UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF STATIC STANDING WORKSTATION DESIGN DIMENSIONS FOR MALAYSIAN WORKERS

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DEVELOPMENT OF STATIC STANDING WORKSTATION DESIGN DIMENSIONS FOR MALAYSIAN WORKERS

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Master of Science

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DEVELOPMENT OF STATIC STANDING WORKSTATION DESIGN DIMENSIONS FOR MALAYSIAN WORKERS

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Chair : Associate Professor Ir Faieza Abdul Aziz, PhD
Faculty : Engineering

A good workstation design must be comfortable, safe and easy to use for the workers. Unsuitable design of workstation may lead to musculoskeletal symptoms such as at the upper limbs, neck and lower back. Using the anthropometric dimensions of the workers, a better fit between the workers and the workstation design can be achieved. A total cost of RM13, 593,357.59 was paid by the Social Security Organization of Malaysia (SOCSO) compensation of musculoskeletal disorder for 537 cases within the last 5 years which are the highest cases claimed under the category of others occupational diseases. Although workstation design guideline is available and various standards are being referred to, there is a limited study on matching the anthropometric data of the Malaysian workers with the dimensions of the workstation in Malaysia. This study was carried out to identify the relevant anthropometric dimension for standing workstation, develop an ergonomics workstation standing dimension suitable for the Malaysian population and to validate anthropometric dimension for standing workstation design. Methodology of this study was by using questionnaire and a total of 1268 data was successfully collected with 30 anthropometric dimensions of Malaysian workers consist of 929 males and 329 females from 10 sectors of industries classified under Occupational Safety and Health Act 1994. The measurements based from the guidelines recommended by MS ISO 7250-1:2008, Basic Human Body Measurement for Technological Design using anthropometric grid and traditional measuring tools. Statistical Program for Social Science (SPSS) is used to analyse the data Descriptive statistics and T-test between male and female. CATIA V5 RULA Analysis and CATIA V5 Biomechanics Single Action Analysis are used to validate the recommended dimension. This study was carried out 17 anthropometry dimensions (standing measurement) from 30 anthropometry dimension, there is no significant difference found in the researcher measured data for 11 out of the 17 measurements. Four significant findings were recorded in this study namely, anthropometric dimensions for standing workstation design which are stature, standing eye height, standing elbow height and fingertip reach. It also highlighted that the best dimension are overhead clearance more than 183.4cm, working

height range of adjustable from 93.4cm to 115.9cm, Visual Display Terminal (VDT) height adjustable range from 148.9cm to 157.6cm and maximum reach with 73.5cm. Findings of this study has granted imperative information in designing standing workstation for Malaysia industry to help in creating a safer, healthier and comfortable workplace.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PEMBANGUNAN DIMENSI REKABENTUK RUANG KERJA BERDIRI STATIK BAGI PEKERJA MALAYSIA

Oleh

SITI NURANI BINTI HASSAN

Mac 2019

Pengerusi : Profesor Madya Ir Faieza Binti Abdul Aziz, PhD
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Reka bentuk stesen kerja yang baik mestilah selesa, selamat dan mudah digunakan untuk para pekerja. Rekabentuk stesen kerja yang tidak sesuai boleh mengundang simptom penyakit otot rangka seperti tangan, leher dan belakang. Dengan menggunakan dimensi antropometri para pekerja, kesesuaian antara pekerja dan reka bentuk stesen kerja dapat dicapai. Kos sebanyak RM 13,593,357.59 telah dibayar oleh Pertubuhan Keselamatan Sosial (PERKESO) untuk pampasan ke atas 537 kes penyakit otot rangka sepanjang 5 tahun yang lalu yang juga merupakan rekod paling tinggi yang pernah dicatatkan di bawah kategori lain-lain penyakit pekerjaan. Walaupun garis panduan reka bentuk kerja boleh didapati dan pelbagai piawaian sedang dirujuk, terdapat kekurangan kajian mengenai hubungan data antropometrik pengguna dengan dimensi stesen kerja di Malaysia. Kajian ini dijalankan untuk menentukan dimensi antropometri yang berkaitan dengan stesen kerja yang berdiri, untuk mengesahkan dimensi antropometri untuk reka bentuk stesen kerja berdiri dan membentuk dimensi berdiri ergonomik yang sesuai untuk pekerja Malaysia. Metod kajian menggunakan borang kaji selidik dan sebanyak 1268 peserta meliputi 929 lelaki dan 329 wanita bagi 30 antropometrik dimensi statik dari 10 sektor industri yang di senaraikan bawah Akta Keselamatan dan Kesihatan Pekerjaan (Akta 514) telah dikumpulkan. Ukuran diambil berdasarkan cadangan garispanduan bawah MS ISO 7250-1:2008 iaitu pengukuran asas badan manusia untuk rekabentuk teknikal menggunakan peralatan yang dikenali antropometrik grid dan pengukuran secara tradisional. Statistik deskriptif dan ujian T antara lelaki dan wanita digunakan adalah Program Statistik untuk Sains Sosial (SPSS) untuk menganalisis data. CATIA V5 Analisis RULA dan CATIA V5 Biomekanikal Analisis Tindakan Tunggal digunakan untuk mengesahkan dimensi yang dikenalpasti. 17 dimensi antropometri (ukuran berdiri) daripada 30 dimensi anthropometri statik menunjukkan tidak terdapat perbezaan yang signifikan dalam penilaian data bagi 11 ukuran daripada 17 ukuran. Empat dimensi badan digunakan untuk mereka bentuk stesen kerja berdiri statik iaitu ketinggian puncak kepala berdiri, ketinggian mata berdiri, ketinggian siku berdiri, dan pencapaian hujung jari. Kesemua faktor ini mencadangkan dimensi terbaik

ialah ruang kelegaan atas kepala melebihi 183.4cm, ketinggian meja kerja boleh laras dari 93.4cm hingga 115.9cm, ketinggian terminal paparan visual boleh laras dari 148.9cm hingga 157.6cm dan jangkauan maksima iaitu 73.5cm. Analisis ini menyediakan maklumat penting dalam merekabentuk stesen kerja berdiri untuk industri Malaysia dalam membantu industri mewujudkan tempat kerja yang lebih selamat, sihat dan selesa.

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I certify that a Thesis Examination Committee has met on (18th March 2019) to conduct the final examination of Siti Nurani Binti Hassan on her thesis entitled **Development of Static Standing Workstation Design Dimension for Malaysian Workers** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master ofn Science.

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I hereby confirm that:

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This is to confirm that:

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LIST OF ABBREVIATIONS / NOTATIONS / GLOSSARY OF TERMS

AL	Action Limit
BIFMA	Business Institutional Furniture Manufacturer Association
BMI	Body Mass Index
CAD	Computer-aided design
CATIA	Computer Aided Tri-Dimensional Interface Application
COP	Center of pressure
CTD	Cumulative trauma disorders
ISO	International Organization for Standardization
LBP	Low back pain
MMH	Manual Materials Handling
MPL	Maximum Permissible Limit
MRC	Medical Research Council
MS	Malaysian Standard
MSDs	Musculoskeletal Disorders
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RULA	Rapid upper limb assessment
SOCSO	Social Security Organization of Malaysia
SPSS	Statistical Program for Social Science
VDT	Video Display Terminal
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia's economic performance have recorded an increase every year with a 5.9% growth specifically in the year 2017 (Department of Statistics Malaysia, 2018). Musculoskeletal disease have also increased from year to year reported by Social Security Organization (SOCSO) Malaysia. Musculoskeletal diseases occur based on a few factors such as from workstation, work, posture, repetitive, load, fatigue and many more. This is a problem makes workers health condition decrease.

Malaysia would like to maintain the high quality of productivity in the industry but at the same time taking care of workers health is as much important. Taking good care in workers' health condition such as through good workstation design but reference for workstation design in Malaysia is lacking. Malaysia has adopted the International Organization for Standardization (ISO) as a reference standard for most of the local practice in Malaysia. However reference for workstation design is still very few.

The Malaysian Department Occupational Safety and Health (DOSH) has a vision in the planning for the nation's Occupational Safety and Health under Occupational Safety and Health Master Plan (OSH-MP) 2020 which is the inculcation of preventive culture at the workplace. Adapting the work to the individual, especially in regards to the design of workplaces is one of the general principles of prevention element. An important element in designing workstation is by having the Malaysian population anthropometric data which is still lacking especially for workers in the Malaysian industries.

To tackle this problem, the best technique is to design workstation based on Malaysian workers population so that they can work within their limitation and at the same time can increase the productivity. Better creation and innovation of production for machine and equipment must sync with the occupation community and in concurrently with the fast technology advancement (Pimentel et al, 2006). Based on the above, it is time to develop ergonomic workstation design for Malaysian industrial reference and increasing work comfort, work productivity and performance.

1.2 Problem Statement

The existence of the Factories and Machinery Act (FMA) 1967 and the Occupational Safety and Health Act (OSHA) 1994 indicates the importance of OSH at the workplaces in Malaysia. Creating a culture of safety and health among all employers and workers in Malaysia is the main objective of this act. Among the issues of concern is an increase in occupational disease caused by exposure to hazards in ergonomics, chemicals and noise. It is the responsibility of the employer to provide a policy of healthy and safe work environment in the workplace for all its workers and to ensure protections of others as stated in the Section 15 (1) of Occupational Safety and Health Act 154, “It shall be the duty of every employer and every self-employed person to ensure, so far as is practicable, the safety, health and welfare at work of all his employees”.

In principle, control measure at workplace will prevent occupational diseases. On the other hand, most of the control measures have few considerations in terms reduction of occupational diseases. Option for the best study design must include the demographic of the workers (task, type of industry), approach of the intervention (worker, sector, company, national), and expected outcome measure includes expected frequency of injury, accident or disease in certain duration).

Occupational diseases such as workplace musculoskeletal disorders are current situation which must be address as cases are found to be on the increase. Unsuitable design of workstation may lead to musculoskeletal symptoms such as at the upper limbs, neck and lower back (Kalinkara et al., 2011). Moreover, it was reported by Social Security Organization of Malaysia (SOCSO) in year of 2006, 14 cases were recorded followed by 268 cases in 2011 and marked almost double in theyear 2012 (SOCSO, 2015). Total cost SOCSO compensation musculoskeletal disorder for 537 cases from year 2009 until 2014 is RM13,593,357.59 which the highest cases claim among the others occupational diseases (Abidin et al., 2018). Furthermore, most of the industries use standing workstation during working hours (Laprriere et al., 2006). The factors found to be increasing the risk of work related musculoskeletal disorders and work related psychological discomfort are inappropriate adjustment for, or the exclusion of anthropometric data in product and workplace design (Viester et al., 2013).

General guideline on work at standing/sitting positions have been proposed by Occupational Health and Safety Division, Ministry of Manpower, Singapore. Malaysia also have a guideline proposed by Ministry of Human Resources Malaysia under DOSH namely, The Guidelines on Occupational Safety and Health for Standing at Work (2002); Guidelines on Occupational Safety and Health for Seating at Work (2002); and Guidelines on Occupational Safety and Health for Working with Video Display Units (VDUs) (2003). These are the general guidelines mostly used for industrial references.

Generally, the goal of ergonomics is to fit the task to the human, not the human to the task. Nowadays, designer and manufacturer of consumer product has priorities the safety and ergonomics element in their product. Most of consumer product have widen the option regarding in safety and ergonomic features based on their own research and innovation. All workers need to be provided with the appropriate and ergonomically design of their workstation and also working environment. This designed workstation or workplace just need a minimum effort of the workers to performs their daily job task. Any workplace that make workers need to use an excessive power might cause bad effect to the workers.

It is crucial that all place of work design and setup should be accommodate the physical size of the operator. This is because human natural and movement postures are based on the measurement of the arms, legs and also torso (Grandjean, 1998). Previous studies validating the use of self-reported anthropometry (Kouvonen et al., 2013) have focused primarily on stature and weight. No studies have been identified that include anthropometric measurements required for workplace design for Malaysian workers.

Therefore, more knowledge is essential to provide guidelines in designing a safer and healthier comfortable and productive working environments workplace for Malaysian workers. There is a need to determine more specific workstation design dimension base on anthropometric data of Malaysian workers.

1.3 Objectives of the Study

The following objectives were established towards achieving the goal of this study in development of static standing workstation design dimension for Malaysian workers which are;

1. To identify the relevant anthropometric dimension of Malaysian workers for standing workstation design guideline.
2. To develop static standing workstation design dimension for Malaysian workers.
3. To validate anthropometric dimension for standing workstation design.

1.4 Scope of the Study

Body dimensions are varied among the population base of several factors including race/ethnicity, age, gender, nutritional status and sociodemographic status (Chuan et al., 2010; Parkinson and Reed, 2010; Hanson et al., 2009).

Over lifetime, the event of human adaptation occurred spontaneously in term of plasticity, genetic changes, acclimatisation and behavioural changes adaptation which can affect the body dimensions of a particular population (Bridger, 2009). Many studies also had shown the variability of body dimensions between difference race groups such as in Malaysia which consist of three main races including Malay, Indian and Chinese (Karmegam et al., 2011).

This study focuses on getting the anthropometric data for Malaysian workers to develop static standing workstation design dimension at workplace. Total sample size of this study are 1,134 Malaysian citizen workers consist of 863 males and 261 females that came from ten type of industries listed in Schedule 1 of OSHA 1994 were taken for first phase of screening parameter workstation. Respondents was the participants who came to National Institute of Occupational Safety and Health (NIOSH), Bandar Baru Bangi, Selangor, Malaysia to attend for safety and health course. Data was collected in year 2013. Additional data sample size of 134 comprising 66 males and 68 females were taken to confirmation parameter for design which were collected among workers in NIOSH Bandar Baru Bangi in 2015. The data was collected from different demographic groups including all industries as listed in OSHA 1994 Act 514 to ensure greater understanding of the body dimension of particular population in workstation designing.

Seventeen static anthropometric dimensions out of thirty which are vertical grip reach, stature, standing eye height, standing shoulder height, armpit height, standing elbow height, hip height, knuckle height, fingertip height, tibial height, biacromial breadth, bideltoid breadth, elbow span, grip reach for forward reach, fingertip reach for forward reach, span and body weight. This anthopometric dimension selection according to Pheasant and Haslegrave (2006) and Business Institutional Furniture Manufacturer Association (2013) for static standing workstation design dimension. The design will also require the principles of ergonomics which include the comfort, safety and ease of use of systems, products and machines to be incorporated into the design. The findings will be useful reference for industries in Malaysia.

1.5 Limitation

Although measurers were properly trained, the potential of measurement inaccuracies may occur. Body dimensions selected for this study were based on the research by Siti Nurani, Rosnah, Raemy, Mohd Rizal, & Hari Krishnan (2015) which followed the MS ISO 7250-1:2008, Basic Human Body Measurement for Technological Design. The available body dimensions measured were limited to static standing workstation only.

1.6 Thesis Outline

Chapter 1 of this thesis identifies and presents the problem statement, objectives and scope of this research. Chapter 2 is the literature review of the study which covers previous studies, relevant topics related to this work and also the background such as workplace ergonomics, application anthropometry in designing workplace and validation technique in ergonomic analysis software. Chapter 3 explains the data collection protocol, preparation and proposed research methodology. Details of the results and discussion are provided in Chapter 4 and the conclusion of the current work and potential future investigations are presented in Chapter 5.

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PUBLICATIONS

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