UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN OF MANUAL MILLING OPERATION WORKSTATION FOR PRODUCT DIMENSIONAL ACCURACY AND SAFE POSTURE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours.

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design of Manual Milling Operation Workstation for Product Dimensional Accuracy and Safe Posture**

SESI PENGAJIAN: **2015/16 Semester 2**

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I hereby, declared this report entitled “Design of Manual Milling Operation Workstation for Product Dimensional Accuracy and Safe Posture” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory is as follow:

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(Dr. Isa bin Halim)

ABSTRAK

Dalam krisis ekonomi semasa, syarikat-syarikat di bawah Perusahaan Kecil dan Sederhana (PKS) lebih mengutamakan keuntungan berbanding keselamatan, kesihatan dan kebajikan pekerja. Operasi mengisar secara manual merupakan kerja yang memerlukan ketepatan tinggi dan operator mestilah lebih teliti untuk menghasilkan produk yang berkualiti. Walau bagaimanapun, operator terdedah kepada pelbagai faktor risiko seperti getaran dan bunyi bising, paparan mesin yang tidak jelas, ketinggian bekerja yang tidak sesuai, waktu kerja yang panjang, pengudaraan tempat kerja yang tidak baik dan tahap pencahayaan yang tidak mencukupi semasa menjalankan operasi mengisar. Tujuan kajian ini adalah untuk membentuk semula stesen kerja mengisar manual. Kajian ini menggunakan kaedah temu bual, pemerhatian di tempat kerja, kajian literatur dan kajian soal selidik melibatkan 20 pekerja industri untuk menentukan faktor risiko yang terdapat di stesen kerja mengisar manual. Faktor risiko yang berkaitan dengan postur kerja dianalisa menggunakan Rapid Upper Limb Assessment (RULA). Untuk membangunkan stesen kerja yang optimum, kajian ini melakukan eksperimen secara faktorial penuh dalam Design of Experiment (DoE). Selain itu keperluan operator mengenai reka bentuk stesen kerja didapati melalui soal selidik dan dipindah ke House of Quality (HOQ). Lima konsep reka bentuk telah dilakar dan disaring melalui kaedah pemilihan Pugh berdasarkan kesesuaian dan keberkesanan kos. Analisa kos dan faedah telah digunakan untuk menilai kesesuaian kos supaya dapat memenuhi keperluan keusahawanan. Kajian ini menyimpulkan bahawa reka bentuk baru stesen kerja telah meningkatkan postur kerja dan kualiti produk. Kajian ini mencadangkan bahawa siasatan lanjut mengenai bunyi bising yang melampau dan getaran perlu dipertimbangkan dalam kajian akan datang.

ABSTRACT

In the economic crisis, the small and medium enterprises (SMEs) is trying to drive their business to profit based rather than safety, health and welfare of workers. Manual milling operation is widely applied in manufacturing industries under the SMEs. This operation is a precise task that requires the operators to pay high concentration to ensure the work piece being milled is accurate. However, the operators are exposed to various risk factors such as excessive vibration and noise, unclear machine gauge display, inappropriate working height, prolonged working hours, poor workplace ventilation and inadequate lighting level at the workstation while performing manual milling operation. The aim of this study is to redesign the existing manual milling operation workstation. This study applied interview, workplace observation, literature review and questionnaires survey among 20 workers in a medium sized machining company to determine risk factors associated with the manual milling operation. The risk factor which relate to non-neutral work posture was analysed by Rapid Upper Limb Assessment (RULA). This study explored the optimum manual milling workstation design through an experimental work using full factorial design of Design of Experiment (DoE). Additionally the operators' requirements regarding manual milling workstation were captured using questionnaire survey and then transform to House of Quality (HOQ). Furthermore, five concepts of improved design of the workstation were sketched. They were screened through Pugh selection method based on practicability and cost effectiveness. Cost and benefit analysis (CBA) was used to evaluate the cost effectiveness of the screened concepts so that the final design also able to meet the entrepreneurial requirement. This study concluded that the new design of the workstation has improved the work posture and products quality. This study suggested that further investigation on excessive noise and vibration should be considered in the future research.

DEDICATION

For my beloved family, academic supervisor, industrial supervisors, lecturers and friends that always believe in me to complete this project and report.

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LIST ABRREVAITIONS, SYMBOLS AND NOMENCLATURES

GDP	-	Gross development product
CNC	-	Computer numerical control
NC	-	Numerical control
MPI	-	Multi Precision Industries Sdn. Bhd.
WMSDs	-	Work related musculoskeletal disorders
PPE	-	Personal protective equipment
WELS	-	Workplace exposure limit
FKP	-	Fakulti Kejuruteraan Pembuatan, UTeM
UTeM	-	Universiti Teknikal Malaysia Melaka
RULA	-	Rapid upper limb assessment
REBA	-	Rapid entire body assessment
OWAS	-	Ovako working posture assessment system
NBM	-	Nordic body map
QEC	-	Quick exposure check
DoE	-	Design of experiment
ANOVA	-	Analysis of variance
QFD	-	Quality function deployment
HOQ	-	House of quality
QC	-	Quality characteristics
CR	-	Customer requirements
CBA	-	Cost and benefit analysis
NPW	-	Net present worth
NPV	-	Net present value
cm	-	Centimetre
mm	-	Millimetre

m	-	meter
kg	-	kilogram
®	-	Registered
™	-	Trademark
SPSS	-	Statistical package for social science
Lux	-	Luminance flux
VOE	-	Voice of engineers
VOC	-	Voice of customers
ISO	-	International Standard Organization

CHAPTER 1
INTRODUCTION

This chapter presents the background of the study, problem statements, objectives of the study, and the scope of study. The background of the study is focused on the working principles of manual milling operation and various risk factors associated with this operation. The problem statements reveal the impacts of different risk factors to the operators of manual milling operation. In the objectives, the intention of this study is to propose a design of the workstation for improving the quality of the milled product in line with reduced the impacts of various risk factors. At the end of this chapter, the scope of the study highlights the focus and limitations of the study.

1.1 Background of Study

Accordingly for Malaysia (1991, 2000, 2006), the Malaysian Gross Domestic Product (GDP) had developed a standard development rate of 6.7% during 1971 to 1990, meanwhile during 1990 to 1999 and 2001 to 2005, Malaysia achieved a record of development rate where respectively 8.1% and 4.5% per annum. Malaysia was recognized one of the most active in reforming their investment management in manufacturing market among the ASEAN, especially during the 1980s and 1990s. The most significant and remarkable strategy of the Malaysian had successfully spur Malaysia's economic growth by attracting foreign direct investment (FDI) and partially was credited to its own trade. Manufacturing sector had become a part of major growth for Malaysian economy since the late of 1970s. The export earnings of the sector contributed 80.5% of the total export earnings in 2005, it was

approximately 31.4% of the Malaysian GDP (Chandran *et al.*, 2009). Hence, the contribution of manufacturing sectors is highly significant to the growth of Malaysian economy.

The fundamental idea of manufacturing processes is to create or transform the raw materials into useful products with a predetermined set of physical geometry. There are various manufacturing processes such as moulding, casting, joining, machining and so on while sharing a common set of goals. The goals of these processes are to meet the performance requirements in term of tolerance and the production cost. Moreover, the goals also have been set to reproduce with constant quality in mass production and have consistent material properties throughout the manufacturing processes.

In machining process, a product is created to its desired dimensions by removing excess material of a work piece via a force exerted through a certain material removal tool (Kalpakjian, 2008). Milling operation and turning operation are both common machining processes where milling and turning operation are applied in rectangular work piece and cylindrical work piece respectively. Milling operation is very versatile where it can be used for drilling, boring, producing slot, pocketing, chamfering, facing, squaring and others applications. Basically, milling machine is divided into Computer Numerical Control (CNC) and manual control. CNC milling machine uses Numerical Control (NC) codes in controlling the positions of the cutting tools while manual milling machine is a type of conventional milling operation operated by the human operators. Manual milling machines still widely used in many industries though CNC milling machines show high efficiency in productivity and quality because manual milling operation able to perform simple operations such as squaring process and chamfering process to reduce the lead time of the overall production.

Figure 1.1 shows the steel plates being processed by manual milling operation. The steels plates are cut into pieces by the plasma cutter then follow by squaring process by manual milling operation. Figure 1.2 shows that an operator is performing the manual milling operation by using vertical-spindle column-and-knee-type milling machine.

Figure 1.1: Steel plates after squaring process in manual milling operation
(Source: Multi-Precision Industries Sdn. Bhd., 2015)