UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE EFFECTS OF CUTTING PARAMETERS ON DIMENSIONAL ACCURACY IN WET AND DRY TURNING

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

by

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TAJUK: **The Effects of Cutting Parameters on Dimensional Accuracy in Wet and Dry Turning.**

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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) with Honours. The member of the supervisory committee is as follow:

……

(Project Supervisor)

ABSTRAK

Operasi larik adalah salah satu proses pemotongan yang dilakukan dalam kebanyakan sistem pembuatan. Dengan teknologi yang semakin membangun pada, operasi larik juga telah berkembang daripada manual kepada kawalan komputer. Selain itu, keadaan pemesinan ini juga telah ditingkatkan bagi mengikut kehendak industri yang menginginkan persekitaran yang mampan, sebagai contoh, keadaaan pemesinan dengan atau tanpa menggunakan cecair penyejuk. Bagi mengkaji sistem pengeluaran yang menyeimbangkan keberkesanan penggunaan kos serta kualiti produk yang memuaskan, satu kajian berfokus telah dijalankan untuk membandingkan keberkesanan penggunaan melarik menggunakan cecair penyejuk dan melarik tanpa menggunakan cecair penyejuk. Objektif kajian ini adalah untuk mengkaji faktor-faktor yang memberi kesan dan impaknya terhadap ketepatan dimensi produk, untuk mengeluarkan model regresi yang efektif serta membandingkan keberkesanan kedua-dua keadaan pemesinan ini bagi mendapatkan ketepatan dimensi yang lebih baik. Sebanyak 81 sampel digunakan untuk setiap satu eksperimen menggunakan mesin larik CNC, menggunakan faktor-faktor seperti kelajuan pemotongan(80-120 m/min), kadar suapan (0.5-0.7mm/rev), kedalaman pemotongan (0.2-0.4mm), panjang (25-35mm) dan diameter produk (10-15 mm) . Data dari eksperimen ini dianalisis menggunakan regresi analisis di dalam Minitab 17. Berdasarkan eksperimen, diameter memberikan impak terbesar kepada keadaan pemesinan dengan cecair penyejuk, manakala kedalaman pemotongan memberi impak terbesar kepada keadaan pemesinan tanpa cecair penyejuk. Selain itu, keadaan pemesinan dengan mengunakan cecair penyejuk telah memberi lebih banyak kelebihan kerana ia telah memenuhi kehendak pembuatan mampan, mengurangkan kos serta pengeluaran ketepatan dimensi yang lebih baik ke atas produk.

ABSTRACT

In brief, turning operation is one of the cutting processes that are used in the major manufacturing system. With advancing technology nowadays, the operation of turning process has also developed from manual to computer numerical control (CNC). Other than that, the machining condition has also improved in order to keep up with the sustainable environment, for instance the machining condition with or without the presence of cutting fluid. In order to investigate production system that can balance the effective cost utilization and maintaining satisfied quality for customer requirements, a focused investigation is conducted to compare the effectiveness of using wet turning and dry turning and the effect on part's dimensional accuracy in terms of their significant effect. The objectives of this research are to investigate the factors that influence affecting the dimensional accuracy for both machining conditions, to establish and validate the regression model of dry cutting and wet cutting and to compare the effectiveness of these machining conditions to achieve better dimensional accuracy. 81 samples were used in both experiments using CNC turning machine for both wet turning and dry turning within the factors of cutting speed (80-120 m/min), feed rate (0.5-0.7mm/rev), depth of cut (0.2-0.4mm), actual final cutting length (25-35mm) and actual final cutting diameter (10-15 mm). The results from these experiments were analyzed by regression analysis in Minitab 17. It has found that actual final cutting diameter gives the biggest impact on wet turning and depth of cut gives the biggest impact on dry turning. Other than that, the usage of wet turning in this specific parameter condition is better than dry turning, since it comply all the requirements of sustainable manufacturing, minimizing cost and most importantly producing better dimensional accuracy.

DEDICATION

To my late father, Tuan Haji Saari bin Mahamudin, my beloved mother, Hajjah Rushidah binti Masngat, and my siblings,

I love you.

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Bismillahirrahmanirrahim. With the name of Allah, the most Gracious and the most Merciful.

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LIST OF ABBREVIATION AND SYMBOLS

AD	-	Actual Final Diameter
AL	-	Actual Final Length
ANOVA	-	Analysis of Variance
CNC	-	Computer Numerical Control
CS	-	Cutting Speed
DOC	-	Depth of Cut
F	-	Feed Rate
MQL	-	Minimum Quantity Lubrication
PSM	-	Projek Sarjana Muda
RPM	-	Revolutions per Minute
RSM	-	Response Surface Methodology
VIF	-	Variance Inflation Factor
σ	-	Standard Deviation
α	-	Alpha

CHAPTER 1
INTRODUCTION

This chapter contains the background of the research which comprises of problem statement, objectives to be accomplished throughout the project and the scope of the study. They were clearly defined the limited boundaries of this study. This chapter also likewise gives a report arrangement which generally describes about chapter division and related substance to that particular chapter. In general, it summarizes the advancement of the whole project, depicting how the whole investigation has been carried out.

1.1 Introduction

Industries nowadays tend to go for sustainability as the importance of the environment is highly emphasized to ensure an efficient production. From Department of Commerce, sustainable manufacturing is characterized as the formation of manufactured products. This process concerned for non-polluting activities, conserve energy and natural resources. Economic aspect and safety for workers, communities and consumers are also considered. However, machining, a broad term to describe removal of material at any of various processes that transform a piece of raw material into a desired final shape and size (Kalpakjian, S et al. 2001), usually generate higher cutting temperature and need the use of cutting fluid to overcome the problem.

During machining, the heat would be generated caused by the friction between tool and by the workpiece. The other source of heat is due to adiabatic from the deformation of the workpiece (Kasim et al. 2013). These will eventually reduce tool life (Ezugwu E.O, 2005). As machining only would inherently generate high cutting zone temperature. The application of cutting fluid would help in lubricating the workpiece-tool interface (Yildiz, Y et al. 2008). Besides that, it also helps in increasing cutting tool life by reducing thermal distortion while flushing away the machine chips. It also acts as the corrosion protection of the machine surface. However, the use of cutting fluid has given the negative effect to the environment and the workers' health. Skin exposure is the major route of exposure, thus, the contact of the skin and fluid may cause the diseases such as dermatitis, which may cause either irritant or allergic mechanism (Byers, 1994). Bennett E.O and Bennett D.L (1985) state that, it is accepted that 80 percent of all occupational diseases are due to skin contact with fluids. While it affects the environment for the after use. The way to dispose the cutting fluid may actually harm the environment.

Dry and wet machining are introduced according to the needs. Dry machining is a material removal method which does not require the usage of cutting fluid. It is desired as it is environmentally friendly, this factor may consider as a necessity for a sustainable manufacturing. The usage of dry machining giving lower cost in manufacturing as the use of cutting fluid is usually higher than the cutting tool (Bhambale, S.S et al. 2012). Other than that, dry machining also do not cause damage to health and environment as there is non-injurious and allergy free to the skin also does not need any disposal (Narutaki, N et al. 1997). In any machining process, chips are produced. In sustainable manufacturing the chips are advisable to be recycled and without using cutting fluids the chips is not contaminated with the residue of the cutting fluid, thus there are no expenses needed for chemical treatment. However, dry machining could cause higher cutting temperature; it also promotes shorter tool life and higher wears rates. Whereas, wet machining promotes better quality and less tool wear.

Dimensional accuracy of a part product represents the degree of agreement between the dimension of partial product manufactured and its designed specification (Islam M.N et al. 2013). Dimensional accuracy of a part product is the most important factor that every machining process operator must consider as it is the most critical aspect for ensuring dimensional repeatability of the manufactured parts product. Furthermore, they must be fit to be assembled properly with other mating parts so that it can perform its intended function during its service life. Tolerance; the permissible range of variation of a dimension of the desired size is designated for every part that is going to be manufactured (Kalpakjian, S et l. 2001). The tolerance designates the accuracy to which a particular dimension should be produced, with that, the difference of the dimension of the part produced and the specification designed must be in the tolerance to ensure a high quality manufactured product. The quality of manufactured part product is gaining more attention. Customers nowadays demand a high quality product that can ensure their satisfaction, thus, dimensional accuracy has become a measure of quality.

1.2 Project Background

In order to keep up the high product quality to fulfill the customer's requirements, industries are searching for various ways to increase the efficiency and effectiveness in machining processes. Taking the sustainability concept into consideration will view manufacturing in the new way, with that, firm understanding on how to respond to environmental, social, economic challenges and transforming industrial behavior is needed. Even so, do these can really bring the quality of manufacturing to another level? Therefore, it is important to find out the possible appropriate methods to ensure higher quality product produce can be achieved efficiently with the optimum cutting conditions and parameters, while keeping up long tool life, adequate surface finish and good part accuracy.

Turning is a machining process operates by lathe machine; a machine device which rotates the workpiece on its axis to perform miscellaneous operations with tools that are

applied to the workpiece to create objects with straight, conical, curved or grooved workpiece (Kalpakjian, S et al. 2001). Some of other regular operations performed on a lathe are facing, drilling, threading, knurling, and boring, etc. It is one of the earliest machines used in manufacturing industry. The use of lathe machine is very important as it produces most of the part in various fields including automotive and aerospace sectors. As the technology advances, this machine has also developed from conventional machine to computer numerical control (CNC).

Quality of part produce is vital for product profile therefore; dimensional accuracy has been a main measure of it. Dimensional accuracy is important to ensure the continuance of assembled parts product. It can be measured through its dimensional deviation and diameter error. This factor plays significant role in deciding and accessing the overall quality of a part produce as it influenced the functional characteristic. According to Ahmed D.A. (2007) dimensional deviation is significant in turning slender part, in deciding the precision machining; significant role is highly considered, thus making dimensional accuracy as an important criterion of the production.

In this project, mild steel AISI 1020 is turned with lathe machine. This experiment will be held in dry and wet conditions. Both conditions will be using the same three machine parameters during this experiment, which are depth of cut, cutting speed and feed rate. Minitab software will be used in this experiment to build up an analysis of variance (ANOVA) in order to obtain the significant factors influencing the dimensional accuracy. Regression model will be developed and validated using t-test.

1.3 Problem Statement

Turning, in which material is removed from the external surface of a rotating workpiece, is the most essential material removal processes used in manufacturing industry. However, machining alone could cause higher friction and adhesion between chip and tool, which lead to higher heat generated, higher wear rates and, therefore, reducing tool

lives (Galanis, N.I et al. 2008). The application of cutting fluid can be a great influence to the performance of turning operation as it acts as lubrication that can lower the cutting zone temperature, besides reducing the friction coefficient between tool and chip (Isik, Y., 2010). Nevertheless, the application of cutting fluid is occasionally become less viable when higher machining productivity, better surface finish quality and severe cutting condition are needed (Bhambale, S.S et al. 2012). But, the main concern of the usage of cutting fluid is, it is costly and can give negative effect on the environment and health (Kouam, J et al. 2012). In this regard, there are several material removal methods are introduced, for instance, turning operation can be classified into various types, such as, dry turning and wet turning. Yet, there are some factors that might give the differences between these two material removal methods that can affect the quality of the part produce. Thus, the influence of input parameter on dimensional accuracy is investigated so that a comparison can be made between the significant effects on the part product by using these two methods.

1.4 Objectives

(a) To investigate the factors that influence and its effect on the taper accuracy for dry and wet cutting.

(b) To establish and validate the regression model of dry cutting and wet cutting.

(c) To compare the effectiveness of machining condition to achieve better dimensional accuracy.

1.5 Scope

To investigate the effect on part quality for dry and wet turning process, this experiment focuses on investigating the dimensional accuracy of part product which uses different method of material removal. The details are listed below:

(a) Turning operation is performed using a CNC turning machine.

(b) Material used is mild steel AISI 1020.

(c) VBMT 160404 carbide turning insert is used as cutting tool, and it is assumed to be always sharp.

(d) Machining parameters; cutting speed, depth of cut and feed rate.

(e) Tool wear and vibration are not taken into consideration.

(f) The taper accuracy of the workpiece is measured by micrometer.

(g) Minitab 17 is used to analyze data.

(h) Regression model will be established to validate the findings.

1.6 Project Outlines

Project outlines will describe the processes through each chapter. All the processes are characterized according to its chapter so that a clear process flow can be seen. This will help to proceed the project, according to what that have been planned.

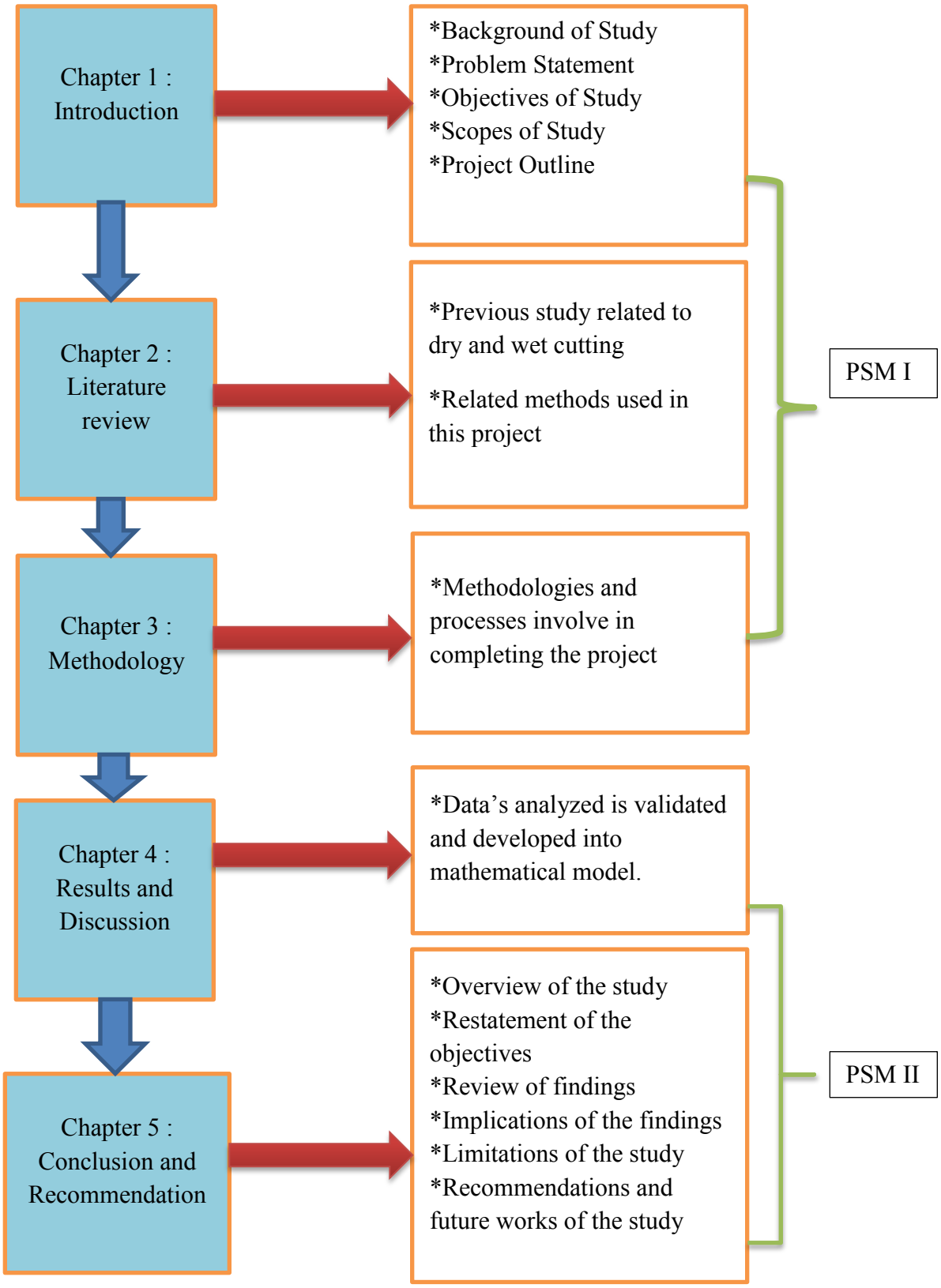

Figure 1.1 : Project outlines

CHAPTER 2
LITERATURE REVIEW

This chapter covers the literature review of this project, which will depict about the process of the undertaking improvement, various references and some researches that satisfy the objectives desired. A large number of analytical and experimental studies on dimensional accuracy akin to turning operations have been directed. Literature review describes the subject identified related to the experiment so as to give general up-to-date ideals, theoretical concepts and analytical review correspondingly.

2.1 Dimensional Accuracy

Customer requirements are the most important factor in manufacturing industry. Nowadays, customer demands a high quality product. Yet, machining has been commonly portrayed by the generation of heat and high cutting temperature. At such elevated temperature the cutting tool may immediately or wear out quickly lose their form of stability if they are not enough hot hard resulting in increase of cutting force, dimensional error of the product and shorter tool life (Ahmed, A.D., 2007). Thus, to deliver what customers want, to do it in the most efficient and cost effective manner, there are factors that needed to be considered by the manufacturer. As for that, quality can be defined as a measure of how manufacturer fulfilling their promises to the customer. Besides, quality also can be seen as a measure of performance of the manufactured product. To assess the performance and comparing the product, quality can be measured from several considerations, for instance, surface finish, functionality,

accuracy, performance, aesthetic value and so on. However, product quality does depend on various factors, for example, the material used for making the product, method of manufacturing, tools and equipment used. For example, the choice of cooling method in metal cutting does affect the deformation mechanism, which related to dimensional accuracy and surface finish (Islam M.N., 2013).

In manufacturing industry, dimensional accuracy of part product has been taken as the important measure of quality. Accuracy is defined as capability to get the exact measure of a dimension (Nagendra Parashar B.S et al. 2003). It can be another way to ensure the part functionality. Accuracy can be determined by referring to the tolerance of the designated part. While, it is impossible to manufacture any part to absolute dimension without regard to the methods of manufacturing, tolerance is introduced. It is crucial for the dimensions, shape and the mutual position of surfaces of individual parts of the product to be kept within a certain accuracy to obtain their correct and reliable functioning. Furthermore, it is enough that the actual dimension of the part is in between two limit dimensions and allowable deviation is kept with production. Dimensional accuracy can be measured by various ways, such as dimensional deviation, diameter error and also its circularity. As in the preliminary study of investigation concerning dimensional accuracy and surface finish in dry turning, dimensional accuracy of parts produced can be defined by the measurement of the size; which are length, height, width and diameter, besides it also can be determined by its geometric or shape properties such as straightness, angularity, cylindricity and circularity.

Referring to the right size, correct work of making things to meet tolerances, dimensional accuracy can ensure the reliability of parts produced. Any part product should be able to function in their designed manner as they were manufactured for some specific purpose and it should function properly over its expected life under common operating conditions. This condition can determine the level of the product reliability. The reliability requirements of a product depend upon the type of product and its end use. Hence, part produced with poor dimensional accuracy may have lessened the reliability of the part. Moreover, the reliability of parts produced can affect the