Effect of Machining Parameter Variance toward Turning Machine Machinability

JOHAN STYFEN CATNER NEYLAND[1], RUDY POENG[2], I NYOMAN GEDE[3]
[1, 2, 3] *Mechanical Engineering Department, Sam Ratulangi University, Indonesia*

Abstract- This research purpose to determine the effect of machining parameters on the machinability of a Turning Machine. To get this effect, it is necessary to test on a Turning Machine, using varying rotation and depth of cut while the feeding motion is constant. Based on the Excellence Sector of research at Sam Ratulangi University, the research outputs which related to the proposed research relate to the superior fields of maritime affairs. The result obtained from this research is that increasing cutting parameters, whether the rotation or cutting depth in the turning machine process, will reduce the specific cutting energy. Thus, this shows that the condition of the turning machine is considered good because by decreasing the specific cutting energy it can reduce production costs. However, the results of the two-way analysis of variance without interacting show that the rotational machining parameters have a significant effect on the machinability of the turning machine, while the depth of cut does not.

Indexed Terms- Machining parameter, machinability, Turning Machine.

I. INTRODUCTION

In general, the metal cutting process by a machine (machining process) uses machine tools as a means of interaction in the form of cutting and feeding between the cutting tool and the workpiece material. Thus, the machine tool can be moved in such a way as to allow the cutting process (machining) of the workpiece material by the cutting tool.

The machining properties of machine tools are the characteristic in the development of the world of manufacturing technology. Increasing the accuracy, precision and reliability of the process result become a challenge, including conventional machine tools that produce products or workpieces or machine components. The development of the world of machinery and manufacturing is very dynamic so that to fulfill these needs it is necessary to increase the quality of the quality of production. Therefore, in fulfilling the need for accuracy and reliability, good and high-quality machine tools are needed.

The turning process in the manufacturing industry is one of the machine tools used to make products in bulk so that monitoring of the condition of the machine is required. One technique for monitoring cutting conditions involves specific cutting energies to determine the machining properties of machine tools. The greater cutting, both the rotation and the depth of cut, generally the lower the specific cutting energy, thus the turning condition is considered good because it can reduce production costs. Specific cutting energy is a characteristic of the workpiece material. Therefore, it is sometimes used as a measure in determining the level of ease with which the workpiece material can be formed in the machining process, and is known as machinability.

The problem of this research is whether by varying the parameters of rotary machining and cutting depth will affect the machinability of a turning Machine.

The purpose of this study was to obtain the effect of rotation and depth of cut on the machinability of a turning Machine by using the method of analysis of variance using a spreadsheet application.

The benefits of this research are as input and information in improving product quality from the results of the machining process of a turning Machine in the Unsrat Mechanical Engineering Laboratory, so that appropriate usage and maintenance actions can be taken.

II. LITERATURE REVIEW

2.1 Turning Machine

The workpiece is held by a chuck which is fixed at the end of the main shaft (spindle), see figure 2.1.

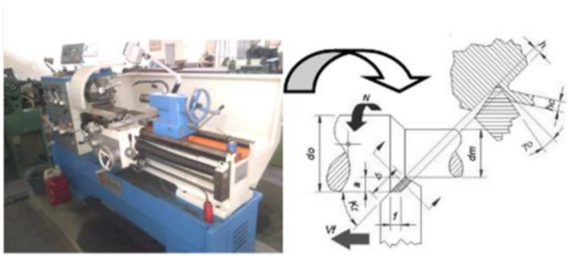


Figure 2.1 KNUTH DM 1000 A turning machine in the Laboratory of Mechanical Engineering Unsstrate and Cutting processes (Rochim, 1993)

2.2 Specific Cutting Energy

Mechanically decreasing the nominal power of the machine tool motor until it becomes the power used. Beside to calculating machining efficiency, the condition of a machining process can also be assessed based on specific cutting energy as follows: (Rochim, 1993)

$$E_{sp} = \frac{N_c}{Z}.(60.000)\ \left(\frac{\text{J}}{\text{cm}^3}\right) \quad (2.1)$$

where, N_c = cutting power (kW)

Z = speed of chips produce $\left(\frac{\text{cm3}}{\text{min}}\right)$

Beside the influenced by the type of machining process and the cutting conditions which used, the specific cutting energy is a characteristic of the workpiece material. Therefore, it is sometimes used as a measure in determining the level of ease of the workpiece material to be formed in the machining process, and it is called mach inability. The formula for the velocity of furious income is, (Rochim, 1993)

$$Z = f.a.v\ \left(\frac{\text{cm3}}{\text{min}}\right) \quad (2.2)$$

where, f = feeding (mm/r)

a = cutting depth (mm)

v = cutting speed (m/minute)

$$= \frac{\pi.d_o.n}{1000}\ \left(\frac{\text{m}}{\text{minute}}\right) \quad (2.3)$$

3 phase electric motor power formula: (Abidin, 2013)

$$N_c = \frac{\sqrt{3}.V.I.\cos\varphi}{1000}\ (\text{kW}) \quad (2.4)$$

where, I = electric motor current (ampere) of the ampere pliers measurement

V = electrical voltage (volt)

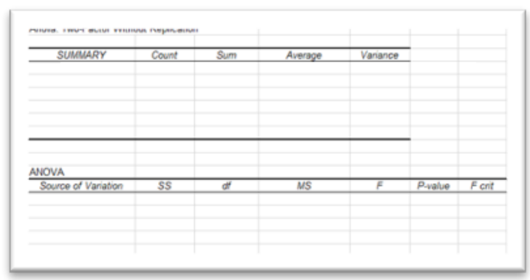
= for 3 phase 380 volt

$\cos\varphi$ = power factor

for electric motors 3 *phase* 380 volt have 0,84 power factor.

2.3 Variance Analysis

Variance Analysis (anova) is divided into three types, namely one-way anova, two-way anova without interaction and two-way anova with interaction. To make a conclusion, compare the results of the F_count with F_table, where H0 is rejected if F_Count> F_table and H0 is accepted if F_hitung≤F table. Two-way ANOVA without interacting can be analyzed using a spreadsheet application (Microsft Excel), with an output display as in Figure 2.2.



SUMMARY	Count	Sum	Average	Variance

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit

Figure 2.2 Anova result display

III. RESEARCH METHODS

The place where this research was carried out was carried out in the Mechanical Engineering Laboratory of the Unsrat Engineering Faculty. The material used in this study is steel shaft with a diameter of 1 inch. While the equipment used is the Cut-Off Machine and its equipment, turning machine and its equipment, Ampere pliers, Steel Ruler and Sigmat.

3.1 Research procedure

The procedure to be carried out in this study, as shown in Figure 3.1.

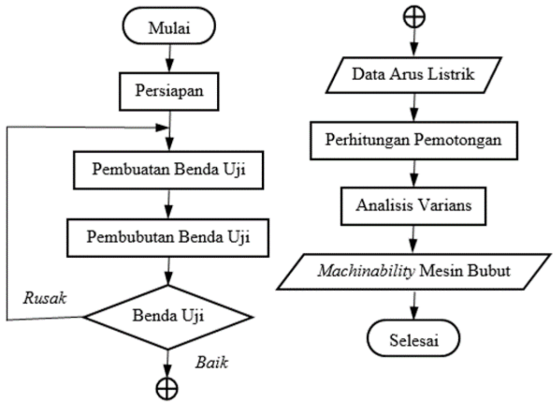


Figure 3.1 Research procedure

3.2 Data processing

The source of the data processed in this study is primary data. Primary data, namely data that is directly obtained from the object of the implementation of this study, that is conducting cutting tests on the KNUTH DM 1000 A turning machine at the Unsrat Mechanical Engineering Laboratory.

The machining parameters used in the turning test and the results of measuring the current of the electric motor in this study are shown in Table 3.1.

Tabel 3.1 Turning test result data

Arus Motor Listrik (ampere)				
No	**Putaran** (rpm)	**Kedalaman Pemotongan** (mm)		
		0.250	**0.500**	**1.000**
1	**300**	3,8	4,0	3,8
		3,9	3,9	3,9
		3,7	3,9	3,9
2	**700**	3,9	3,7	3,9
		3,7	3,8	3,7
		3,9	3,8	4,0
3	**1600**	5,8	5,5	6,0
		5,4	5,9	6,3
		5,3	5,7	6,6

3.3 Test Result Documentation

The process of making a test object, testing turning and measuring the current of an electric motor is documented below:

Figure 3.2 The process of making test objects

Figure 3.3 The process of turning and measuring the current of an electric motor

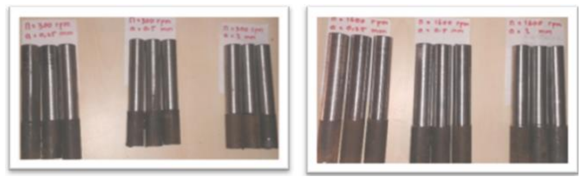


Figure 3.4 Test object after turning

IV. RESULTS AND DISCUSSION

4.1 Turning Calculation Results

A test was carried out to examine the effect of machining parameters with varying rotation conditions and depth of cut on the KNUTH DM 1000 A turning machine. The calculation results are as in Table 4.1.

Table 4.1 The result of the deduction calculation

Energi Pemotongan Spesifik ((J/cm3)				
No	**Kedalaman Potong** (mm)	**Putaran** (rpm)		
		300	700	1600
1	0,25	**191.479**	**82.782**	**52.594**
2	0,50	**99.099**	**40.671**	**26.927**
3	1,00	**48.710**	**20.876**	**14.881**

4.2 Relation of Machining Parameters with Specific Cutting Energy

1. Effect by increasing the depth of cut

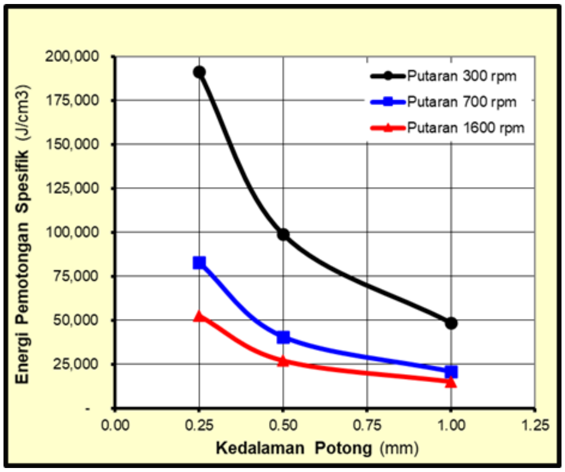


Figure 4.1 Graph of the depth of cut toward specific cutting energies

Based on Figure 4.1, both the 300 rpm, 700 rpm and 1600 rpm rotation curves show that, by increasing the depth of cut, the specific cutting energy decreases.

2. Effect by Increasing Rotation

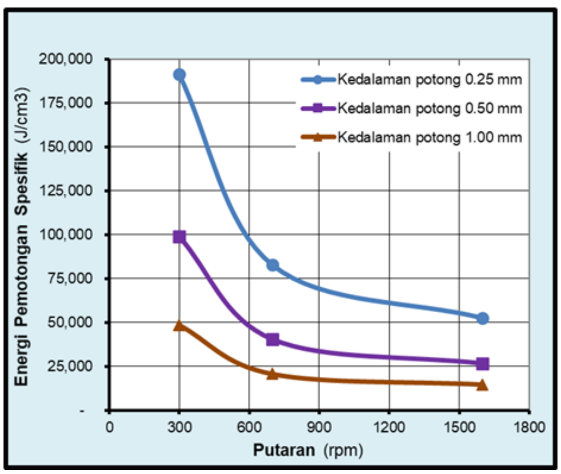


Figure 4.2 A rotation graph of the specific cutting energy

Based on Figure 4.2, both the rotation curves of 0.25 mm, 0.50 mm and 1.00 mm show that, by increasing the rotation, the specific cutting energy decreases.

4.3 Variance Analysis

For the Accurate varians analysis, this test is used, it is two-way anova wihtout intraction.

- Hypothesis:

1. Column anova hypothesis is depth of cut

$H0 : \mu_1 = \mu_2 = \mu_3 = \mu_k$

There was no significant difference between the average of depth of cut. This means that the variation in parameters for depth of cut has no effect on machinability.

$H1 : \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_k$

There is a significant difference between the calculated means of the depth of cut category. This means that the variation in the parameters for the depth of cut has an effect on machinability.

2. The line anova hypothesis is round

$H0 : \mu_1 = \mu_2 = \mu_3 = \mu_j$

There was no significant difference between the averages of the rounds. This means that the variation in parameters for rotation has no effect on machinability.

$H1 : \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_j$

There is a significant difference between the calculated averages of the rounds. This means that variations in parameters for rotation have an effect on machinability.

- Data analyst with Spreadsheet

The confidence level is 95%, thus the error rate is 5%, using data analysis with a spreadsheet application, two-way ANOVA results without interaction, as in Figure 4.3.

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Kedalaman potong 0,25 mm	3	326.855	108.952	5335.9
Kedalaman potong 0,50 mm	3	166.697	55.5657	1468.59
Kedalaman potong 1,00 mm	3	84.467	28.1557	325.845
Putaran 300 rpm	3	339.288	113.096	5242.68
Putaran 700 rpm	3	144.329	48.1097	999.589
Putaran 1600 rpm	3	94.402	31.4673	371.029

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Kedalaman potong	10129.4	2	5064.68	6.541	0.05483	6.944
Putaran	11163.4	2	5581.72	7.209	0.04717	6.944
Error	3097.24	4	774.309			
Total	24390	8				

Figure 4.3 Two-way ANOVA results without interaction

From figure 4.3, it show that:

1. At the depth of cut $F < F_{crit}$ it is 6,541 < 6,994 $H0$ received, so the difference in cutting depth has no effect on the machinability of the lathe.
2. At Rotation $F > F_{crit}$ it is 7,209 > 6,994 $H0$ Rejected, hence the difference in rotation has a

significant effect on the machinability of the Turning Machine.

V. CONCLUSION AND RECOMMENDATION

- Conclusion

From the research on the effect of parameter variations on the machinability of turning Machine, the conclusion is that by increasing the cutting parameters, be it rotation or cutting depth in the turning process, the specific cutting energy will decrease. Thus, this shows that the condition of the turning machine is considered good because by decreasing the specific cutting energy it can reduce production costs. However, the results of the two-way analysis of variance without interacting show that the rotational machining parameter has a significant effect on the machinability of the turning machine, while the depth of cut does not.

- Recommendation

1. The cutting process should be carried out on several types of materials and other machining processes, so that the comparison or difference of the effect of cutting on specific cutting energy (machinability) can be known.
2. For the development of further research, it is expected to involve machining parameters by varying the feeding motion against specific cutting energy (machinability) on machine tools.

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