepenuhnya kepada pekerja asing (Nurul Azita 2014). Hal ini menyebabkan aspek-aspek keselamatan

Jadual 1 : Statistik Pengeluaran Pas Pekerja Asing Sehingga 31 Disember 2010 Mengikut Negara Dalam Industri Pembinaan Di Malaysia

Warganegara	Sektor Pembinaan
Indonesia	151,333
Nepal	3,050
Myanmar	12,221
India	3,488
Vietnam	1,965
Bangladesh	3,036
Pakistan	6,217
Filipina	3,335
Kemboja	307
China	2,033
Thailand	463
Sri Lanka	77
Laos	30
Lain-lain	188
Jumlah	**187,743**

tidak diamalkan oleh pekerja asing secara menyeluruh. Kadar kemalangan dalam industri pembinaan negara terutamanya dalam kalangan pekerja asing sepanjang menjalankan kerja-kerja di tapak bina turut meningkat. Masalah bahasa semasa penyampaian maklumat keselamatan dikenal pasti menjadi punca utama kepada permasalahan ini. Hal ini telah dibuktikan dalam kajian Nurul Azita *et al*. (2012) di mana hasil temu bual yang telah dilaksanakan dengan lima syarikat kontraktor di Malaysia membuktikan bahawa wujudnya masalah bahasa dalam kalangan pekerja asing bukan warga Indonesia dalam industri pembinaan. Dapatan kajian menyatakan masalah bahasa dalam kalangan pekerja asing bukan warga Indonesia merupakan antara faktor penyumbang berlakunya kemalangan dalam industri pembinaan di Malaysia. Penggunaan bahasa Melayu sebagai bahasa pengantar di tapak bina dan dalam kursus KIKK gagal difahami oleh pekerja asing, menyebabkan mereka tidak memahami langsung panduan keselamatan yang disampaikan. Rumusan kajian juga menegaskan bahawa kemalangan yang disebabkan oleh masalah bahasa ini berpunca daripada kesukaran memahami arahan kerja, peraturan keselamatan serta sukar mengintepretasikan tanda amaran keselamatan di tapak bina iaitu seperti yang dinyatakan dalam kajian Abdul Rashid dan Abdul Aziz (2003).

f. Dapatan-dapatan kajian lain seperti kajian Trajkovski dan Loosemore (2006) dalam industri pembinaan di Australia turut mendedahkan bahawa faktor bahasa telah menyumbang kepada peningkatan kadar kemalangan yang tinggi meliputi 85.7% di tempat kerja. Hal ini kerana pekerja asing di negara tersebut menggunakan bahasa selain dari bahasa Inggeris di tempat kerja. Kajian Trajkovski dan Loosemore turut membuktikan 48.7% pekerja asing tidak memahami arahan yang disampaikan kerana kurang memahami arahan dalam bahasa Inggeris manakala 66.7% daripada pekerja asing melakukan kesilapan dalam kerja mereka kerana tidak memahami arahan. Di samping itu, kajian Wah (2000) turut mendapati bahawa masalah bahasa yang kritikal di Singapura turut menyumbang kepada berlakunya kemalangan di tapak bina. Kebanyakan pekerja asing dalam industri pembinaan Singapura yang datang dari Bangladesh, India dan Thailand adalah tidak memahami arahan yang disampaikan dalam bahasa Inggeris ataupun Mandarin. Perkara ini turut dinyatakan oleh Abdul Rashid dan Abdul Aziz (2003) di mana masalah komunikasi menggunakan bahasa Malaysia telah menyebabkan pekerja asing di negara ini sukar memahami arahan kerja selamat, peraturan keselamatan serta sukar mengintrepretasikan tanda isyarat keselamatan sehingga berlakunya kemalangan.

g. Cara penyampaian maklumat dalam KIKK yang kurang interaktif, berbentuk presentasi dan bersifat satu hala juga menjadi penyebab utama maklumat tidak difahami sepenuhnya oleh pekerja asing. Tenaga pengajar hanya bertindak menayangkan *PowerPoint* iaitu memberikan maklumat menerusi media pengajaran semata-mata. Manakala pihak pekerja asing hanya menerima maklumat daripada media penyampaian maklumat *PowerPoint* terbabit tanpa dapat memahami maklumat tersebut. Malah, penglibatan aktif serta pembinaan pengetahuan dalam kalangan pekerja asing juga tidak terhasil berikutan aktiviti pembelajaran yang sukar dilaksanakan akibat kekangan bahasa (Nurul Azita 2014).

Kesimpulan

Medium penyampaian maklumat ini sesungguhnya amat penting dalam memberikan maklumat yang berguna kepada pekerja agar mereka dapat menggunakannya semasa bekerja di tapak bina. Malah, penggunaan medium yang sesuai, menarik dan difahami amatlah diharapkan terutamanya oleh pekerja asing agar mereka dapat memahami keseluruhan aspek keselamatan di dalam senario pekerjaan dalam industri pembinaan Malaysia. Rentetan daripada permasalahan ini, maka satu kajian dalam skop yang lebih luas akan dijalankan bagi mengenalpasti kekangan yang dihadapi oleh pekerja asing semasa menerima maklumat, mengenalpasti keperluan, menilai kebolehbantuan medium penyampaian maklumat sedia ada dalam memenuhi keperluan kerja pekerja asing dan menilai tahap kepuasan pekerja asing sepanjang menggunakan medium penyampaian maklumat sedia ada di dalam KIKK.

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The Implementation Of Osh Management System In Small And Medium Enterprise For Sustainable Development

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Abstract

Occupational safety and health (OSH) in Small and Medium Enterprises (SMEs) have not received the proper attention not only in Malaysia, but also in most countries all over the world, in terms of research or support for implementation. In Malaysia, many agencies such as the Department of Occupational Safety and Health (DOSH), Social Safety Organization (SOCSO), National Institute of Occupational Safety and Health (NIOSH) and many more agencies related to OSH have been in collaborations to conduct and promote a safety working environment and to protect human rights economically, morally and legally. This research mainly focuses on the implementation of the occupational safety and health in small and medium industries in the southern region of peninsular of Malaysia. This exploratory study will be based on conducting a survey to 500 SMEs owners and workers throughout the southern region of Malaysia to get the in-depth knowledge on how the implementation of safety and health management system in the SMEs will affect them both morally and economically. A site visit will also be conducted in order to enhance and to get to know the real situation happening in the real working environment. The results of this study will be used to make and initial evaluation of the implementations of OSH management system in SMEs and hopefully will help for future interventions and researches.

Keywords: Small and Medium Enterprise (SMEs), Industry, Occupational Safety and Health.

Introduction

Small and medium enterprises have earned a reputation of being the main contributor towards a country's Gross Domestic Products (GDP) and constructing the majority number of all business sectors. Being the majority number in all business sectors makes SME a prime candidate for Occupational Safety and Health (OSH) issues to arise in their workplace. One of the key ingredients for a successful business is to minimize costs. A safe and healthy workplace is one of the effective strategies to hold down the costs of doing business. Number of accidents and damages in properties can cause great burden of impact for a business to run as they are not only giving delays in productions and operations, but they can cause a direct and indirect impact towards minimizing costs.

Occupational safety and health at the workplace is an issue that affect almost all types of businesses globally. The issues regarding safety and health in SME are relatively being abandoned as there were not much research been conducted. Consequently, implementation of safety and health in the SME sector need to be set as a necessary goal in order to improve and provide a great stability and sustainability for business development in the future.

Background of the Study

Small and medium enterprise is an important and pivotal sector nationally and globally for their essential roles in economy, mainly regarding the employment potential and business growth that they can offer. According to (Khalique, Abdul, Shaari, & Ageel, 2011), one of the challenges faced by the SME is access towards management ability and skilled workforce. This tends to provide a stumbling block for safety and health practices in the workplace to be implemented, hence causing the number of accidents, injuries and fatalities in the SME sector to be consistently at high rates. The awareness level regarding the importance of safety practices in the SME sector tends to be low, mainly because of their limited access to finance causing safety practices to be the first item in their list to be thrown out for cost cutting. As stated by (Lam, 1997), small firms are particularly difficult for OSH practices to engage with. Business issues such as cash flow, sales, staffing and production are even more critical for small firms than for larger ones, thus health and safety is often given a very low priority.

The implementation of OSH management system in SME has recently becoming a key issue to be talk about among fellow safety and health researchers and practitioners. It is because, the implementation in this area of business remains neglected and a systematic approach towards implementation and research need to be intensively pursued as a goal for future development. High rates of injury are primarily due to inadequate OSH management system (Bakri, Zin, Misnan, & Mohammed, 2006). Therefore, the implementation of OSH management system in SME sector can hopefully reduce the occurrence of accidents, injuries and work-related disease.

Small and medium enterprise in Malaysia

Small and medium enterprises (SME) in Malaysia have played a pivotal role in the economic development and contributed significant figures in the country's Gross Domestic Products (GDP). According to the data released by the National SME Development Council (NSDC), companies falls in the SME category which have less than 150 employees, made up 99.2% of all firms in 2011, offering 59% of jobs in all sectors and contributing 32% towards the nations' GDP (SME Annual Report, 2012). In the EU economy, SMEs make up 99.8% of non-financial enterprises, providing an estimated 67% of jobs and contributing 58% to the region's gross value-added (GVA). The same trend is also observed within the ASEAN member states, where SMEs form 96% of all enterprises, contributing a significant 50 - 95% in domestic employment and 30 - 53 % to gross domestic products (GDP). Despite the staggering numbers and the significant roles that the SMEs played in, very little attention was given from the occupational safety and health (OSH) researchers not only in Malaysia, but the problem persists across the world.

Since 2005, the SME definition that has been used across all ministries and agencies, financial institutions and regulators are as follows:

- Manufacturing (including agro-based) and Manufacturing-related Services: Sales turnover of less than RM25 million OR full-time employees of less than 150.
- Primary Agriculture and Services (including ICT): Sales turnover of less than RM5 million OR full-time employees of less than 50.

However, due to the many developments that Malaysia has undergone since 2005 such as price inflation, structural changes and changes in business trends, new SME definition has been reviewed by the NSDC in 2013 at the 14th NSDC Meeting in July 2013 (Guideline for New SME Definition, 2014). The new definitions are:

- Manufacturing: Sales turnover not exceeding RM50 million OR full-time employees not exceeding 200 workers.
- Services and other sectors: Sales turnover not exceeding RM20 million OR full-time employees not exceeding 75 workers.

A business will be classified as an SME if it meets either one of the two specified qualifying criteria that are sales turnover and full-time employees, whichever is the lowest. The definitions have been detailed and classified by their size of operation. The details of the definitions are as per figure below:

Upon this definition, if a business fulfils either one of the criteria, the smaller size of the industries will be applicable. For example, if a firms' turnover falls under medium enterprise but the full-time employees fall under small enterprise, then the firm will be considered as a small enterprise (Guideline for New SME Definition, 2014).

Challenges Faced by the Small and Medium Enterprise in Malaysia

Small and medium industries across the world proves to be an essential building block in a nations' economy. However, these companies cannot strive without having to faced some obstacles. According to (Khalique, 2011) there are several challenges that have to be faced by the country's SME in order for them to survive due to the economic environment changing towards services and knowledge-based economy. Among the challenges are barrier from global sourcing, low productivity, lack of managerial capabilities, and lack of financing, difficulty in accessing management, technology and heavy regulatory burden. These challenges can prevail companies in the SME sector from moving forward and thus limiting their contribution towards the economy. (Ali Salman Saleh & Ndubisi, 2006) also stated that SME in Malaysia are facing new challenges both domestically and globally. The challenges are:

i. Intensified global competition
ii. Competition from other producers (e.g China and India)
iii. Limited capability to meet the challenges of market liberalisation and globalisation
iv. Limited capacity for technology management

Category	Small	Medium	Microenterprise
Manufacturing	Sales turnover from RM300,000 to less than RM15 million OR full-time employees from 5 to less than 75 workers	Sales turnover from RM15 million to not exceeding RM 50million OR full-time employees from 75 to not exceeding 200 workers	Sales turnover of less than RM300,000 OR less than 5 full-time employees
Services and other sector	Sales turnover from RM300,00 to less than RM 3million OR full-time employees from 5 to less than 30 workers	Sales turnover from RM3 million to not exceeding RM 20 million OR full-time employees from 30 to not exceeding 75 workers	

and knowledge acquisition

v. Low productivity and quality output

vi. A shortage of skills for the new business environment

vii. Limited access to finance anf capital, and the infancy of venture funds in initial or mezanine financing

viii. The high cost of infrastructure

ix. A general lack of knowledge and information

On the other hand, (Ali S Saleh, Caputi, & Harvie, 2008) stated that perceptions towards government policies and infrastructure availability are considered as a major barrier for business to succeed. Challenges like this must be addressed in order for small and medium industries to thrive and have a brighter future in business development for the future.

Occupational safety and health management system in SME

Occupational safety and health main concern is preserving and protecting human and facility resources in the workplace (Friend and Kohn, 2007). It is also a field where catastrophic losses can be prevented by identify, assess and take certain action in order to eliminate or minimize the probability of the event to occur. In Malaysia, there are many agencies that are committed on ensuring safety and health practices in the workplace are being conducted such as Department of Occupational Safety and Health (DOSH), the National Institute of Occupational Safety and Health (NIOSH), Social Safety Organization (SOCSO) and many other OSH related agencies. These agencies are obligated not only to ensure the application of safety and health practices, but also involved in protecting human rights at the workplace economically, morally and legally.

A study done by (Jørgensen, Duijm, & Troen, 2010) stated that installing OSH management system for collecting information on the activities and hazards associated with a certain occupation proved to be very easy and useful. An OSH management system always associated with large company particularly Multi-National Company (MNC) as they have the financial source and the workforce to implement and enforce the system. As stated by (Floyde, Lawson, Shalloe, Eastgate, & D'Cruz, 2013), organisation and management of knowledge within organisations is an important factor in business success. Occupational safety and health is a field where knowledge management is often used and it proved to be effective. Several studies have found a very large gap in this area between the SMEs and the MNC. As stated above, the financial power and the vast available resources in MNCs are some of the factors leading to this gap. While the effectiveness of implementing OSH management system was proven by the MNCs, the SMEs participation in this area is scarce. This is because some of the problems faced by the SMEs such as financial and managerial skill appear to be a stumbling block for them as they cannot afford to do so. Other problems include low commitment from the managers and the workers, low level of OSH inspection, low awareness level of OSH in the workplace and a tendency to take a backdoor upon dealing with accidents in the workplace. With these problems, SME will face major problems in practicing occupational safety in the workplace according to the OSH Master Plan 2015 and also facing a problem to produce a safe and healthy workplace for a sustainable development in the future.

Implementation of OSH Management System in SME

Safety and health practices in the small and medium enterprises has been attracting attention of researchers and safety practitioners lately. There are not much research has been done on the implementation of OSH management system in SME and few results were gathered in this area. According to (Kongtip, Yoosook, & Chantanakul, 2008), SME companies implements OSH management system mainly because their products are the country's most exported products or because their customers wanted them to. This proves that most of the SME owners have a relatively low awareness on safety and health practices and only implement it because they were told to do so.

Despite the low awareness, (Gervais *et al*, 2009) stated that the cost of poor safety and health practices particularly in SME can be substantial. For example, in the European Union (EU) in 2000, the cost of workplace accidents amounted to 55 billion Euros or equivalent to 0.64% of the GDP while 1250 million working days were averagely lost each year due to health problems. These impacts can subsequently halted the development of SME sectors and most importantly can affect the country's GDP. The economic performance of implementing OSH management system can be measured by applying cost-benefit ratio (CBR) in the afforementioned sectors (Gervais et al, 2009). This ratio can be achieved by using several analysis such as cost-minimization analysis (CMA), cost-benefit analysis (CBA), cost-utilization analysis (CUA) and cost-effectiveness analysis (CEA). However, cost estimates like this do not have the desired impact as there is no agreed methodologies for cost estimation and the enterprises seems to ignore them in their decision-making process (EU-OSHA, 2013). Therefore, (EU-OSHA, 2013) also suggest that research should focus in the socioeconomic aspect of the company and the factors that promote or hinder the consideration of OSH issues at the company level to better understand on how to integrate OSH into the company's daily decision-making process.

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Methodology

Data Collection

There are currently 5912 companies registered under SME Corp for the northern region of Malaysia that consist of the state of Johor, Melaka and Negeri Sembilan. 500 companies will be chosen randomly and a series of questionnaires will be distributed to this company for data collection. The questionnaires will be divided into three sections that covered:

i. Company information (sectors, number of employees and age)

ii. OSH management (number of hours spend on OSH related activities, awareness towards OSH, safety information)

iii. Accidents and prevention (accident rates, acts and preventive measures, management commitement)

The questionnaires will be in a 7 point Likert scale to ensure correct data measuring.

Data Analysis

The data collected in this research will be analyzed using statistical tools such as SPSS and Microsoft Excel to determine the end result of the research. Statistical techniques such as descriptive statistics, frequency distribution and many other will be used to analyze the data collected.

Site Visit

Site visits will be done in several companies particularly in sectors that have the potential for accidents to occur. The selection of the companies to be visited will be based on the statistical figures of accidents that had happened in the industry that were released by the Department of Occupational Safety and Health (DOSH) or the Department of Statistics. Face to face interviews also will be conducted in order to have a deeper perspective into the safety and health practice in the company.

Expected Results

This study expects to determine the relationship between managing and implementing occupational safety and health practices in the Small and Medium Enterprise and the benefit of implementing it can bring financially, morally and legally.

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Development of Safety and Health Performance Indicators for SMEs

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Abstract

The aim of this paper is to share views on the Safety and Health Performance Indicators (SPIs) for the Small Medium Enterprises (SMEs) to assist SMEs in improving their business performance, growth and resilience through effective Safety and Health Performance Management framework. Traditionally, industries are relying on the "lagging" indicators of safety and health performance. Lagging indicators are limited due to the reactive approach and to some extent, they create complacency among the industries which do not have any accidents or to the SMEs which face low risks at work. As a result to their limitation, there has been a move in using "leading" indicators in measuring safety and health performance in the industries. SMEs are important to Malaysia. However their contribution to the workplace accident statistics is equally substantial. They are the major contributors to 80% of the total accidents. Hence, effective Safety and Health Performance Indicators is indeed crucial to assist SMEs in measuring their safety performance to enable them to move forward in achieving safety culture which is good for their business to stay strong and resilient in this new business millennium.

Keywords: Small Medium Enterprises, Accidents/Illnesses, Safety and Health Performance Indicators, Safety Culture

Introduction

Malaysia Prime Minister, Y. Bhg. Dato' Sri Mohd Najib Tun Haji Abdul Razak mentioned in the SME Annual Report 2012/13, that Small Medium Enterprises (SMEs) development in the country has evolved over the years and continuously supported the growth of multinational companies and large firms operating in Malaysia. They have become the nation's future engine of growth.

SMEs development is also important in the context of inclusive and balanced growth as three-quarters of the nation's business establishments are micro enterprises, involving the bottom 40% of the income group (SMECORP, 2013). The most recent data indicates that SMEs now account for more than 90% of all the establishments in the manufacturing, services and agricultural sector, providing around 65% of total employment in the country. The value added production of SMEs is expected to be around RM120 billion or 50% of total production in the manufacturing sector in Malaysia by year 2020. It is no doubt that SMEs play a significant role in the development of Malaysian companies (Kannan P., 2013).

Literature Review

Small Medium Enterprises in Malaysia

SMEs have long been recognized as the backbone to any economy as they have been an important generator of employment and growth. Currently there are 645,136 SMEs all over Malaysia. Malaysia Prime Minister, Y. Bhg. Dato' Sri Mohd Najib Tun Haji Abdul Razak mentioned in the SME Annual Report 2012/13, that SMEs development in the country has evolved over the years and continuously supported the growth of multinational companies and large firms operating in Malaysia. They have become the nation's future engine of growth. SME development is also important in the context of inclusive and balanced growth as three-quarters of the nation's business establishments are micro enterprises, involving the bottom 40% of the income group (SMECORP, 2013). SMEs in Malaysia may be categorized into three sectors, namely; general business, manufacturing and agriculture (Khairuddin, 2000). SMEs were given new definitions in 14th NSDC Meeting July 2013. The new definitions are as follows:

i. Manufacturing: Sales turnover not exceeding RM50 million OR full-time employees not exceeding 200 workers

ii. Services and other sectors: Sales turnover not exceeding RM20 million OR full-time employees not exceeding 75 workers

A business will be deemed as an SME if it meets either one of the two specified criteria, namely sales turnover or full-time employees, whichever is lower (SMECORP, 2013).

Salleh and Ndubisi (2006) explained that even though many governmental programmes have been implemented in boosting the performance of SMEs, Malaysian SMEs still face challenges, both domestically

and externally, which could obstruct their hardiness and aggressiveness. Sin (2010) supported Ting's finding based on the SMIDP's 2001 – 2005 study report which stated that SMEs in Malaysia are facing many new challenges, domestically as well as globally. These challenges include intensified global competition; competition from other producers (for example China and India); limited capability to meet the challenges of market liberalization and globalization; low productivity and quality output; a shortage of skills for the new business environment; limited access to finance and capital and the infancy of venture funds in initial or mezzanine financing; the high cost of infrastructure; and a general lack of knowledge and information. These challenges could be the reasons for the low priority given to safety and health in SMEs.

A previous study conducted by Surienty, L (2012) in "Management Practices and OSH implementation in SMEs in Malaysia" found that SMEs contributed to 80% of the total accidents in the country. Likewise, results from audits conducted by DOSH for 2600 SMEs in 2002 also showed poor compliance of SMEs in Malaysia. Based on the survey carried out by Deros, M. B. *at al*. (2012), among the top three reasons given by the SMEs why they were unable to conform to the OSH regulations are "no knowledge" (34.9%), "difficult and expensive" (27.9%) and "low risk" (23.3%). Understanding the constraint and challenges faced by SMEs, it is necessary to assist them in improving their business performance, growth and resilience through effective OSH performance management. Hence, the development of effective Safety and Health Performance Indicators (SPIs) are certainly important for SMEs.

Performance Management

Performance management is a strategic and integrated approach to delivering sustaining success to organizations by improving the performance of the people to achieve their corporate and functional strategies and objectives. (Bittci, Carrie & McDevitt, 1997; and Armstrong & Baron, 1998). Performance management comprises the systems, processes, structures and supporting arrangements established by management to identify, assess, monitor and respond to the performance issues in an organization (Harlow Council, 2013). According to Dr. Aubrey Daniels (2000), performance management is a scientifically based, data-oriented management system which consists of three primary elements namely measurement, feedback and positive reinforcement. As a matter of fact, it can be said that performance management is about creating a culture in an organization which allows individuals and groups to take responsibility and thus continuously improve their own skills and behaviour and drive the business excellence. In terms of safety and health perspective, through effective Occupational Safety and Health Management Systems (OSH-MS) which act as a tool in the performance management, measurement of the safety and health performance of an organization to drive success in establishing safety culture can be done.

Occupational Safety and Health Management Systems

Occupational Safety and Health (OSH) is a discipline dealing with the prevention of work related injuries and diseases as well as the protection and promotion of the health of workers. It aims at the improvement of working conditions and environment and ultimately achieving safety culture in an organization. OSH is good for a business as well as being a legal and social obligation.

OSH-MS is one of the tools used to improve business' safety and health performance, making changes for better organizations and continual improvement by ensuring that OSH matters are integrated across the business operation. It also contributes in improving the organization's image. A D LaMontagne *et al* (2004) quoted Frick K in their journal which stated that in the past two decades, OSH-MS have emerged internationally as a major strategy for addressing workplace safety and health. For SMEs, OSH-MS will act as a platform to determine a comprehensive and effective SPIs.

OSH-MS is based on the principle of the "Plan-Do-Check-Act" Deming Cycle (PDCA), designed in the 1950s to monitor business performance on a continual basis. OSH-MS is a logical toolbox that is flexible and can be tailored to the size and activity of an organization and can be focused on general or specific hazards and risks associated with such activities. This is in line with the self-regulations concept introduced in Occupational Safety and Health Act (OSHA) 1994. OSH-MS supports the organizations to cope and manage effectively, efficiently and competently with the fast changing and complexity nature of the work to remain resilient to future global shocks. Indeed, this feature makes OSH-MS an important tool for SMEs in managing their safety and health hazards at the workplace to reduce accidents, damage and poor health in order to stay strong and

Figure 1: OSH Elements (adapted from ILO- OSH 2001), Source: DOSH, 2011

resilient in this new business millennium. The OSH-MS framework adopted by Malaysia is shown in Figure 1.

OSH-MS acts as the "leading" safety performance indicators or based on proactive approach which enable employer to anticipate and respond to the changing circumstances and take actions to achieve desired outcomes or avoid unwanted outcomes (Mearns, 2009). Indeed, "leading" safety performance indications will limit the dependency of organization on the traditional "lagging" indicators which are based on reactive approach

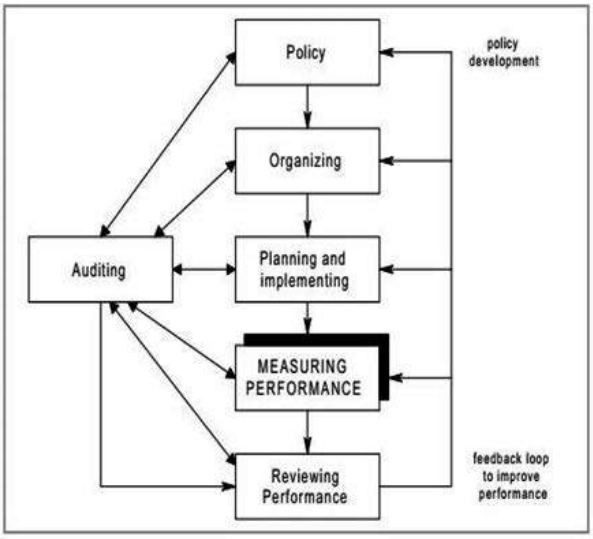

Figure 2: Performance measurement within the OSH management system (adapted from HSE, 2001) Source: Petro M. Arezes et al., 2003

and not portraying the overall safety performance in an organization. Figure 2 shows the use of OSH-MS in measuring the safety and health performance for an organization.

Safety Performance Indicators

Peter Drucker said "you can't manage what you can't measure". OSH performance measurement is an important part of the management of OSH. The measurement of OSH performance enables the detection and resolution of problems and provides information needed to evaluate the effectiveness of organizational OSH initiatives. (HSE, 2001 quoted by Pedro M. Arezes *et al*., 2003). It also helps the organization to design and develop new OSH intervention to continually improve the safety and health performance.

Traditionally, industries are relying on the "lagging" indicators of safety and health performance. "Lagging" indicators measure an organization's incidents in the form of past accident statistics, for examples the injury frequency and severity, Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease recordable injuries, lost work days and worker's compensation costs. Some organizations also report "lagging" indicators in the form of compliance, indicating, for example how many citations and penalties or fines relating to safety and health issues the organization had, in the period of being measured. In SMEs or low-risk organizations, the use of "lagging" indicators provides limitations because a hypothetical low accident rate can lead to complacency. Therefore, as a result to its limitation, there has been a move in using "leading" indicators in measuring safety and health performance in the industries.

"Leading" indicators of safety can be defined as indicators that change before the actual level of risk to which people are exposed changes (Kjellèn, 2009). "Leading" indicators offer advantages in terms of providing a more direct measure of how well an organization is managing safety and health risk so that the occurrence of accidents, which include an element of chance and providing an immediate feedback mechanism, enabling organizations to improve OSH management processes, before deficiencies resulted in incidents, injuries or illnesses (Hinze *et al*., 2013). In short, "leading" indicators measure proactively what "lagging" indicators explain of safety and health in an organization and act antecedents to organizational safety rather that consequences of organizational safety. However, the "leading" indicators chosen must be directly related to the organization's overall goals and objectives to ensure the right measurement takes place and provides outcome of improvement of the safety and health performance. If chosen correctly, "leading" indicators can drive an organization towards increasing level of maturity in safety and health awareness. "Good input, Good output performance".

"Leading" indicators can be determined within the context of a formal management system. According to Fleming, 2001, "leading' indicators are management commitment and visibility, communication, productivity versus OSH performance, learning organization, OSH resources, participation, shared perceptions about OSH, trust, industrial relations and job satisfaction and training. (ICMM, 2012).

Besides, safety culture elements can also be used as "leading" indicators. A successful safety culture is based on the eight core elements namely management commitment to safety; job satisfaction; training, equipment and physical environment; organizational commitment; worker involvement; co-worker support; performance management; and personal accountability. (Jackson et al, 2012) The culture of an organization represents certain predefined policies which guide the employees and give them a sense of direction at the workplace so that each and every one is clear about the roles and responsibilities in the organization and know how to accomplish the tasks ahead of the deadlines. In addition, the existence of safety and health policy which evidenced the "self-regulation" principle under Occupational Safety and Health Act 1994 provides a platform in driving the safety and health performance of an organization moving towards the achievement of a safety culture.

Safety Culture

Safety culture is the ways in which safety is managed in the workplace, and often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety. Cox, S. & Cox, T.(1991) IOSH (2009) stated that safety culture was associated with the safety performance at the corporate level. This association was positive, showing that a more favourable safety culture was associated with improved safety performance. Certainly safety culture elements are able to act as the "leading" indicators to measure the safety and health performance of an organization.

Recognizing the importance of safety culture, the Government of Malaysia has taken an initiative by developing the Occupational Safety and Health Master Plan (OSH-MP) for Malaysia 2015 to create, cultivate

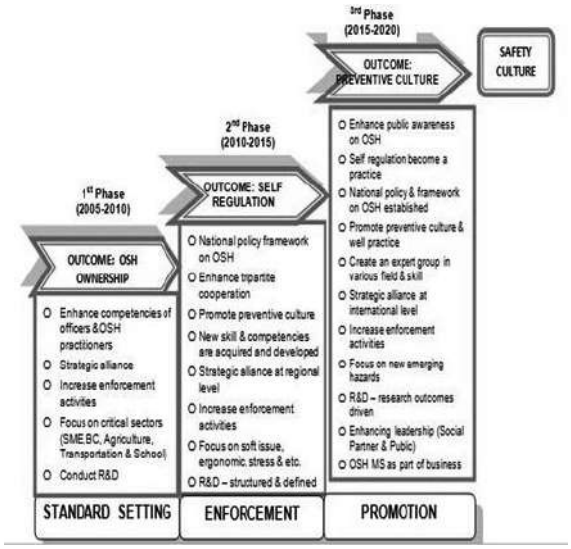

Figure 3: OSH Strategic Drives

and sustaining a safe and healthy work culture in all organizations throughout Malaysia. OSH-MP 15 (Figure 3) is intended to increase the awareness, knowledge and commitment to OSH in all undertakings to reduce injuries, diseases and fatalities through its three phases namely; OSH Ownership, Self-Regulation and Preventive Culture.

To achieve OSH-MP15, four key strategies have been identified as illustrated in Figure 4. Strategy 2 of the OSH-MP15 is to inculcate preventive workplace culture. The outcomes of this strategy are, by year 2015, reduced occupational fatality and occupational injury rates as follows:

- Work-related fatality rate down by 20% from 12.4 fatalities per 100,000 workers and
- Work-related injury rate down by 30% from 6.1 injuries per 1,000 workers.

In achieving the outcomes, one of the recommendations is for both employers and employees to have advanced injury prevention knowledge and

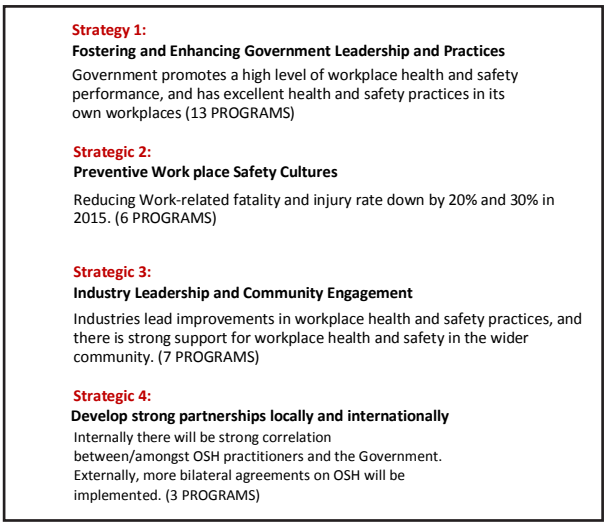

Figure 4: Four Key Strategies

information in OSH. This can be achieved through lifelong learning practice in the organization. Educated and well-trained employees are a prerequisite for an organization's competitive advantage (Tung-Chun, 2001). The importance of OSH education is also being emphasized in the OSH-MS under element "Organising" Clause 3.2.2 Competence and Training. Hence, the OSH-MP 15 can also be used as the "leading" indicators to measure the safety and health performance for an organization.

Conclusion

SMEs have long been recognized as the backbone to any country economy as they have been an important generator of employment and growth. Even though SMEs are important to the country, their contribution to workplace accident statistics is equally substantial. This could be due to the nature of SMEs which face constraints in terms of human resources, shortage of information on customers and potential markets, lack of access to finance, global competition and limited capacity or inability to cope with the great challenges in business. Safety culture is the ways in which safety is managed in the workplace, and often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety. Cox, S. & Cox, T.(1991) IOSH (2009) in their research findings stated that safety culture was associated with the safety performance at the corporate level. This association was positive, showing that a more favourable safety culture was associated with improved safety performance. Understanding the constraint and challenges faced by SMEs, it is necessary to assist them to reduce or even eliminate workplace injuries and illness through OSH performance measurement. OSH performance measurement enables the detection and resolution of problems and provides information needed to evaluate the effectiveness of present organizational OSH initiatives which currently most industries are relying on the "lagging' indicators. The adoption of OSH-MS among SMEs and the move toward establishment of safety culture in SMEs will act

as the "leading" indicators to ease them in tracking their OSH performance. As a result, SMEs will stand strong in this new millennium business.

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Osh Audit Compliance At National Service Training Programme (NSTP) Camps In Malaysia: Training Elements

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Abstract

There were a number of accidents reported throughout the implementation of the National Services Training Programme (NSTP) since 2004 until 2012. The National Services Training Department (NSTD) is responsible for the Occupational Safety and Health (OSH) aspects in the NSTP camps. The study was conducted with its objective to compare the levels of OSH audit compliance at NSTP between 2011 and 2012. A cross sectional method was used, involving a total of 67 randomly selected NSTP camps. The data analysis was conducted on two types of audit checklists using SPSS version 2.1. The r-value of 0.197 obtained indicates a weak relationship between the document review and physical training element. The p-value of 0.118, meanwhile, shows that there is no statistically significant correlation between the results of document review and physical training element. Most of the elements show an increased percentage of compliance as a result of initiatives taken by the Camp Training Management and the Camp Operator. Despite an improved compliance level seen from 2011 to 2012, NSTD should look into certain critical elements considered high risk by the regulatory requirements. NSTD should also continue with its initiatives to enhance safety and health aspects in NSTP camps not only for the benefit of the trainees but also for themselves.

Keywords: NSTD, Document review, Training elements, Physical inspection, Audit

Introduction

National Service Training Programme (NSTP) is a programme designed specifically for the development of human capital to the post Sijil Pelajaran Malaysia (SPM) students, drawn up by the Malaysian government (NSTD, 2011). NSTP is one of the programmes for development of personality among Malaysian's youths, initiated by the government since 2004 through the gazettement of National Service Training Act 2003 (Act 634) (JLKN, 2011). Being a joint venture alliance established between NSTD Infrastructure Management Division and National Institute of Occupational Safety and Health (NIOSH), the implementation of OSH at NSTD camps has become one of the main agendas of NSTD. Ab. Aziz Yusof (2002) stated that occupational safety and health is one of the human resource management activities, which is important as it serves to protect workers from injuries and accidents while working. Therefore, the National Service Training Department (NSTD) as a responsible organization has taken some proactive steps in the OSH implementation (Mohd Azlan Jaafar, 2011).

This study was conducted to compare the levels of OSH audit compliance at NSTP between 2011 and 2012 in Malaysia. Other objectives were to identify NSTP camp zones under audit compliances score for training elements. Audit programmes on training elements have been established to ensure the compliance of NSTP to the legislation and also OSH guidelines. The Audit has been conducted in two parts, consisting of documentation and physical training elements.

Throughout the establishment and implementation of NSTP from 2004 until 2012, there were several cases of accidents reported, due to diseases and unsafe practices during training. Daily News reported, "the Director-General of NSTD: Only a total of 8 deaths recorded over the establishment of NSTP" (The Star, 2010). Although the reported number of deaths is small compared to the total number of trainees, the National Service Training Council (NSTC), established to monitor the progress of the training programme, has suggested that more proactive measures should be taken to completely prevent accidents from happening in NSTP camps.

Methodology

This is a cross sectional study carried out at NSTP camps where a total of 67 NSTP camps were selected from the 82 NSTP camps operating throughout Malaysia. The data obtained was a secondary data, namely the

percentage of marks obtained by all the PLKN camps as a result of the audits carried out, the first stage being in the period of February to May 2011 and the second stage May to November 2012. The audit checklist consists of documentation checklist and training elements physical inspection checklist. Percentage scores are based on scores of compliance with documentation requirements on camp to camp infrastructure management, documentation management of the training camps and training infrastructure needs on physical examination. The data was analyzed using 'Statistical Package for the Social Sciences Version 21.0 (SPSS v21.0). The specific objective was determined by applying Pearson Correlation and Sig (2-tailed) analysis.

Results and Discussion

Based on the results obtained, most of the camps show an increased level of compliance either in document review or training element physical inspection parts. Overall, for Camp Operator (CO), the percentage of compliance increased in 21 elements (an increase of 87.5%). For Camp Training Management (CTM), out of 24 elements audited in 2011 and 2012, a total of 22 elements show an increased number of compliance (91.7%) in 2012.

In training elements, there are 6 courses, some being mandatory to be done. The first course is on obstacle, mandatory to be operated at NSTP camps. The second course is on low ropes while the third on initiatives. These three courses show an increased percentage of compliance in majority of the elements from 2011 to 2012. For the obstacle course, the numbers of compliance increased in 16 elements from the total of 26 elements (16/26). For the low ropes course, the numbers of compliance increased in 10 elements from the total of 15 elements (10/15). While, for the initiatives course, the numbers of compliance increased in 16 elements from the total of 18 elements (16/18). For the high ropes course, high ropes equipment storage area course and water element course, the increases in compliance are (29/46), (13/21) and (7/9) respectively course. From 46 elements of high ropes course, 29 elements show an increased percentage of compliance which it is about 72.5% from total elements. Fifth part is high ropes equipment storage area and from 21 elements audited in these parts, 13 elements show increased percentage of compliance. Water element is the sixth part to be audited during OSD audit program. There are 9 elements in this part and from 9 elements, 7 elements show increased level of compliance.

The increases in compliance from 2011 to 2012 more than fifty percent of elements in every course show us that the commitment given by both CO and CTM in the audit programme was very good. Nevertheless, this is not enough to verify that the NSTP is safe, since most of the non-compliances were elements of physical form which are critical since they could cause serious injuries and are high risks in nature.

In identifying the association between documentation review and training element physical review, Table 1.0 shows the results using Pearson Correlation and Sig (2-tailed) analysis. The *r*-value is 0.197 which shows that it is a weak relationship between both variables since it is close to 0 value. *p*-value of 0.118 shows that there is no statistically significant correlation between document review result and training element physical result. This means that, increases or decreases in document review result do not significantly relate to increases or decreases in training element physical results. Even though most of the elements inspected during audit are listed or stated in the document, it does not mean that both had a dependency on each other.

Table 1.0: Correlation between Document Review Results and Training Element Physical Results

Variables	Pearson Correlation (*r*-value)	Sig (2-tailed) (*p*-value)
Document review results Training element physical results	0.197	0.118
p-value is significant it is ≤0.05		

Overall, from the data review, training element inspection and interview session, some aspects that affect the results are the commitment from CO and CTM in applying safety and health requirements in their job routine, lack of staff competent in safety and health, lack of safety and health competency training among staffs and lack of procedure and standard operating procedures.

Conclusion

For the conclusion, the number and percentage of compliance in OSH audit increased from 2011 to 2012 either in documentation review or training element physical results. However, in certain important aspects, further analysis and improvement are needed because of the risk created by a particular element. Collaboration between NIOSH and NSTD will ensure that every important aspect related to safety and health issue in National Training Services Programme is given a priority. Cooperation between camp operator and NSTD is important and it is not impossible for the safety and health values to be absorbed into trainees' mindset.

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Behaviour-Based Safety (BBS) Implementation Reduce Incidents at the Workplace in Major Industry

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Abstract

Unsafe behaviour is the key factor which contributes to the high number of incidents. Applying Behavior-Based Safety (BBS) into safety risk controls has been adopted in major industry toward improving safety performance. This approach to prevent incident has a number of advantages. The objective of this study is to identify the BBS factors which can contribute to reduce incidents at the workplace. Human factors, behaviour and environment have been identified as BBS factors. Human factors are influenced by knowledge and understanding of the workers while behaviour factors are influenced by culture and practices in a daily life. In addition, environmental factor involves equipment and work area. For an effective BBS approach, level of knowledge, understanding and practices by the workers become the main concerns in the implementation of BBS. The findings can become the reference model for future implementation in other organizations and as a guidance for better safety management.

Keywords:BBS, behaviour, safety performance, risk control

Introduction

Effective risk control plays an important role to prevent accidents at the workplaces. However, worker's attitude while doing works can create major impacts on risk control. Personal Protective Equipment (PPE), systems, procedures and good engineering controls are not enough if the workers do not practise safe behaviour.

Currently, safety awareness among most employers is increasing. Many efforts have been taken to ensure that employees are in a safe and healthy condition while at work and doing their task.

Accidents at the workplace can occur due to many causes, such as, employee carelessness, not wearing proper PPE and maintenance of the equipment not being carried out. Accident can happen when employees do not perform safe practices. Although numerous efforts, programmes and promotions have been done, employee's carelessness still exists and accidents keep occurring.

Accidents among employees carry serious implications such as fatality and disability which incur cost. For example, compensation expenses paid by SOCSO for the year 2012 due to accidents amounted to about RM 2 billion. Occupational accident statistics for the year 2013 showed that the number of accidents was increasing as reported by DOSH. Manufacturing industry contributed to the highest number of accident involving about 1655 victims. Therefore, this study will focus only on the major manufacturing industry with the hope to assist industries to reduce number of accidents at the workplaces.

Behavioural-based Safety or BBS is a process and an approach to improve safety and health performance at the workplaces through observation and feedback to the people (employers/employees) to change their behaviour. (Mann, 2014: Geller, 1994). This program is based on research conducted by Heinrich(1931). He concluded that 80% to 90% from the accidents and injuries at the workplaces are caused by unsafe acts. At risk work behavior become the main problem contributing to the accident at the workplaces. (Geller,1999). Most of the major industries has introduce and implement BBS to overcome this problem.

This study was conducted to identify factors that

contributed to the accidents in major manufacturing industries and identify the level of BBS awareness at the workplaces. Although training has been given to the workers, behavior plays an important role in reducing accidents. Several studies have previously been done to identify factors that influence the BBS, however, this studies is conduct to identify contributing factors to BBS in the major manufacturing industries and make revisions to previous studies.

Problem Statement

Statistic reported by DOSH, 2013 has shown that the number of fatality and permanent disablement cases due to accident at the Malaysia industries is the highest as compared to the other sector. Even though the number of industrial accidents decreasing but the benefits paid to the accidents victims are ever increasing. By identify factors that contributed to the accidents in major hazard industries and level of BBS awareness at the workplaces, related planning and program can be established. Although training has been given to the workers, behavior plays an important role in reducing accidents. Several studies have previously been done to identify factors that influence the BBS, however, this studies is conduct to identify contributing factors to BBS in the major manufacturing industries and make revisions to previous studies.

Objectives

The purpose of this study is to :-

1. Identify BBS factors contributing to accidents
2. To identify the level of BBS awareness in major industry

Literature review

Organisational Culture

Human can create and program a machine to be able to work quickly and accurately everyday. This machinery will not complain even if been used everyday regardless of the time. However, worker is not a machine that can be programmed to perform task without interruption. The most challenging task at the workplaces is to manage workers to enable them to properly carries out it duties and the most importantly is safely. BBS not only involves procedure and discipline but also a commitment from the top management to improve safety at the workplace.

BBS is an effective method in reducing accident at the workplace (Purdue, 2000). If BSS fully implement, it will be more effective. After a few years, BBS have been implements by organisation as one of the risk control method. Risk control become more dependent on the procedures, warning signs and PPE, in line with worker's behaviour improvement to comply to the existing regulations (Sulzer-azaroff & Austin, 2000).

However, the implementation of the BBS will not completely replace the risk control hierarchy. BBS actually is in addition to the existing hierarchy of risk control. For example, it is the responsibility of the workers to follow and comply with the instruction given by the employers if the management is to provide procedures, warning sings and PPE. BBS may be applied to internalise hazard avoidance strategies or administrative controls (including use of PPE), but should not be used in preference to the implementation of reasonably practicable safety measures further up the hierarchy. Failure to follow and comply with the instruction is actually at-risk behavior. To reduce workplace incidents, the management and workers should be actively involved in identifying hazard and promoting safe behaviour practices.

The objective of this study is to identify factors which influence the implementation of BBS in the workplace. According to Geller , there are 3 main factors which contribute to the safety culture which is Human, behaviour and environment.

Human as an activator

Human, become the main factor contributing to BBS. Human refers to the individuals who have knowledge, experience, ability, motivation and personality. Human factor are influenced by many situation such as safety training received, workload and level of understanding (Geller 1994).

Study from previous researchers also mention about the factors that influence BBS. Top management and safety training are among the factors that affect safety management in SMEs (Liu, Mei, & Shen, 2010). In addition, enforcement by the authority and top of the management are Human factors(LI, 2009). Furthermore, the efective supervision from superior also plays an important role in Human factors (Luria, Zohar, & Erev,2008). Self confidence, involvement from the workers and support form top of management are hopefully to create safety culture (Depasquale & Geller, 1999).

Behavior by the workers

Behavior refers to compliance, coaching, recognition, communication and action. Behavior factors mostly influenced by culture and practices that are used in daily life (Geller, 1994).

Behavior is simply anything someone does or says. Psychologically, behaviors are actions or reactions of per-sons or things in response to external or internal stimuli. Over the past decade, much research has been conducted on Ajzen and Fishbein's (1980; Fishbein and Ajzen, 1975) theory of reasoned action. According to the theory, behavior is determined by the behavioral intention to emit the behavior. The theory proposed that behavior is affected by behavioral intentions which, in turn, are affected by attitudes toward the act and by

subjective norms (Fishbein and Ajzen, 1975).

Safety culture which is implement by the industry influence the attitude and behaviors of the workers are the behavior factors (Geller, 1994). Safety work practices can improves safety performances at the workplace. Communication among collegues such as criticize the collegues bad practices is a good example. To ensure safety culture implementation, workers need to be concerned overall safety aspect and they should believe that they can control their own organisation's safety. Reward may become the catalyst to the workers to the implementation of overall safety. (Al-Hemoud & Al-Asfoor, 2006).

Environment Effect

Environment refers to equipment, machinery, housekeeping, weather and temperature changes, and engineering (Geller, 1994).

From the previous study by other researchers, it is stated that environment factors such as machinery, equipment and engineering aspect also will involved workers behavior (Geller, 1994).Environment scope also covers selection of equipment, purchase of equipment according to specification and also good housekeeping (L.Ostrom, C.Wilhelmsen,1993).

Behavior Based Safety

Although the main purpose of most safety programs is to change behavior, it should be emphasized that the unwanted behavior will not be changed as soon as possible unless beliefs, attitude and value that lead and support been given a priority. (Topf, D. Michael & A. Petrino, 1995)

The program which focuses on workers awareness, attitudes and thinking will become most effective method for reducing incidence at the workplace. This program advantage the organisation in return and improve the competetiveness of the companies.

Human motivate to perform a task as an inducement either positive or negative, through gifts and punishment. Human will be happy if they get a reward and feel unhappy if they get punishment. Workers should always be motivated to maintain an optimum spirit. Although workers need to be given words of encouragement to motivate, but awarenes should arise from the workers own self , starting from the commitment of each workers to remain safe.

Several organization already implement BBS program. BBS program implement observation and feedback concept. Before BBS program is fully implemented, awareness training must be given to all level of workers. In addition, training to the observers also need to be conducted to ensure the observer get a correct and accurate picture when doing the observation.

Observations were conducted on workers while performing their work and identify at risk behavior that exist. Feedback will be given to the workers regarding their behavior shown. For workers who perform work with safe behavior, praise given to encourage them to continuously implement good behavior. However, for workers who perform at-risk behavior, root cause of the behavior will be identified. Causes of at-risk behavior should be eliminate to achieve BBS culture. Workers will be interviewed to obtain neccessary information. Workers also will be provided with the solutions to improve their behaviors.(Sulzer-azaroff & Austin, 2000).

Implementing BBS is a cost effective approach and previous study suggest Return On Investment (ROI) of 281% resulting from reductions in incidents, insurance premiums and workers compensation (D. Cooper, 2010).

Methodology

Research Design

This study will cover major manufacturing industry in Malaysia.

Sampling Design

Sampling will involved registered Safety & Health Officer (SHO) with DOSH and involved all SHO in Malaysia. There are 2007 registered and active SHO which covers all industries. However, only 40% of 2007 or 802 person are from industries. 60% of 2007 are form construction industries. The sampling also focuses only to those major manufacturing factory.

Data collection

Data collection which covers online and offline questionnaire will be used. Online questionnaire is used as a fast and easy approach to use by respondent. In addition, respondents may easily answer the question at any time they are either on a computer, laptop or smart phone. However, the use of an online questionnaire also has some disadvantages. Among the disadvantages are registered SHO did not answer the questionnaires given, SHO did not open and read their e-mail, and sometimes email cannot be delivered due to a full inbox. Some of these disadvantages cause the number of respondents who answered this questionnaire is not encouraging.

Types of analysis

All data received will be analysis using latest version of Statistical Package for Social Science (SPSS).

Discussion

This study will last for 6 months. Short duration become the main limitation to finish the study. In addition, response and feedback from respondent also may become the limitations.

This study may be the guidance to the organizations in worker's safety and health aspects. People and behavior factors geared towards unsafe acts and environment factor are leading to unsafe conditions.

Registered Safety & Health Officer (SHO) view as an expert in Safety, Health and Environment (SHE) aspects will be the main concern. Therefore, the findings of this study may be used by the SHO and organizations in planning programs or action plans to improve existing at risk behavior. Intervention or alteration of behavior is needed in order for the program to achieve the goals.

Conclusion

BBS implementation has been adopted by several organizations in Malaysia. The main purpose in implementing BBS is to reduce number of workplace incident by changing the behavior of the workers in a culture of workplace safety and health.

The three factors that influence the BBS should be emphasized and related program should be established to reduce accidents in the workplace. The combination of these three factors will help reduce the amount of incident in the workplace. In addition, it is important for encouraging safe behaviour and controlling unsafe behaviour.

View from the SHO of the level of knowledge, understanding, and practical level reflect of their work environment. Therefore, it is important to increase the level of knowledge and level of understanding among employees to ensure that workers can exercise their way to safe work practices. By increase the level of practice, accident reduction can be achieved.

By reducing the number of accidents, the organization will also get the benefit by reducing cost that need to be paid for treatment, compensation and other expenses. Environments with less number of incidents will increase the productivity of the workers. At the meanwhile, workers morale will increase towards working harder and implement safe work culture.

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Occupational Accident Cost Estimation: A Case Study In Wood Based Related Industries

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Abstract

This objective of the study is to estimate occupational accident cost in manufacturing industries, especially in wood based related industries. The study attempts to identify, define, and classify the cost components of occupational accident related cost and to catalogue the various economic approaches used to estimate the entire costs of occupational accident and to propose the risk prevention plan. The study uses local specific approach by reviewing company historical records on occupational accident as reported in JKKP 6, JKKP 8, JKKP 9 and company internal investigation reports. For each occupational accident, the site safety officer in charge, human resource and, account employee, supervisor, victim, related co-workers and relatives were interviewed in order to estimate direct costs, indirect costs, prevention costs and other personal cost related to the accident. Other related information such as personal data of the victim, type of injuries, location of injuries and cause of injuries were recorded. A total of 24 occupational accidents data for the past five years were analyzed in the cost of accident summary report to determine the overall ratio of direct to indirect cost and ratio of total cost of accident to prevention cost. A further analysis was carried out to determine the most significant cost of accident related to demographic profiles for Malaysian and Non Malaysian employees. In conclusion, this study has determined the ratio of direct to indirect cost of occupational accident and has proposed the risk prevention plan with additional information on cost of accident and cost of prevention.

Keywords:Accident cost calculations, direct cost, indirect cost, direct-indirect cost ratio

Introduction

Workplace accidents are a substantial expense to society and individual companies. The costs for workplace accidents are expensive and the amount of money paid either directly or indirectly is increasing in this modern era. Aside from direct costs such as medical and hospitalization cost, property damage cost and medical treatment cost, there are also some indirect cost of worker's discomfort in doing her/his duties and rehabilitation cost, lost time injuries cost, productivity loses and others hidden cost inevitable as a result from each workplace accident.

The high percentage of working accidents is more related to management compared to engineering. It is the highest level of management that determines the policies of Safety and Health Environment (SHE) such as working conditions, quality of production, and quality of devices or machines being used.

Hazard in a working environment can be defined as a condition, or combination from various conditions, where when not corrected could result in an accident, disease, or damage of property. Also, hazard in a working environment is a condition of working environment where there is a variable or many variables that has potential in creating accidents, serious damage, disease, or losses. According to Heinrich (1980), accident is an event that occurs coincidentally, unplanned, and unexpected, where action and reaction happened between objects, matter, or materials, with human, hence causing injury. Accidents that occur have many causes which generally can be prevented in the first place. Efforts in preventing accident can be performed by correcting, or at least minimizing every hazard that can be identified. An accurate analysis on potential hazards in a working environment is an effort to control the issue of Safety and Health Environment which can be used as a tool to implement Safety, Health and Environment Management System. Therefore, identification and elimination of potential hazards are the main elements in preventing accidents in a working environment.

Most organizations do not systematically calculate accident cost, owing to managers' lack of knowledge and understanding of compensation mechanisms involved in accidents. Managers tend to believe that most expenses are insured and therefore do not see a real reason to calculate these costs which requires data collection. Furthermore, the common economic approach for calculating the advantages of safety investment is based on the assumption that managements regard industrial accidents as undesired side effects, while their direct and indirect costs are assumed to be a kind of sank costs. One

of the goals of the current paper is to provide tools which will help overcome the narrow economic approach adopted by many managers.

Other possible reasons for the marginalization of accident costs by managers include: measurement difficulties, overloaded managers, biased accounting methods and the low status of safety departments. In their studies, (Jallon *et.al*, 2010) and (Arieh et.al 2009) suggested that, managing risk properly, not only necessitates the development of techniques but also processes, at the personnel level as well as at the organizational level, which will take human nature into account.

Appropriate mechanisms will also have to be set up to reconcile ‘‘public interest’’ and ‘‘risk management’’. It will thus be necessary to define, implement and improve a series of processes and most importantly, provide guidance to managers.

The real challenge in evaluating the costs of industrial accidents is to develop reliable evaluation of indirect costs which are usually also the uninsured costs. Yet, researchers have recognized also the importance on indirect costs. For example, (LaBelle,2000) suggested a method for cost evaluation based on several categories: cost of time spent in relation to medical care, reduced production of the injured worker after returning to work, cost of supervision and investigation, reduced production, cost of replacement, learning and management cost and cost related to legal processes.

Yet, the methods used for these evaluations are relatively old and especially lack integration of central components in the production process. Therefore, they may be regarded not reliable by managers. The model we propose assume that as the workload increases, whether it is mental or physical workload, the probability of industrial accidents increases. This assumption is supported in the literature both theoretically and empirically (Jallon *et.al* 2009). Since the definition of a bottleneck station refers to the workload which characterizes this station, we infer that the probability for industrial accidents is relatively higher in bottleneck stations as compared to other locations in the production process.

The objective of this study is to provide an overview of the current state of knowledge regarding the calculation and evaluation of the direct and indirect costs of workplace accidents and identify the preventive action plan to eliminate or mitigate the risk of such undesired accidents.

Direct and Indirect Cost Classification

The research on accident cost has already begun since 1920s and was pioneered by Heinrich (1959). The study was based on 75,000 cases of occupational accidents. He was quoted as saying that, the indirect cost components can exceed as much as four times of direct costs (Head and Harcourt, 1997) and most of work accident costs are hidden and cannot be identifiable easily.

His direct cost includes hospital and medical cost, cost of lost work time except when it is being paid by the employer without reimbursement, insurance premium and compensation claims. Otherwise, hidden costs taken into account are time of injured employee , the other employees who stop work or who are upset; time of foremen, supervisors or other executives who give attention to the injury; time spent by first-aid attendants and hospital department staff when not paid for by the insurance carrier; damage to any machines, equipment and other property, and interference with the site’s production; costs to the employer of welfare and benefit systems and continuing the full wages of the employee after returning to work who are not fully recovered; loss of profit on the injured person’s production, on idle machines; overhead (e.g., lights, heat) when the employee is away or not fully productive.

Heinrich claimed that there are linear correlations between direct and indirect costs. This ratio (1:4) has been widely used in safety management since last five decades due to its simplicity. Besides, safety practitioners have long used this ratio to inform the management on total accident costs (Manuelle, 2011). The conclusion made by Heinrich was extended further by Bird (1974) by representing this finding into a graphical form, known as Accident Cost Iceberg, which is easier to understand.

The iceberg above shows that the indirect cost proportion is much larger than the cost directly related to an accident. He added that direct costs can be estimated based on nature of accident while indirect costs still remain a major obstacles to determine for each cost component. However, Simonds and Grimaldi (1956) argued that many cost components included in Heinrich’s study can be termed as direct costs in the sense of appearing as distinct monetary outlays in a firm’s financial accounts. Therefore, they proposed an alternative terminology of direct and indirect costs based on insurance coverage. Cost covered by insurance is regarded as direct cost while indirect cost is cost which is not insured by insurance body. This study has prompted many researchers to redefine their definitions of direct and indirect costs.

In separate issues, Manuele (2011) claimed that the ratios determined by Heinrich (1931), Grimaldi and Simmonds (1989) and Leigh et. al. (1997) are invalid although the elements of direct and indirect cost categories are differed from those studies. The basis of this statement is direct cost of accident has increased in the past 15 years at a greater pace than indirect cost. A study done by Head and Harcourt (1997) also depicted different conclusions when they established a ratio of direct to indirect cost of 2.9:1. Laufer (1987), in his cost assessment, indicated that insured to uninsured cost ratio stood at 3:1. Thus, it is hard to generalize the ratio obtained by different researchers since each of them has

different interpretation of direct and indirect components whereas each study would include different cost components in their study. In addition, it is not accurate to say indirect cost will always be more than direct costs since opposite findings have already been demonstrated in previous studies.

In fact, the study by Heinrich was done back in 1920s. The validity of the ratio calculated at that time is something that can be questionable due to enormous change in business and industry since past decades. Besides, structural changes in compensation system and work practice also will definitely influence the ratio between direct and indirect costs. The variations of direct and indirect cost ratios are affected by several factors. The factors identified are type of processes, criticality of the workstation where the accident happened and severity of accidents (Everett & Frank, 1996). In addition, the ratio can vary between 1:1 to 20:1, largely depending on cost calculation methodology adopted by the researchers and type of industry sector (Dorman, 2000).

Despite those arguments on ratio calculations, the classification of workplace accident costs used for this study still maintains its relevance and has a staying power. Jallon et. al (2011) found that most researchers separate workplace accident cost into two categories which are direct and indirect costs. Direct cost is regarded as visible components easily identifiable by the employers who are already aware of its existence in the event of accidents. On the other hand, indirect cost, also known as invisible cost, is hidden and it poses more difficulties in cost quantification. Employers always tend to underestimate this type of cost.

Nevertheless, there is no consensus on the definitions of these cost types but this kind of distinction of direct/ indirect costs is often used in scientific literatures. Common cost components always being included in direct cost category are cost of hospitalization and ambulance service, cost of accident victim's compensation and cost of medical expenses and rehabilitation cost (Neville, 1998; Hinze, 1991; Leigh *et.al*, 2004; LaBelle, 2000, Heinrich, 1959, Brody et. al, 1990).

Generally, direct cost is covered by government compensation body or private insurance company. These two entities would compensate the victims and cover hospitalization and injury treatment costs. Besides, employers are obliged to pay annual premium for this accident coverage and the fees are reflected to risk posed by organization activities.

In contrast, Sun *et. al*. (2006) categorized indirect cost components into four groups which are:

- Legal and administrative cost: resources that need to be allocated by the employers in term of manpower or financial aspects. The resources are utilized to do data entry in the accident registry, issue accident notification report, compile accident statistics and monitor the file
- Productivity costs: when an accident occurs, the company may need to shut down their plants with a directive from DOSH. This will require overtime when the plant is set to resume its operation in order to fulfil customers' demand, thus causing a production delay at the same time
- Replacement costs: any injured or death workers need to be replaced to maintain the production output. Additional workers would incur hiring cost and cost associated with staff training.
- Cost of investigation: internal and external investigation team will be dispatched to the accident location once a workplace accident happens. This team will assess the cause of accidents before taking any further actions. Deployment of this investigation team involve certain cost since they need to spend their time to focus on this accident rather than doing their normal job.

Actually there are more cost components such as goods or property damage that can be added in this list. Some of the costs also can be considered as direct costs if the costs are insured (Laufer, 1987; Hinze, 1991; Dorman, 2000; Leopold and Leonard, 1987). However, it is difficult to identify and classify these costs since each company may have insurance policy to cover its machine, property or goods while some may not.

In addition, the cost components stated above are something that can be measured. There are also less quantifiable costs available such as increased employee turnover, tarnished company reputation (Hinze, 1991), reduced employee morale and motivation (Rikhardsson and Impgaard, 2004). Nevertheless, differences between cost classifications are not due to contradictions between studies but rather due to different levels of aggregation (Sun *et.al*, 2006). The major issues in this cost assessment are to estimate the indirect cost components while most researchers already agreed on direct cost estimation.

Methodology

For data collection, a total of 24 accident cases were collected, starting from year 2011 until 2013 in order to complete this study. Data from interview session, observation, company previous records, JKKP6 and JKKP8 forms were collected, analyzed, reported and the findings and results discussed. Suitable suggestions were evaluated and recommendations made for future studies. This study consists of three types of severity, including 22 cases of temporary disability (HUS), one case of permanent disability and one case of fatality (FOT). 19 cases of accidents involved Malaysian citizenships and 5 cases non-Malaysians. The distribution of age in this study is between 22 to 60 years old.

Results Analysis and Discussion

Table 1 illustrates the cause of accidents reported by Company X. The category for cause of accidents was organized according to JKKP table 9. Based on Table 1, the main causes of occupational accident within the company are, caught between moving object (25%), followed by striking against moving object and struck by moving objects (21%).

Direct Cost Component

Table 2 is the summary of the components for direct cost of occupational accidents for all 24 cases. The components for direct cost were reviewed against Malaysian and foreign workers for each Permanent Disability (PD) or *Hilang Upaya Kekal* (HUK), Temporary Disability (TD or *Hilang Upaya Sementara* (HUS), Fatal (F) or *Faedah Orang Tanggungan* (FOT) for Malaysian and Foreign workers.

Indirect Cost Components

Table 3 is the summary of the components for direct costs of occupational accidents. The components for indirect costs were reviewed against Malaysian and foreign workers for each Permanent Disability (PD) or *Hilang Upaya Kekal* (HUK), Temporary Disability (TD) or *Hilang Upaya Sementara* (HUS), Fatal (F) or *Faedah Orang Tanggungan* (FOT) for Malaysian and Foreign workers.

Total cost of occupational accidents

Table 4 illustrates the summary for direct and indirect costs of occupational accidents and the ratio of direct and indirect accident costs for HUK, HUS and FOT for Malaysian and Foreign workers.

Based on the above figures, the overall ratio of direct to indirect cost is 1 to 6.8.

Estimation of costs of occupational injury and costs of prevention.

- *Costs of accidents for each type of Injuries*

Table 5 illustrates the pareto chart of costs of accidents for each type of injuries. Amputations and enucleations contribute the highest costs of accidents (RM452, 833.25) and MC (6,000 days). This is because the accidents were fatal, requiring a total plant shutdown and the default value for the number of MC as required by JKKP/DOSH was 6000 days.

Accident costs by Cause of accident

Table 6 illustrates the cost of accidents for each cause of accidents. "Caught between moving objects" contributes the highest cost and the most number of days for MC leave. (RM462 837 and 6,106 days)

Cost of Accident Prevention

Table 7 illustrates the cost of accident prevention. Based on the Accident cost survey, the highest accident cost prevention is Training/Procedures (RM16,404), followed by Engineering control (RM10,358). Training contributes the highest cost of accident prevention, since the appointed Safety & Health Officer had to undergo the Certified Safety & Health Officer (CHSO) programme organized by NIOSH.

Total Cost of Accident Prevention :$28 622.25

Total Cost of Accident :$562,296.85

Ratio of Prevention to Total Cost of accident is 1 : 19.6

Based on the above ratio for cost of accident and cost of accident prevention, the greatest return of investment to the company is investment on Safety & Health issue.

Conclusion of the Accident Cost Estimation.

Based on the local survey on the cost of accident, the established format for calculation of accident cost is appropriate to identify the details estimation of cost for each component and sub component of direct and indirect accident costs. The established format for cost of accident estimation was successfully implemented to all 24 cases of reported occupational accidents in Company X. The details of all the reported cost of accidents were further analyzed to justify the ratio of direct and indirect costs. Based on the analysis of accident costs in the selected wood industry, the ratio for direct and indirect cost is 1:6.8. The ratio for cost of accident and cost of accident prevention is 1:19.6.

CAUSE OF ACCIDENT	MALAYSIAN	%	FOREIGN	%
Striking against moving objects	5	26%		
Struck by moving objects (including flying fragments, particles)excluding falling objects	5	26%		
Caught between moving objects (except flying or falling objects)	3	16%	3	60%
Contact with hot substances or objects	3	16%		
Struck by falling objects during handling	2	11%		
Fall of the person on the same level	1	5%		
Caught in an object			2	40%
TOTAL CASE	19		5	

Table 1: Cause of Accident (JKKP Table 9)

	MALAYSIAN			FOREIGN		
COST COMPONENT	**HUK**	**HUS**	**FOT**	**HUK**	**HUS**	**FOT**
Medical	$800.00	$3,512.00	$0.00	$0.00	$1,259.00	$0.00
Rehabilitation	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Compensation	$3,225.00	$24,339.00	$0.00	$0.00	$0.00	$35,000.00
Funeral	$0.00	$0.00	$0.00	$0.00	$0.00	$4,800.00

Table 2: Table for direct cost components

	MALAYSIAN			FOREIGN		
INDIRECT COST COMPONENT	**HUK**	**HUS**	**FOT**	**HUK**	**HUS**	**FOT**
Productivity Loss	$0.00	$20,062.00	$0.00	$0.00	$2,247.00	$374,000.00
Workers Replacement	$3,780.00	$17,788.00	$0.00	$0.00	$633.00	$160.00
Legal and Administration	$600.00	$2,200.00	$0.00	$0.00	$200.00	$100.00
Investigation	$300.00	$4,547.00	$0.00	$0.00	$200.00	$10,375.00
Machine or Equipment Damage	$3,500.00	$9,743.00	$0.00	$0.00	$150.00	$16,100.00
Product Damage	$0.00	$877.00	$0.00	$0.00	$0.00	$0.00
Fine / Penalty	$0.00	$0.00	$0.00	$0.00	$0.00	$19,000.00
Other Cost	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Table 3: Table for indirect cost components

	MALAYSIAN			FOREIGN		
COST ANALYSIS	**HUK**	**HUS**	**FOT**	**HUK**	**HUS**	**FOT**
DIRECT COST	$4,025.00	$26,439.00	$0.00	$0.00	$1,059.00	$39,800.00
INDIRECT COST	$8,180.00	$55,218.00	$0.00	$0.00	$7,840.00	$419,735.00
TOTAL MC (DAYS)	59	371	0	0	67	6,000
RATIO	1:2	1:2	0	0	1:7	1:10
NO. OF EMPLOYEES	200	200	200	40	40	40
TOTAL COST	$12,205.00	$81,657.00	$0.00	$0.00	$8,899.00	$459,535.00

Table 4: Table for Accident cost analysis

	MC	MALAYSIAN			FOREIGN		
TYPE OF INJURY	**(DAYS)**	**HUK**	**HUS**	**FOT**	**HUK**	**HUS**	**FOT**
Other wounds	231	$47,878.24	$38,666.02	$0.00	$0.00	$3,689.54	$0.00
Burns	47	$0.00	$8,645.74	$0.00	$0.00	$0.00	$0.00
Contusions and crushing	44	$0.00	$5,516.43	$0.00	$0.00	$632.45	$0.00
Fractures	119	$0.00	$13,403.59	$0.00	$0.00	$707.68	$0.00
Superficial injuries	11	$0.00	$3,777.83	$0.00	$0.00	$0.00	$0.00
Amputations and enucleations	6000	$0.00	$0.00	$0.00	$0.00	$0.00	$452,833.25
Sprains and strains	7	$0.00	$0.00	$0.00	$0.00	$1,465.43	$0.00
TOTAL	6459	$47,878.24	$70,009.61	$0.00	$0.00	$6,495.10	$452,833.25

Table 5: Accident Costs for type of injuries (JKKP TABLE 10)

Company management very rarely assesses the direct and indirect costs of workplace accidents, usually because such an assessment involves a long, tedious data collection process if the calculations are to be sufficiently accurate to be taken into account when calculating the return of investment of accident prevention programme spending. The model for cost of accident estimation developed in this study has been tested in the selected company and proven to be effective in calculating cost of accident. The data collection phase during the local specific survey and interview session provides decision makers, researchers and practitioners, with a precise, reliable format for accident cost estimation that is quick to use and understand.

CAUSE OF ACCIDENT	MC (DAYS)	MALAYSIAN			FOREIGN		
		HUK	HUS	FOT	HUK	HUS	FOT
Striking against moving objects	103		$15,641.78	$0.00	$0.00	$0.00	$0.00
Struck by moving objects (including flying fragments, particles)excluding falling objec	121	$47,878.24	$26,430.81	$0.00	$0.00	$0.00	$0.00
Caught between moving objects (except flying or falling objects)	6106		$7,831.60	$0.00	$0.00	$2,173.11	$452,833.25
Contact with hot substances or objects	47		$8,645.74	$0.00	$0.00	$0.00	$0.00
Struck by falling objects during handling	15		$2,013.69	$0.00	$0.00	$0.00	$0.00
Fall of the person on the same level	39		$9,445.99	$0.00	$0.00	$0.00	$0.00
Caught in an object	28		$0.00	$0.00	$0.00	$4,321.99	$0.00
TOTAL	6459	$47,878.24	$70,009.61	$0.00	$0.00	$6,495.10	$452,833.25

Table 6: Cause of Accident (JKKP TABLE 9)

Elimination and Substitution	Engineering Control	Warning system	Training/ Procedures (Admin. Control)	Personal Protection Equipment	Total Cost
$0.00	$10,358.25	$0.00	$16,404.00	$1,860.00	$28,622.25

Table 7: Costs of accident prevention

This study has provided a snapshot for higher education academician, OSH practitioners and researchers to estimate the total costs of occupational accidents in the manufacturing industries and to further investigate and analyze the costs.

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