CONSIDERATION OF HAND GRIP STRENGTH IN THE HAND GRINDER HANDLE TO IMPROVE SUBJECTIVE COMFORT AND WORK PRODUCTIVITY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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CONSIDERATION OF HAND GRIP STRENGTH IN THE HAND GRINDER HANDLE TO IMPROVE SUBJECTIVE COMFORT AND WORK PRODUCTIVITY

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management)(Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Manufacturing Management) (Hons). The member of the supervisory committee is as follow:

…….....

(Dr. Isa Bin Halim)

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ABSTRAK

Pada era globalisasi ini, inovasi peralatan tangan amatlah penting kerana permintaan produk industri pembuatan semakin meningkat. Peralatan tangan perlu direka dengan menerapkan asas ergonomik untuk memastikan pengguna dapat menggunakan peralatan tersebut dengan usaha yang minimum, tetapi boleh menghasilkan keluaran yang maksimum. Dalam industri pembuatan, pencanai tangan merupakan peralatan yang digunakan untuk melaksanakan operasi pemesinan am. Walau bagaimanapun, ramai pengguna menghadapi masalah berkaitan dengan rekabentuk mesin pencanai sedia ada seperti tidak dapat mengenggamnya dengan kemas, saiznya yang besar dan berat, rekabentuk pemegang yang tidak ergonomik, dan terdedah kepada postur pergelangan tangan yang tidak neutral semasa menggunakannya. Hal ini akan mempengaruhi tahap keselesaan dan produktiviti pengguna. Oleh itu, objektif kajian ini adalah untuk mereka bentuk dan membangunkan satu prototaip pemegang pencanai tangan yang dapat meningkatkan keselesaan dan produktiviti pengguna semasa proses mencanai. Untuk mencapai objektif ini, keperluan pengguna telah diutamakan dan diubah suai kepada parameter melalui House of Quality (HoQ). Sementara itu, kaedah saringan telah digunakan untuk memilih konsep pemegang pencanai tangan yang terbaik dan telah dilakar dengan menggunakan perisian SOLIDWORKS. Pemegang pengisar tangan yang selesa telah dihasilkan dengan menggunakan paip PVC. Rekabentuk pemegang pencanai tangan sedia ada dan rekabentuk pemegang pencanai tangan yang dihasilkan melalui kajian ini telah dibandingkan untuk menilai keberkesanannya. Analisa kos telah dilakukan menggunakan kaedah anggaran Return on Investment (ROI). Keputusan kajian ini menggambarkan prototaip pemegang pencanai tangan telah dicipta berjaya meningkatkan tahap keselesaan dan produktiviti pengguna.

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ABSTRACT

In the world of globalization, the innovation of hand tools is important due to the increasing of demand in competitive manufacturing environment. Hand tools should be designed ergonomically to ensure users could use the tools with minimum effort to perform maximum operation. In manufacturing industry, a hand grinder is the common tool that used in various fabrication tasks. However, many users faced difficulties such as unable to grip the hand grinder firmly, larger size or weight of hand grinder, inappropriate design of support handle and faced awkward posture in the wrist when overexposure to the existing design of hand grinder handle. It would influence the subjective comfort and work productivity of the user. Therefore, the aim of study is to design and fabricate a high fidelity prototype of hand grinder handle for the improvement of subjective comfort and work productivity during grinding process. In order to achieve the objective, users requirements were translated and modified to technical parameters through House of Quality (HoQ). Meanwhile, concept screening method was applied to select the best concept of hand grinder handle and then sketched with SOLIDWORKS software. A high fidelity prototype of hand grinder handle was fabricated by using the PVC pipe. The existing grinder handle design and proposed handle design developed by this study were compared to evaluate the effectiveness. In order to meet the entrepreneurial requirement, the profitability of the proposed hand grinder was evaluated using Return on Investment (ROI). The result of this study illustrated that a high fidelity prototype of hand grinder handle was able to improve comfort level and work productivity of users.

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DEDICATION

Only

my beloved father, Chin Kang Ming

my appreciated mother, Tik Yam Nyap @ Tan Yam Nyap

my adored brother and sister, Chin Yan Ann and Chin Ee Xuan

for giving me moral support, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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TABLE OF CONTENTS

Abstrak i
Abstract ii
Dedication iii
Acknowledgement iv
Table of Contents v
List of Tables ix
List of Figures x
List of Abbreviations xii
List of Symbols xiv

CHAPTER 1 INTRODUCTION 1

1.1 Background of Study 1
1.2 Problem Statements 5
1.3 Objectives 7
1.4 Scope of Study 8
1.5 Significance of Study 9

CHAPTER 2 LITERATURE REVIEW 11

2.1 An Overview of Hand Grip Strength 11
2.1.1 Factors affecting hand grip strength 12
2.1.1.1 Posture 12
2.1.1.2 Time 13
2.1.1.3 Hand circumference 13
2.1.1.4 Gender and handedness 13
2.1.1.5 Age 14
2.1.1.6 Smoking 14
2.1.1.7 Alcohol consumption 15

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2.1.1.8 Grip force 15
2.1.1.9 Handle orientation 16
2.1.1.10 Vibration 16
2.1.2 Type of hand grip 16
2.1.3 Hand grip measurement tools 19
2.1.4 Hand grip measurement procedures 20
2.1.5 The importance of hand grip data 23
2.2 Analysis of Subjective Measurement and Objective Measurement 23
2.2.1 Subjective measurement 24
2.2.1.1 Comfort Questionnaire for Hand Tools (CQH) 25
2.2.1.2 Rate of Perceived Exertion (RPE) 25
2.2.2 Objective measurement 26
2.2.2.1 Hand grip strength measurement 27
2.2.2.2 Electromyography (EMG) 27
2.3 Redesign and Fabricate Prototype of Hand Grinder Handle 28
2.3.1 Hand anthropometry 28
2.3.2 House of Quality (HoQ) 29
2.3.3 Concept screening method 30
2.3.4 User experience 31
2.3.5 Focus group 31
2.3.6 Design Software 32
2.3.7 Return on Investment (ROI) 32
2.4 Differences between Previous Studies and Current Study 33
2.5 Summary 35

CHAPTER 3 METHODOLOGY 36
3.1 Measurement of the Maximum Hand Grip Strength when Wrist at Vertical, Supination and Pronation Positions 36
3.1.1 Calibrate of hand dynamometer 37
3.1.2 Obtain approval from Research Ethics Committee (RECs) and participant screening form 38

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3.1.3 Perform pilot study 38
3.1.4 Execute actual data collection 39
3.1.5 Develop a database of maximum hand grip strength 40
3.1.6 Perform statistical analysis by using Microsoft Excel 41
3.2 Analysis of Hand Grip Strength, Muscle Activity, Subjective Comfort and Work Productivity when Using the Existing Design of Hand Grinder Handle 42
3.2.1 Develop questionnaire survey form and standard operating procedure with consent form 43
3.2.2 Experimented tasks 43
3.2.3 Execute hand grip strength performance 44
3.2.4 Perform Electromyography (EMG) analysis 45
3.2.5 Distribute questionnaire survey 45
3.2.6 Estimate work productivity by using time study 46
3.3 Design and Fabricate a High Fidelity Prototype of Hand Grinder Handle 46
3.3.1 Measurement of hand anthropometry 46
3.3.2 Perform interview 48
3.3.3 Apply House of Quality (HoQ) 48
3.3.4 Apply concept screening method (Pugh method) 49
3.3.5 Handle design by using SOLIDWORKS software 50
3.3.6 Fabricate the prototype of handle 51
3.3.7 Effectiveness of the proposed handle design versus existing handle design 53
3.3.8 Perform the Return on Investment (ROI) 53
3.4 Summary 54

CHAPTER 4 RESULT AND DISCUSSION 58
4.1 Measurement of the Maximum Hand Grip Strength when Wrists at Vertical, Supination and Pronation Positions 58
4.1.1 Demographic of participants 59
4.1.2 Hand grip strength data 61
4.2 Analysis of Hand Grip Strength, Muscle Activity, Subjective Comfort and Work Productivity when Using the Existing Design of Hand Grinder Handle 63

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4.2.1 Hand grip strength performance 64
4.2.2 Muscle activity assessment 65
4.2.3 Subjective comfort 67
4.2.4 Work productivity 69
4.3 Design and Fabricate a High Fidelity Prototype of Hand Grinder Handle 70
4.3.1 Interview 71
4.3.2 House of Quality (HoQ) 73
4.3.3 Concept screening (Pugh method) 76
4.3.4 Effectiveness of the proposed handle design versus existing handle design 78
4.3.5 Payback period analysis 84

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 86
5.1 Assessment of Maximum Hand Grip Strength Measurement 86
5.2 Assessment of Hand Grip Strength, Muscle Activity, Subjective Comfort and Work Productivity when Using the Existing Design of Hand Grinder Handle 87
5.3 Design and Fabricate High Fidelity Prototype of Hand Grinder Handle 87
5.4 Recommendations for Future Study 88
5.5 Sustainable Design Development 88

REFERENCES 89

APPENDICES
A Participant Screening Form 104
B Questionnaire Survey Form 107
C Standard Operating Procedures with Consent Form 110
D Interview Form 112
E Database of Maximum Hand Grip Strength 115
F Full Data Collection 119
G Gantt Chart of FYP I 121
H Gantt Chart of FYP II 122

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LIST OF TABLES

2.1	Rating of Perceived Exertion	26
2.2	Differences between previous studies and current study	33
3.1	Hand anthropometry of male and female Iban population	47
3.2	The weightage of interrelationships matrix symbols	49
3.3	Concept screening matrix	50
3.4	Types of rating symbols used in concept screening matrix	50
4.1	Age groups	59
4.2	Ethnic groups	60
4.3	Descriptive statistics of weight, height and BMI	60
4.4	Descriptive statistics of maximum hand grip strength for different wrist position (kg)	62
4.5	Descriptive statistics of muscle activity (μV)	66
4.6	Comfort level of the hand grinder handle	69
4.7	Affinity diagram obtained from the interview session	71
4.8	Importance rating of customer requirements	74
4.9	Absolute importance of technical requirements	74
4.10	Concept screening matrix	77
4.11	Comfort level of the proposed handle	83
4.12	Return on investment after ergonomics invention of hand grinder handle	85
4.13	Occupational health saving cost	85

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LIST OF FIGURES

1.1	Main components of hand grinder	2
1.2	Hand with CTS when holding a handle	4
1.3	Hand grinder unable to grip firmly by female‟s hand	5
1.4	Comparison of size among hand grinder and other hand tools	6
1.5	Grinding a slot in a wall	6
1.6	Flexion writs posture when using hand grinder.	7
2.1	A crush grip posture	17
2.2	A pinch grip posture	17
2.3	A support grip posture	18
2.4	A power grip posture	18
2.5	A precision grip posture	19
2.6	Jamar hydraulic hand dynamometer	20
2.7	Procedures of grip strength measurement according to ASHT	21
2.8	Procedures of grip strength measurement according to SHAP	22
2.9	House of Quality	29
2.10	Concept screening matrix	30
2.11	The formula of single payback period	33
3.1	Calibration of hand dynamometer with 10kg load and 15kg load.	37
3.2	Hand dynamometer after calibration	37
3.3	Comparison of three hand dynamometer	38
3.4	A light trial of hand grip strength measurement	39
3.5	Hand grip strength measurement	40
3.6	Descriptive statistics of hand grip strength	41
3.7	Regression analysis of hand grip strength	42
3.8	Schematic diagram of mild steel work pieces	44
3.9	Brachioradialis muscle situated in the forearm	45

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3.10	Schematic diagram of hand palm	47
3.11	Interview with a user – assistant engineer of FKP, UTeM	48
3.12	Flow chart of the fabrication the prototype handle	52
3.13	Formula of payback period	53
3.14	Flow chart of method used	57
4.1	Distribution of dominant hand of participants	61
4.2	Normal probability plot of vertical position	62
4.3	Normal probability plot of supination position	63
4.4	Normal probability plot of pronation position	63
4.5	Average maximum hand grip strength for different wrist position.	64
4.6	Box plot analysis of muscle activity	66
4.7	Work productivity of grinding process	70
4.8	House of Quality	75
4.9	Concept A	76
4.10	Concept B	76
4.11	Concept C	77
4.12	Proposed hand grinder handle	78
4.13	Average maximum hand grip strength between proposed handle and existing handle	79
4.14	Muscle activity for male respondents between proposed handle and existing handle	81
4.15	Muscle activity for female respondents between proposed handle and existing handle	81
4.16	Work productivity of grinding process between proposed handle and existing handle	84

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LIST OF ABBREVIATIONS

a.m.	-	ante meridiem
ANOVA	-	Analysis of Variance
ASHT	-	American Society of Hand Therapists
BMI	-	Body Mass Index
CQH	-	Comfort Questionnaire for hand tools
CTS	-	Carpal Tunnel Syndrome
EMG	-	Electromyography
FKP	-	Faculty of Manufacturing Engineering
FSR	-	Force Sensing Resistors
HAVS	-	Hand-Arm Vibration Syndrome
HoQ	-	House of Quality
LPD	-	Local Perceived Discomfort
NIOSH	-	National Institute of Occupational Safety and Health
OSHA	-	Occupational Safety and Health Administration
p.m.	-	post meridiem
PVC		Polyvinyl chloride
QFD	-	Quality Function Deployment
RECs	-	Research Ethnics Committee
ROI	-	Return on Investment

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RPE	-	Rate of Perceived Exertion
RS	-	Raynaud‟s syndrome
SD	-	Standard deviation
SHAP	-	Southampton Hand Assessment Procedure
SOCSO	-	Social Security Organization
SV	-	Standard variance
UTeM	-	Universiti Teknikal Malaysia Melaka
WHO		World Health Organization

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LIST OF SYMBOLS

cm	-	centimetre
kg	-	Kilogram
mm	-	millimetre
mV	-	micro-Volt
%	-	percent

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CHAPTER 1
INTRODUCTION

This chapter presents the background of study, problem statements, objectives, scope, and significant of the study. The background of study is concentrated on the design of hand grinder handle and the work-related injuries due to hand grinder. The problem statements demonstrate the problems that faced from the users in current situation. In the objectives, the target of this study is to design and fabricate a high fidelity prototype of hand grinder handle whereas the scope of study highlights the focus and limitations of the study. At the end of this chapter, significant of study highlights the importance of the study.

1.1 Background of Study

In the world of globalization, the innovation of hand tools is important due to the increasing of demand in competitive manufacturing environment. Hand tools are instruments that have ergonomically designed with unique structure, characteristic and function to ease human work. It is useful in the surface finishing of products such as removing the rough surface or changing the product shape. Due to the simple operation of hand tools, many users can perform their task easily although they have a limited knowledge on that particular hand tool. Hand tools are actually designed ergonomically from time to time to improve the

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performance and efficiency of the tool. This is to ensure human could use the tools with minimum effort to perform maximum operation. There are various types of hand tools in the industry, such as hand grinders, hammers, cutters, clamps, saws and hand drills. In manufacturing industry, hand grinder is one of the common tools used in simple tasks.

Hand grinder is a handheld tool that used in the grinding, polishing and cutting processes. It can be either powered by electric motor, petrol engine and compressed air, or used by the battery supplied. During operation, the motor drives at a high speed to turn on the geared head at the right angle. The geared head is fixed with an abrasive disc which can be replaced by a new disc when it is worn after extensive grinding operation. Figure 1.1 shows a hand grinder that normally use for Faculty of Manufacturing Engineering (FKP) in Universiti Teknikal Malaysia Melaka (UTeM). Basically, a hand grinder has 4 main components such as support handle, long arm handle, spindle lock and motor. The hand grinder is designed with a side handle to provide support. Users with right hand or left hand dominant also can use the hand grinder smoothly due to the design of both sides support handle. Although the hand grinder is a multi-purpose tool, it had been reported with various imperfections in recent year.

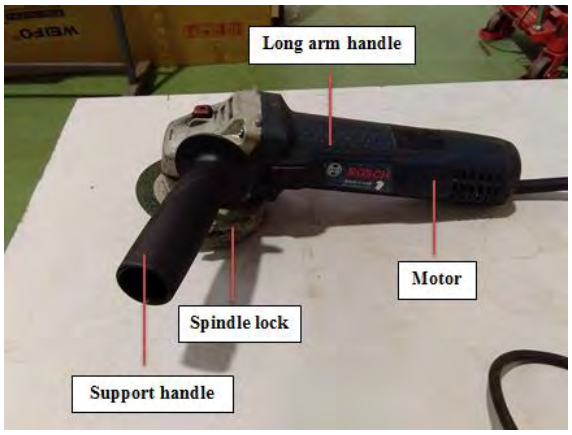

Figure 1.1: Main components of hand grinder

According to Social Security Organization (SOCSO) of Malaysia, there are 39 cases of accidents associated with electrical hand tools in 2014. Besides, during 1988 to 1992, Swedish

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Labour Market Insurances reported that 2830 victims of occupational use of vibrating hand-hold tools suffered from permanent medical disabilities (Greenslade & Larsson, 1997). The researchers also declared that the number of permanent debilitate injures in one year caused by these tools is more than half compared to other injuries. Recently, the Occupational Safety and Health Administration of United States Department (OSHA 2017) reported one worker burned in the hand and head when using a hand grinder. This is due to ignition of magnesium chips that produced by the hand grinder.

Apart from the various imperfections of hand grinder, subjective comfort and work productivity will also affected when overexposure to hand grinder. When user exposures to the hand grinder at a long time, their hands will start with a vibration effect and they will feel uncomfortable. At this time, the rough motion will disturb the effectiveness of the user. There was a user make a lamentation about reduction of motion freedom during grinding process (McDowell *et al*., 2016). This is due to the poor position for the support handle of hand grinder. Therefore, this user was unable to perform well in the grinding process and lead to the reduction of work productivity.

Moreover, many workers who overexposure to hand grinder would easily experience the work-related injuries. The work-related injuries such as Carpal Tunnel Syndrome (CTS) and Raynaud‟s syndrome (RS) may cause by various factors. These factors could be contributed by human lifestyle, working procedural, working environmental, physiological and socio-economic (Pelmear *et al*., 1992). Handle design becomes one of the elements that contributed to injuries of CTS. In a previous study, it stated that handle change are being brought due to the sanitation and the increase of motion-related disease such as CTS (Cochran *et al*., 1985). Figure 1.2 shows a hand that contributed to CTS when holding a handle

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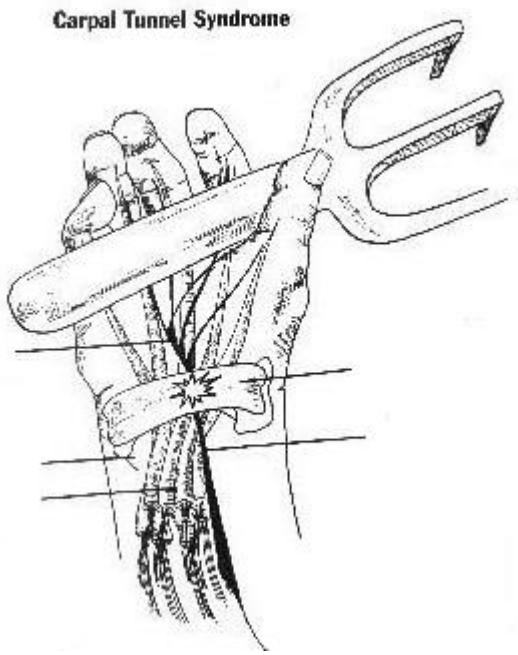

Figure 1.2: Hand with CTS when holding a handle (Master Garden Products, 2014)

Based on the overall considerations, redesign of hand grinder handle is compulsory to achieve future improvement of this hand tool. Many researchers and studies were performed to reduce the exposure of vibration in hand grinding process. However, the effects of handle design parameters such as handle size and shape on Malaysia users remain unexplored. Additionally, the existing hand grinder was designed and manufactured by foreign countries such as Japan and Germany; hence, the anthropometric data applied in the handle design were based on their populations.

To the best of author knowledge, a very few ergonomics studies been conducted to design the handle of hand grinder which considering Malaysian anthropometric data and strength. Therefore the aim of this study is to design and fabricate a handle of hand grinder to increase the comfort level and work productivity in grinding process.

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1.2 Problem Statements

Muscle fatigue is a condition where an individual is short-term reduction in the capacity to do physical activity (Enoka & Duchateau, 2008). It may be caused by repetitive prolonged use of poor and incompatible design of the product especially the hand tools design. When using the current design of hand grinder handle, workers faced some difficulties such as unable to grip the hand grinder firmly, larger size or weight of hand grinder, inappropriate design of support handle and awkward posture in the wrist.

a) Unable to grip the hand grinder firmly

The existing design of hand grinder handle is not suitable to be used by female users due to their small palm hand. Most of the female users unable to grip the hand grinder firmly because the design of whole hand grinder is mainly focus to the male users. Figure 1.3 shows a female user unable to grip the hand grinder handle firmly. Eventually, this situation will jeopardize female users from injuries caused by sliding down of hand grinder. Therefore, the female users have high risk to face the accident when using the hand grinder.

Figure 1.3: Hand grinder unable to grip firmly by female‟s hand

b) Larger size or weight of hand grinder

Hand grinder is considered as a large and heavy hand tool compare to other hand tool. Due to both characteristics of hand grinder, it can slightly affect the users‟ performance.

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