UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ERGONOMIC RISK ASSESSMENT ON LABORATORY CHAIR USER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

by

NURUL SYIFAA' BINTI JAMALUDDIN

B071610116

931216-05-5074

FACULTY OF MANUFACTURING ENGINEERING TECHNOLOGY

2019/2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: ERGONOMIC RISK ASSESSMENT ON LABORATORY CHAIR USER

Sesi Pengajian: 2019/2020

Saya **NURUL SYIFAA' BINTI JAMALUDDIN** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐	SULIT*	Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD*

Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

NURUL SYIFAA' BINTI JAMALUDDIN

Alamat Tetap:

No. 12 JALAN AMM4

TAMAN AYER MOLEK MESRA,

75460, MELAKA

Tarikh:

Disahkan oleh penyelia:

.....

MOHD HIDAYAT BIN AB RAHMAN

Cop Rasmi Penyelia

Tarikh:

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled ERGONOMIC RISK ASSESSMENT ON LABORATORY CHAIR USER is the results of my own research except as cited in references.

Signature: ……

Author : NURUL SYIFAA' BINTI JAMALUDDIN

Date:

ABSTRAK

Kajian ergonomik ini adalah penilaian risiko ergonomik pada pengguna kerusi makmal dimana kajian yang dilakukan berkenaan postur badan pengguna terutama pelajar semasa menggunakan kerusi makmal yang boleh didapati di makmal-makmal yang bertempat di kilang FTKMP dan FTKEE, Universiti Teknikal Malaysia Melaka (UteM). Kajian ini memberi tumpuan kepada keselesaan pelajar yang menggunakan kerusi makmal dan juga ingin mengenal pasti kecenderungan bahagian kerusi yang berkait dengan masalah tulang belakang dan penyakit Muskuluskeletel apabila menggunakan kerusi makmal. Oleh itu, kedudukan postur yang betul serta reka bentuk dan kejuruteraan kerusi ergonomik dianggap sangat penting untuk kegunaannya dan pandangan keselesaan para pelajar.. Kajian penyelidikan ini menggunakan beberapa teknik seperti menggunakan borang kaji selidik untuk mengenal pasti kecenderungan bahagian kerusi yang berkait dengan masalah tulang belakang dan muskuluskeletel dalam kalangan pelajar, teknik Borg's Scale dan Rapid Upper Limb Assessment (RULA) digunakan untuk membuat perbandingan sebelum dan selepas penggunaan postur yang betul. Setelah itu, hasil dapatan kajian daripada beberapa teknik ini akan dibandingkan.

ABSTRACT

This ergonomic study is an ergonomic risk assessment on laboratory chair users where the research is to find the correct body postures especially students while using laboratory chairs that are available at laboratories located at FTKMP and FTKEE factories, Universiti Teknikal Malaysia Melaka (UTeM). This study focuses on the comfort of students using laboratory chairs and also wants to identify the inclination of the chair features related to spine problems and Musculoskeletal disease when using laboratory chairs. Therefore, proper posture position as well as design and engineering of ergonomic chair are considered very important for its use and comfort of the students. This research study uses a number of techniques such as using a survey form to identify the discomfort of chair parts associated with spinal problems and musculoskeletal among students, Borg's Scale Discomfort Survey and Rapid Upper Limb Assessment (RULA) techniques were used to make comparisons before and after of proper posture use. After that, the findings from these techniques will be compared.

DEDICATION

This thesis is dedicated to my beloved mother, Mrs Marbiyah binti Mohd and my father, Mr. Jamaluddin bin Hj Yeop Malis who always been give support and encouragement during the challenges of my whole university life.

ACKNOWLEDGMENT

Alhamdulillah, thanks to Allah SWT, whom with His willing giving me the opportunity to complete this Final Year Project with successfully.

Foremost, I would like to take this opportunity to express my sincere acknowledgement to my previous supervisor for my Final Year Project 1, Mrs Umi Hayati and also my current supervisor, Mr Mohd Hidayat bin Ab Rahman for their essential supervision, support and encouragement towards the completion of this research.

Also, I would like to thanks to Mr Janatul Hafiz Bin Basir and Mr Muhammad Zuhri Bin Shari for allowing me to use Laboratory equipment and complete my experiments in the Laboratory. Thanks also to all the lecturers and UTeM staff and who had been involved directly or indirectly throughout this project.

Deepest thanks to all my peers, my beloved parents and family for their moral support, cooperation and encouragement in completing this degree. Lastly, thank you to everyone who had been to the crucial parts of realization of this project.

TABLE OF CONTENTS

TABLE OF CONTENTS		PAGE
LIST OF TABLES		**xii**
LIST OF FIGURES		**xiv**
LIST OF APPENDICES		**xviii**
LIST OF ABBREVIATIONS		**xix**
CHAPTER 1	**INTRODUCTION**	**1**
1.0	Background	1
1.1	Objective Project	4
1.2	Problem Statement	4
1.3	Work Scope	6
CHAPTER 2	**LITERATURE REVIEW**	**7**
2.0	Ergonomic Issues	7
2.0.1	Musculoskeletal disorders (MSDs)	7
2.0.2	Low Back Pain	8
2.1	Methods to use	9

2.1.1 Anthropometric analysis 10

2.1.2 Questionnaire Survey 14

2.1.3 RULA technique 17

2.1.4 Analysis of Variance (ANOVA) 19

2.1.5 Minitab 20

2.1.6 Microsoft Excel 21

CHAPTER 3 METHODOLOGY 23

3.0 Introduction 23

3.1 Project Flowchart Development 24

3.2 Process flow explanation 25

3.2.1 Survey Type of Chair 27

3.2.2 Questionnaire 27

3.2.3 PUGH Weighted Decision Matrix 27

3.2.4 Statistical Data using Microsoft Excel 28

3.2.5 Propose Guideline for sit posture 28

3.2.6 Discomfort Survey using Borg's CR-10 scale 28

3.2.7 Anthropometric Data 30

3.2.8 Anthropometric Analysis 31

3.2.9 Participants Selection for Anthropometric Data Collection 31

3.2.10 RULA Technique 32

3.2.10.1 Example of Using the RULA Assessment Tool 35

3.2.10.2 RULA Assessment Tool using ErgoFellow Software 40

CHAPTER 4 RESULT & DISCUSSION 46

4.0 Introduction 46

4.1 Survey type of chair 46

4.2 Laboratory Chair Selection 49

4.3 Questionnaire 55

4.4 Ergonomic Posture Experiment 64

4.5 Measurement of Anthropometric data 66

4.6 Anthropometric Percentile Data Analysis 69

4.7 Validation of RULA ErgoFellow Software 71

4.8 Result of RULA Analysis on respondents' current sitting posture 78

4.9 Result of Borg's Scale Discomfort Survey on respondents' current sitting posture 79

4.10 Improvement on respondents' current sitting posture 81

4.11 The Guideline of Right Sitting Posture on Laboratory Chair 83

4.12 Result of Borg's Scale experiment between respondents' current sitting posture and The Proposed guideline of right sitting posture. 85

4.13 Comparison result of RULA method between Respondents' current sitting posture and the guideline of right sitting posture 89

CHAPTER 5 CONCLUSION & RECOMENDATION 92

5.1 Conclusion 92

5.2 Recommendation and contribution 93

5.3 Future Research 94

REFERENCES 95

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Percentile of Each Body Dimension	11
2.2	Descriptive Statistics for measured anthropometric dimension for male students	13
2.3	Descriptive Statistics for measured anthropometric dimension for female students	13
2.4	Comparison of Point Prevalence of Musculoskeletal Symptoms in Neck, Back and Large Joints in General Iranian Population and the Study Population	14
2.5	RULA and REBA score averaged (SDs) for library work tasks/activities observed before the ergonomics training was conducted in this study	20
3.1	Grand score of RULA	33
4.1	Type of laboratory chair that available in FTKMP Factory	53
4.2	Type of laboratory chair that available in FTKEE Factory	54
4.3	Criteria of Lab Chair chosen by 45 respondents from questionnaire	55
4.4	PUGH Weighted Decision Matrix Method of type of laboratory Chair	56
4.5	Female Respondent Anthropometric Measurement Data	73
4.6	Male Respondent Anthropometric Measurement Data	74
4.7	The statistics of the anthropometry of the Female Respondents	75

TABLE	TITLE	PAGE
4.8	The statistics of the anthropometry of the Male Respondents	76
4.9	The comparison method used between RULA Employee Assessment Worksheet and RULA by ErgoFellow	72
4.10	Improvement of posture based on body parts	80

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Sources of Joint Pain	7
2.2	Discomfort Questionnaire in Naddeo et al., 2019 research	16
2.3	The body chart discomfort using Borg's CR-10 scale	17
2.4	RULA Employee Assessment Worksheet	18
2.5	Normal Distribution Curve	20
2.6	Pareto chart for ergonomic assessment	21
2.7	Microsoft Excel comparison bar graph	22
3.1	Flow Chart Process	23
3.2	The Wooden Lego of Bulldozer	25
3.3	Measuring tape is used for taking respondent's anthropometric data	26
3.4	Respondents during experiment with different type of laboratory chair	26
3.5	The body chart discomfort using Borg's CR-10 scale	29
3.6	Borg's CR-10 scale	29
3.7	Anthropometric data needed in the layout of school furnishing	30
3.8	RULA Employee Assessment Worksheet	28
3.9	Level of MSD Risk	32
3.10	Arm & Wrist Analysis	35
3.11	Arm and Wrist analysis based on step 3-5	36
3.12	Neck, Trunk and Leg Analysis (Step 9-11)	37

FIGURE	TITLE	PAGE
3.13	Total score for Group B (Steps 12-15)	38
3.14	Last step of RULA	39
3.15	Selected Ergonomic Tools that required in Ergo Fellow Software	40
3.16	Step 1 of Upper Arm	41
3.17	Step 2 of Wrist Analysis	41
3.18	Step 3 of Neck Analysis	42
3.19	Step 4 of Legs Analysis	42
3.20	Step 5 of Lower Arm Analysis	43
3.21	Step 6 of Wrist Twist Analysis	43
3.22	Step 7 of Trunk Analysis	44
3.23	Step 8 of Muscle Use and Load	44
3.24	The score that highlighted with yellow colour is the result of the score	45
4.1	Bar chart of Criteria of Lab chair by 45 respondents.	49
4.2	Type of laboratory chair that will be used for this research.	53
4.3	Question and result of Laboratory chairs that are usually used among FTKMP and FTKEE students using Google Survey Form	54
4.4	Bar chart Gender vs Age	55
4.5	Bar chart Year vs Faculty	55
4.6	Pie chart of questionnaire	56
4.7	Bar Chart of back rest	57
4.8	Bar Chart of Adjustable feature	57
4.9	Bar Chart of Health issue	58
4.10	Frequent of Using Laboratory Chair Feature	59

FIGURE **TITLE** **PAGE**

4.11 User Comfort on the Lab Chair with Duration 30 Minutes 60

4.12 The effect of wheel on comfort user 61

4.13 The effect of Swivel Chair on the comfort user 62

4.14 The most uncomfortable body part of students during lab session 63

4.15 Finalize Laboratory Chair that were used for Ergonomic Posture Experiment 64

4.16 Year against gender 64

4.17 Year against faculty and course 65

4.18 A technician performing electrical wiring installation 71

4.19 Score A 75

4.20 Score B 76

4.21 The risk factor scores for section A and B 76

4.22 Score C 76

4.23 The total RULA Grand Score 77

4.24 RULA score against Respondents' current sitting posture on both Lab Chair 78

4.25 Result of Borg's Scale on Lab Chair Blue 79

4.26 Result of Borg's Scale on Lab Chair Black 80

4.27 Borg's Scale Score of Respondents' current sitting posture between Lab Chair Blue and Lab Chair Black 80

4.28 Sitting at the comfortable height 81

4.29 Total average of female Borg's Scale against current & the guideline of right sitting posture on Lab Chair Blue 85

4.30 Total average of male Borg's Scale against current & the guideline of right sitting posture on Lab Chair Blue 86

4.31 Total average of female Borg's Scale against current & the guideline of right sitting posture on Lab Chair Black 87

4.32 Total average of male Borg's Scale against current & the guideline of right sitting posture on Lab Chair Black 88

4.33 RULA score against female respondents on Lab Chair Blue 89

4.34 RULA score against male respondents on Lab Chair Blue 90

4.35 RULA score against female respondents on Lab Chair Black 90

4.36 RULA score against male respondents on Lab Chair Black 91

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix 1	Gantt Chart of FYP 1	97
Appendix 1	Gantt Chart of FYP 2	98
Appendix 3	Questionnaire	99
Appendix 4	Data Analysis for Questionnaire	103
Appendix 5	Ergonomic Risk Assessment Experiment	106
Appendix 6	Respondent's Schedule Experiments	109
Appendix 7	Ergonomic Posture Experiment (Current vs Guideline)	110
Appendix 8	Data Analysis of Borg'scale and RULA	115

LIST OF ABBREVIATIONS

FYP	Final Year Project
ANOVA	Analysis of Variance
FTKMP	Fakulti Teknologi Kejuruteran Mekanikal Pembuatan
FTKEE	Fakulti Teknologi Kejuruteraan Elektrik Elektronik
UTeM	Universiti Teknikal Malaysia Melaka
MSD	Musculoskeletal Disorders
WRMSD	Work-Related Musculoskeletal Disorders
RULA	Rapid Upper Limb Assessment
REBA	Rapid Entire Body Assessment
ROSA	Rapid Office Strain Assessment
PERA	Postural Ergonomic Risk Assessment
EMG	Wired Electromyography

CHAPTER 1

INTRODUCTION

1.0 Background

Humans do various activities in life. One of the activities that done is to work for life. Human work activity usually using tools or engaging workstations. Ergonomics are synonymous with tools or workstations involving humans. Ergonomics or factors human or human engineering is referred to as human factor refers to the field or a study of interactions between humans and their work. Ergonomic or Human factor is not only limited to the engineering field alone, it covers a wide range of areas that are closely related and involving human beings. In job context, ergonomics is more geared towards adjusting work with workers rather than adjusting the worker with work.

Ergonomics is not only applied to the industry; ergonomics is applied in all areas especially in our daily routine. One of fields of work that focus on ergonomics are manufacturing sectors, service sector, office work and product production users. While home activity involves activities in the kitchen, cleaning home and gardening in the yard. Other than workers, students also do a lot of activities in the classroom especially engineering students who are doing a lot of activities in the laboratory such as grinding, machining, assembly session and experiments. Laboratory chair is one of important elements for students to concentrate in study as well as for comfort during studying. A

design and engineering ergonomic laboratory chair is also very important for students' point of views of usability and comfort.

(Al-Hinai, Al-Kindi, & Shamsuzzoha, 2018) said, there are only a few studies have been held so far on the chair design and engineering prefer the exact expectations and needs in the classroom environment from the students. Furthermore, from aesthetics point of views, an ergonomic chair preferable have extra features connected to more convenience, convenience to maintenance, comfort and durable to seat.

According to (Purnomo, 2018), it satisfaction in the flow of managing school sessions is a dominant factor of maximizing student performance. Since students spend most of the time sitting, supportive facilities are needed, one of which is school furniture of appropriate dimensions based on the anthropometry of students' bodies to prevent wrong ergonomic postures that interrupt the learning process.

Other than that (R & Suryani, 2015) said, not ergonomic working tools can cause Work Related Musculoskeletal Disorders (WRMSDs) to workers, and will have effect to work productivity. (R & Suryani, 2015) also mention in their studies, one of ergonomic issues that usually happen in the working area, relating to human strength and tolerance while performing the task (biomechanic), is musculoskeletal or muscular strain. These problems were usually happened by workers who did repetitive movements continuously.

The basic theory of ergonomics is to produce any design of furniture which approach to comfortability, physical health, safety, well-being, convenient and give good impact towards studies (Wilson & Desai, 2017). Students need a better designed furniture because they will become fatigue if they are in awkward posture while doing a frequent task such as, typing, writing, drawing, reading on the table and etc. This might impact their study performance during learning process.

There a few most common factors of ergonomics that cause injuries of musculoskeletal disorders (MSDs), such as awkward postures and a heavy application workload. The truth, material handling of manual is considered as a basic type of task that increases ergonomics risks such as low back problems. (Basahel, 2015)

Furthermore, ergonomics has been a reason of innovation products. It is valid to focus on the quality of life of workers that requires the use of ergonomic knowledge to optimize the surrounding environment and to offer accurate contact with humans. Thus, the application of ergonomics can maximise an individual´s comfort and well-being, ensure safety, reduce human costs and increase the yield from the work so that the productivity of service may be improved. (Barros, Marçal, & Soares, 2015)

Musculoskeletal disorders (MSDs) are a common health problem and a major cause of disability throughout the world. Economic losses due to disorder not only affect individuals but also organizations and communities as a whole. At present, MSDs are one of the most dominant problems ergonomists encounter in the workplace all over the

world. Prevention of work-related musculoskeletal disorders (WMSDs) has become a national priority in many countries. (Choobineh, Lahmi, Shahnavaz, Khani, & Hosseini, 2015)

1.1 Objective Project

The objectives of this project are:

i. To identify ergonomic risks for musculoskeletal disorders (MSDs) among engineering student.

ii. To determine the sitting comfort of Laboratory chair in FTKMP and FTKEE factories.

iii. To analyse data of posture students by using Anthropometric Data, Discomfort Questionnaire and RULA methods.

iv. To compare the result between respondents' current sitting posture and the propose guideline of right sitting posture using different type of methods such as Discomfort Questionnaire and RULA methods.

1.2 Problem Statement

In many Science and Engineering students spend considerable parts of their time doing a wide range of practical or laboratory work especially students of Faculty of Engineering Technology since the faculty program is 70% coursework and hands-on activity. Therefore, the posture of students sit on the laboratory chair should be suitable in terms of its position, parameters and postures. This is because the posture of sitting will affect students' Musculoskeletal and Lumbar Spine.