RELATIONSHIP BETWEEN ERGONOMICS AND SAFETY CULTURE AMONG SAFETY AND HEALTH OFFICERS IN MANUFACTURING COMPANIES IN MALAYSIA

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Mechanical Engineering)

Faculty of Mechanical Enginering
Universiti Teknologi Malaysia

JULY 2017

Khas untuk

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Syed Luqmanulhakim dan Sharifah Noor Widad

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to Prof Dr Awaluddin Mohamed Shaharoun as my first main supervisor, then become my co-supervisor after I move to Johor. He gave me a lot of critical and invaluable insightful and guidance in sharpening and strengthening ideas, interminable dedication, and patient with my weaknesses. He gave me motivation and encouragement in which without his support, I would never complete my research.

My deepest appreciation also goes to Dr Jafri Mohd Rohani as my current main supervisor for his support and assistance during my last stage of the research. His encouragement and advice assisted me to finish my writing and do validation of my research.

My warmest thanks to Dr Habibah@ Norehan Haron as my co supervisor for his assistance in analysis and give moral support to finish my research.

My gratitude goes to Department of Occupational Safety and Health Putrajaya and NIOSH Johor for supporting me to get feedback from companies which have Safety and Health Officers (SHOs) and some advice related to ergonomics and safety culture.

I would like to express my deepest gratitude to my husband who always willing to discuss problems in my research and give his assistance and motivation. To my husband and my children, Sharifah Rosheeda, Sharifah Sakinah, Syed Luqmanulhakim and Sharifah Noor Widad, thank you for your unconditional love, sacrifices support and understanding.

Last but not least, to my lovely father and mother, thank you very much for your continuous du’a and encouragement. May Allah give you Jannah. To all of you, thank you very much and may Allah bless you.

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ABSTRACT

Ergonomics is one of the safety and health components that if implemented will contribute to job satisfaction. However, the relationship between ergonomics and safety culture is often neglected due to vague linkage. Although it is crucial, there is a lack of studies that link ergonomics with safety culture. The objectives of this study are to identify the role of ergonomics and safety culture with each other and to establish the relationship between ergonomics awareness (EA), ergonomics practices (EP), beliefs on the importance of safety culture (SCB) and existing safety culture practices (ESCP). Safety and Health Officers (SHO) are persons who are assigned to initiate ergonomics at workplace and good safety culture. Respondents were selected amongst the SHO in manufacturing companies in Malaysia. Pilot study (n=32) was done, full survey (n=146) was conducted and validation of the survey (n=75) was implemented. In order to achieve the first objective, Wilcoxon t-test was used to identify the level of ergonomics awareness and practices, and safety culture beliefs and practices. MANOVA was used to identify the effect of education level, past working experience and training received that significantly affect ergonomics awareness and practices. For the second objective, Exploratory Factor Analysis (EFA) using SPSS was done with Principle Axis Factoring to determine all the underlying dimensions. Then Confirmatory Factor Analysis (CFA) by using AMOS was done to confirm the constructs. Expert validation was done for the development of the constructs. Structural equation modelling technique was employed to assess the relationship between the constructs. The finding shows that the practices are still not in a high level compared to their awareness regardless of their formal education level. Training is believed to be the significant background of respondents that may affect their awareness. The results also show that two SCB constructs, three ESCP constructs, four EA constructs and two EP constructs were obtained. Overall, it illustrates a significant positive relationship between ergonomics and safety culture. Ergonomics awareness is able to inculcate existing safety culture practices, while existing safety culture practices are able to influence the practices of ergonomics at workplace. The conclusion is that there is a significant relationship between ergonomics and safety culture. This study has practical values in that SHO should relate ergonomics awareness and safety culture by managing the critical factors in order to get full benefits. It is proved empirically that ergonomics training that fits the factors considered may increase ergonomics awareness, thus influencing safety culture and ergonomics practices.

ABSTRAK

Ergonomik merupakan salah satu komponen keselamatan dan kesihatan yang mampu menyumbang kepada kepuasan kerja. Namun, perhubungannya dengan budaya keselamatan sering diabaikan berpunca dari perkaitan yang tidak secara langsung. Walaupun ia kritikal, maklumat tentang kaitan di antara ergonomik dan budaya keselamatan tidak mencukupi. Objektif kajian ini adalah untuk mengenalpasti peranan ergonomik dan budaya keselamatan antara satu sama lain dan mewujudkan perhubungan di antara kesedaran ergonomik (EA), amalan ergonomik (EP), kepercayaaan terhadap kepentingan budaya keselamatan di tempat kerja (SCB) dan amalan budaya keselamatan sedia ada (ESCP). Pegawai keselamatan dan kesihatan pekerjaan (SHO) adalah orang yang diberikan tanggungjawab memulakan ergonomik di tempat kerja dan menjadikannya satu budaya. Responden dipilih di kalangan SHO di dalam kilang pembuatan di Malaysia. Kajian rintis (n=32) telah dibuat, soal-selidik (n=146) dikendalikan dan kajian pengesahan dilaksanakan (n=75). Bagi mencapai objektif pertama, Ujian-t *Wilcoxon* digunakan untuk mengenalpasti tahap kesedaran ergonomik dan amalannya, serta persepsi tentang tahap kepentingan budaya keselamatan di tempat kerja serta amalannya. Ujian MANOVA digunakan untuk mengenalpasti kesan tahap pendidikan, tahap pengalaman kerja lepas dan latihan yang diterima yang memberi kesan signifikan terhadap kesedaran dan amalan. Bagi mencapai objektif kedua, analisis faktor penerokaan (EFA) menggunakan SPSS dijalankan dengan *Principle Axis Factoring* untuk menentukan dimensi asas. Kemudian, analisis faktor pengesahan (CFA) menggunakan AMOS dilakukan untuk menentusahkan konstruk. Pengesahan dari pakar dibuat untuk pembangunan konstruk. Teknik Model Persamaan berstruktur dijalankan untuk menilai perhubungan antara konstruk. Dapatan menunjukkan amalan masih tidak tinggi berbanding kesedaran tanpa mengambilkira tahap pendidikan formal mereka. Keputusan juga menunjukkan terdapat dua konstruk SCB, tiga konstruk ESCP, empat konstruk EA dan dua konstruk EP. Keseluruhannya menunjukkan perhubungan positif yang signifikan untuk ergonomik dan budaya keselamatan. Kesedaran ergonomik mampu memupuk budaya keselamatan sedia ada, dan budaya keselamatan sedia ada mampu mempengaruhi amalan ergonomik di tempat kerja. Latihan ergonomik yang diterima dipercayai merupakan latarbelakang signifikan yang boleh meningkatkan kesedaran ergonomik. Kesimpulannya adalah terdapat perhubungan yang signifikan di antara ergonomik dan budaya keselamatan. Kajian ini mempunyai nilai praktikal di mana SHO boleh mengaitkan kesedaran ergonomik dan budaya keselamatan dengan cara menguruskan faktor-faktor berkaitan demi mendapatkan manfaat sepenuhnya. Terdapat bukti yang empirikal bahawa latihan sesuai yang menepati faktor yang perlu diambilkira dalam kajian kajiselidik mampu menambah kesedaran ergonomik, seterusnya membentuk budaya keselamatan dan amalan ergonomik.

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LIST OF ABBREVIATIONS

AGFI	-	Adjusted Goodness of Fit
AMOS	-	Analysis of Moment Structure
ANOVA	-	Analysis of Variance
AVE	-	Average Variance Extracted
BDS	-	Body Discomfort Survey
BIAss	-	Beliefs on the Importance of Assessment
BIASW	-	Beliefs on the Importance of Anthropometrics and the Suitability to workers
BIWNI	-	Beliefs on The Importance of Implication of Work and Need for Improvement
CTS	-	Carpal Tunnel Syndrome
CEP	-	Continuous Education Program
CFA	-	Confirmatory Analysis
CR	-	Composite Reliability
DOSH	-	Department of Occupational Safety and Health
EA	-	Ergonomics Awareness
EFA	-	Exploratory Factor Analysis
Ergo_Ad	-	Ergonomics Administrative Consideration

Ergo_Tech	-	Ergonomics Technical Consideration
ESCP	-	Existing Safety Culture Practices
EP	-	Ergonomics Practices
FMA	-	Factory and Machinery Act
GFI	-	Goodness of Fit
HIRARC	-	Hazard Identification, Hazard Risk and Hazard Control
I_MgmtSup	-	Beliefs on the Importance of Management Support
I_SelfReg or I_SR	-	Beliefs on the Importance of Self-Regulations
KET	-	Knowledge on Ergonomics in Technical
MgmtAct_P	-	Management Action Practices
MSD	-	Musculoskeletal Disorder
NIOSH	-	National Institute of Occupational Safety and Health
OCRA	-	Occupational Repetitive Actions
OSH	-	Occupational Safety and Health
OSHA	-	Occupational Safety and Health Act
OSHMP20	-	Occupational Safety and Health Master Plan 2020
REBA	-	Rapid Entire Body Assessment
RMSEA	-	Root Mean Square Error of Approximation
RULA	-	Rapid Upper Limb Assessment
RQ	-	Research Question
SEM	-	Structured Equation Modelling
SC	-	Safety Culture

SCB	-	Safety Culture Beliefs
SHO(s)	-	Safety and Health Officer (s)
SME(s)	-	Small and Medium Enterprise (s)
SOCSO	-	Social Security Organization
SelfReg_P or SR_P	-	Self-Regulations Practices
SPSS	-	Statistical Packages for Social Science
Tr_P	-	Training Practices

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the on-going trend of reducing fatal accident, injuries and illnesses, managers need to comply with all legislation related to occupational safety and health. There are two Acts required for all organization in Malaysia in order to ensure the workers are being protected from all hazards coming from the workplace: Factory and Machinery 1967 (FMA 1967) and Occupational Safety and Health Act 1994 (OSHA 1994). Regulations, guidelines and codes of practice have been drawn up to support both Acts. Ergonomics is one of the safety and health elements covered. Without ergonomics concern, the effectiveness of safety and health legislation cannot be attained.

1.2 Research Background

Ergonomics is one of the safety and health components that if implemented will contribute to job satisfaction (Dawal *et al.*, 2009) and contributes significantly to human well-being and safety due to a comfortable work environment and ergonomically designed tools, man- machine interface design and suitable work method to human anatomy (Kroemer and Grandjean, 1997). It can indirectly

improve quality, productivity, working conditions, reduction of rejects and rejection cost and increase profit (Yeow and Sen, 2002). The application of ergonomics can have a great impact on improving safety and health especially in industries that currently do not take the effect of work hazard seriously. The unawareness of the bad effect of repetitiveness movement, awkward, and static posture will cause tiredness, numbness, uncomfortable, illness, consequently more serious outcome such as back pain, faint and slip disk. This will lead to an increase in the trend of absenteeism, medical leave and retirement and become worse if the workers take legal action that will result in compensation payment and penalty (Yeow and Sen, 2002; Coluci *et al*., 2009).

This research investigates the degree of influence ergonomics has in shaping the safety culture and the impact of safety culture to the implementation of ergonomics in Malaysian manufacturing companies. This can give us an indicator that is ergonomics is a function of proper attitude. The attitude influences behaviour and the proper behaviour is the cornerstone of safety culture (DOSH, 2013). Thus, root causes of lack of ergonomics implementation will be investigated in order to find out the applicable methods in enhancing the awareness and exposure.

Nowadays, Malaysia is moving towards becoming a fully developed nation by 2020. The manufacturing sector has become a significant contribution for the country towards Vision 2020 (Rozilee, 2010). According to Department of Statistics Malaysia 2013 (DOSM, 2013), total employees engaged in the manufacturing sector until June 2013 was 1,040,020 persons while the accident occurred mostly in manufacturing industries with 62% compared to other accidents/ illnesses statistics as reported by DOSH (2013) until June 2013.

According to Daniellou and Garrigou (1992), manufacturing system become difficult when it starts to involve complex automated system. This situation still requires workers to operate or do maintenance. Subsequently create difficulties such as long setting up, insufficient flexibility in maintenance or poor production. Ergonomics is a hybrid discipline that can solve complex cross-disciplinary

problems including industrial engineering (Bridger, 2009). Its implementation has a substantial impact on the industry, organization, management, employees and overall well-being of the system (Sundstrom, 2000; Gungor, 2009). Ergonomics awareness helps in the application of ergonomics and contributes significantly to human well-being and safety due to a comfortable work environment, ergonomically designed tool, human- machine interface design and suitable work method (Kroemer and Grandgean, 1997; Salvendy, 1998; Ryan *et. al.* , 2009). Thus, the awareness of ergonomics is important to safety and health officers and workers.

The failure in ergonomics practice gives a big implication. Musculoskeletal disorder (MSD) typically account for about one-third of workplace reports of injury, and often account for about three-forth of costs (Walder *et al.*, 2007). Seelay (2009) proved the significance of ergonomics through his finding on the cost of MSD and workers' compensation that far exceeds those for acute incidents such as burns, cuts and fractures. In Malaysia, MSD has been reported as the cause that was on the rise nationwide, attributing it in part to the lack of safe work practice at the workplace. It is an upward trend, with 161 cases of 2009, 238 in 2010, increase to 268 cases in 2011 and 449 in 2012. Lee Lam Thye, chairman of NIOSH mentioned that this is a jump of almost 18 times compared to 2006. The number of cases could be higher as he believed that many cases are not reported (Boon, 2013). According to the 2014 annual report of the Department of Occupational Safety and Health (DOSH), manufacturing sector is reported as the largest contributor to workplace accidents in Malaysia (DOSH, 2015). For the occupational disease, it was reported that in Malaysia, a total of 553 claims which related to MSD have been recorded in the manufacturing industry from 2009 to 2014. According to (Jafri *et al*., 2016), this figure is equivalent to 25.22% from overall occupational diseases reported within the same period.

Other than the accident rate, it is because of the characteristics of the manufacturing industry. The production systems usually have a level of automation as well as production processes with a high number of manual jobs (Thun *et al.*, 2011).

1.3 Problem Statement

Most of the researchers agreed that ergonomics implementation have many benefits for the companies (Ayers and Kleiner, 2002; Dillard and Schwager, 1997; Fernandez, 1995; Pao and Kleiner, 2001; Rowan and Wright, 1995; Munipov, 2009; Gregori *et al.*, 2006; Smallwood and Ajayi, 2009; Niu, 2010; Broberg, 2010, Robertson *et al.*, 2002). It is an important and key requirement in shaping the safety culture (Broberg, 2010; Niu, 2010; Bentley and Tappin, 2010). Although a lot of work (Nagamachi, 2000; Ayers and Kleiner, 2002; Bellamy *et al.*, 2008; Lodre *et al*, 2009; Azadeh, 2008) have been done in the ergonomics implementation, most of the issue do not consider ergonomics in the safety culture. According to Bentley and Tappin (2010) critical review, very few papers are concerned with ergonomics aspects of safety culture or climate. A few frameworks have been proposed for safety culture (Cooper, 2000; Hsu *et al.*, 2008; Guldenmund, 2000; Choudhry *et al.*, 2007; Martinez-Corcoles *et al.*, 2011; Wang and Sun, 2012; Edwards et al, 2013), but the frameworks does not emphasize ergonomics implementation. As yet, in Malaysia, there is no previous research conducted on the ergonomics awareness within safety culture. How the two are related, what the effect is on one relative to the other is not clear. What is even more important to discover is what are the current perceptions of industry implementers, the degree of importance the factor attached that shape their beliefs, values, behaviour and practices. As mentioned by Pater (2008), the important thing is when it comes to reducing ergonomics injuries, developing the right culture is very important.

To initiate change towards improved safety culture, it is thus essential to understand the relationship between ergonomics awareness and its role in shaping the safety culture and the other contributory factors as well as identifying the gaps and the barriers that exist that needs to be bridged. Furthermore, our government under Ministry of Human Resources, targeted Malaysian organizations to adopt in a safety culture under Occupational Safety and Health Master Plan For Malaysia 2020 (OSHMP20) with the mission to increase awareness, knowledge, commitment to OSH in all efforts in reducing injuries, diseases and fatalities, in the hope that efficiency, productivity and business performance will be increased. With the motto

"Towards a safe and healthy culture", Department of Occupational Safety and Health (DOSH) as a government department that was responsible to initiate the safety culture proactively and promote the OSHMP20 from the planning phase until implementation. The role of government is critical in the effort to inculcate the safety culture. Ergonomics is considered under safety and health based on the Occupational Safety and Health Act 1994 (OSHA 1994) and Factory and Machinery Act 1967 (FMA 1967) and should be included in the plan made by the Ministry of Human Resources.

It is also important to be able to explain by means of a theoretical model that explained the behaviour of these phenomena.

1.4 Significance of the Study

Ergonomics plays an important role to improve the quality, productivity, working conditions, a reduction in cost on rejects, and increase profit indirectly (Yeow and Sen, 2002). Ergonomics is very important in job satisfaction (Dawal, 2007).

Bhattacharya and McGlothlins (1996) stressed the importance of ergonomics can be seen based on the implication of not considering it. This is supported by Seelay (2009), who stated that one third to one half of their field injuries are associated with ergonomics problem such as Musculoskeletal Disorders and workers compensation costs for these injuries far exceed those for acute incidents such as burns, cuts and even fractures. Niu (2010) estimated the injuries mentioned above to correspond to USD 13 billion (in the United States). Report by a consultation firm in US called Humantech in 2006 (Humantech, 2007) stated that they have succeeded in reducing the risk of ergonomics in all sectors around the world in which the recordable incident rate and lost workday case rate were reduced by 50% in just four

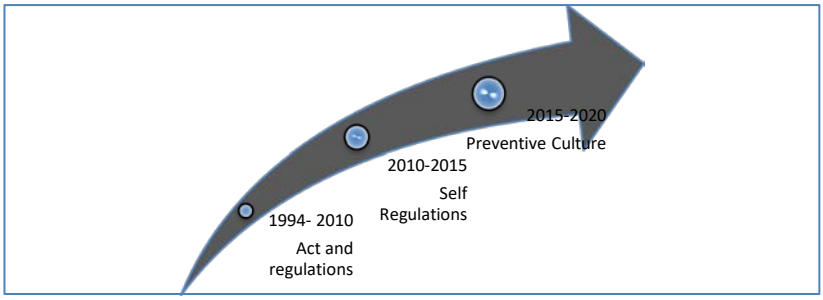
years, cutting ergonomics -related incidents from 70% to 20% of total injuries. This represents an 86% reduction in the ergonomics -related recordable incident rate.

Recently, safety culture is important because it covers the attitudes, values, practices of the workers and top management in companies (Bhasi and Vinodkumar, 2009; Rozlina *et al*, 2012). By emphasizing the importance or the benefits, this research will identify the significant relationships of ergonomics awareness and safety culture, subsequently how ergonomics can play its role in inculcating safety culture.

This research will lead to a better understanding and provide new insight for ergonomics implementation within the safety culture. Finally, a framework will be developed to facilitate the implementation in order to get full benefit of it.

In line with intention to inculcate the safety culture, Malaysian government under Department of Occupational Safety and Health (DOSH) has targeted the organization to work in a safety culture by launching an Occupational Safety and Health Master Plan 2020 (OSH MP 20) (DOSH, 2010) whereby the safety culture is planned to be implemented between the years 2016- 2020. A strategic plan has been developed and publicized to all organization throughout Malaysia.

Figure 1.1 illustrates the chronology of DOSH effort in inculcating safety culture. From 1994, OSHA was introduced and self-regulation has been enforced. The culture of self-regulation and OSH culture is planned to be fully implemented by 2020.



(Source: DOSH, 2010)

Figure 1.1 OSH MP 20 plan to inculcate safety culture in 2020

Although safety and health issues emerge over a long period of time, by the time they are detected, the damage is usually irreversible. Thus, this is a suitable time to bring ergonomics concurrent with safety to be inculcated in the safety culture.

Ergonomics is important at least in theory but its current awareness among Malaysian SHOs has not been explored. Human factors or ergonomics is believed to play a vital role in increasing organizational health and safety performance (Donald and Young, 1996) and this indirectly is also related with safety culture.

1.5 Objectives and Research Questions

The objectives for the research are:

a) to identify the extent of ergonomics awareness, ergonomics practice, safety culture beliefs and existing safety culture practice amongst Safety and Health Officers (SHOs) in Malaysia.

b) to determine the relationship among the ergonomics awareness, ergonomics practice, safety culture beliefs and existing safety culture practice.

In order to achieve the first objectives, some research questions need to be answered:

RQ1a: What is the level of safety culture practice compared to their beliefs in terms of the importance at the workplace?

RQ1b: What is the level of ergonomics practice compared to ergonomics awareness?

RQ1c: What is the constraint of ergonomics practice?

RQ1d: What is the level of the understanding of the legislation regarding ergonomics and safety and health?

RQ1e: Are education, past working experience in companies, working experience as SHO and training affect the level of ergonomics awareness? Which one has more significant effect?

In order to achieve second objective, some other research questions need to be answered:

RQ2a: What is ergonomics awareness constructs and safety culture measures amongst SHOs for manufacturing companies in Malaysia?

RQ2b: What is the relationship among ergonomics awareness, ergonomics practice, beliefs on the importance of safety culture at the workplace and safety culture practice?

RQ2c: What is the mediating impact of ergonomics awareness between safety culture beliefs and the practice?

1.6 Scopes of Study

i) The study focused on ergonomics and safety culture perceptions of SHOs.

ii) The populations and samples were based on the name list of SHOs registered under DOSH in 2009. This is based on the year the research started.

SHOs were chosen because they are expected to be the most knowledgeable in providing the desired information on aspects such as productivity, motivation, fluctuation in absence of the worker as well as ergonomic practices are on the shop floor as mentioned by Thun *et al.* (2011).

1.7 Organization of Thesis

There are seven chapters in this thesis. The first chapter provides a background of study and outlined the objectives and scopes. Chapter two reports on the literature study. The safety culture and ergonomics are highlighted. Current research and relevant frameworks is also described.

Chapter Three reports the construct development and hypotheses. It covers safety culture and ergonomics construct including the hypotheses. In hypotheses, the relationships among factors are explained.

Chapter Four highlights methodology used in the study. Flow chart of the research and the methodology are explained. Reliability, validity, normality and sample size are explained in this chapter.

Chapter Five discusses on results and analysis. Two main parts on analysis are done: the first part is an analysis on the level of safety culture between the awareness and practices and the analysis on the beliefs on the importance of ergonomics at workplace and ergonomics practice. The demographics data such as formal education, past working experiences and ergonomics training obtained are also being analysed to identify the influence to the constructs. Second part is the exploratory factor analysis and confirmatory factor analysis for all four constructs: safety culture beliefs (SCB), existing safety culture practice (ESCP), ergonomics beliefs (EB) and ergonomics practice (EP). Exploratory factor analysis and all procedures required such as total variance, rotated factor matrix, reliability analysis for all four constructs. Subsequently, the confirmatory factor analysis covers the measurement model such as uni-dimensionality, construct validity and convergent validity. The mediating factors are explained. The mediating factors in this study are EA, ESCP and EP.

Chapter Six is discussions. The discussions are done based on research questions. There are three main research questions. Research Question 1 (RQ1) discusses on the level of safety culture practice compared to their beliefs and the level of ergonomics practice compared to ergonomics awareness. RQ2 discusses about the relationships and correlations among the four factors and RQ3 is about the constraints that may influence the ergonomics awareness and practices.

Chapter Seven concluded all the chapters in the thesis. The list of publications is located in the appendix L.

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