Machinability Study: Low Variation and High Repetitive Case

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Abstract: Machining proses or metal cutting process is a main activity practised by small and medium metal enterprise by using conventional machines. This machining process is directed to produce the mass products (low variation and high repetition), such as components of machine or another equipments, but often also the macining process is made inappropriately, or even in total false methode, such as false selection of tool, thus the worn-out fastly, over cutting speed, thus surface is rougher, and etc. In this paper, the machinability on cast iron cutting is assessed (the material usually worked in small and medium metal industries), i.e., by making some experiment to obtain the most optimal cutting condition (v, f ,and a) to have the short cutting time, big cutting volume, lower surface roghness and longer tool life .

1 INTRODUCTION

1.1 Background

Information on the mechinability of a product is needed to find out the quality and quantity of the product to be produced as well as the tool wear information (Cerce and Pusavec, 2016). This information is very important to know the level of productivity that will be achieved in the implementation of a production. Based on this information, it can be determined the type of tool and the right cutting conditions so that productivity is better which affects the increase of the income of small and medium industries (Nayyar *et al.*, 2012).

Usually, small and medium industries carry out the production process based on technology that is usually carried out from generation to generation, this results in difficult production quality to compete in the local market and export markets.

To solve these problems, the machinability study is very important to be done so that productivity from the aspect of quality and quantity can be increased.(Nasution *et al.*, 2005)

1.2 Formulation of Problem

Problems commonly found in small and medium me-tal industries in cast iron machining are as follows:

Inconsistent cutting condition include the depth of cut, tool geometry, cutting speed and feeding, contributes to inconsistency of product geometry produced, or in other word accuracy and precision of product produced is poor. The cutting condition also contributes to surface roughness, that feed is very influential factor on surface roughness.

1.3 Purpose of Research

The purpose of this research are:

a. To investigate machinability of pulley from cast iron materials.
b. To give input and suggestions to Small and Medium Metal Enterprise to increase productivity through study of machinability factor.

2 MATERIAL, EQUIPMENTS AND METHODOLOGY

2.1 Material

The material of pulley is cast iron with chemical composition C = 3.04 %, S = 0.11 % Cr = 0.07 %, Mn = 0.42 %, Cu = 0.05 %, Mo = 0.05 %, Ni = 0.02 %, P = 0.068 %, Si = 2.58 %, and mechanical properties : Brinnel Hardness = 1500 HB, Tensile

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Strength = Min 365 Mpa, Elongation Break = 10 %, Modulus elasticity=300 GPa

2.2 Equipments

CNC Emcoturn 242 was used on cutting condition research, uncoated carbide insert tools with complex chipbreaker (CNMG 120412 EN – TM) was used on cutting condition research. Insert tool chemical properties: Co= 6,0 %, composite carbides = 0,6 %, WC rest and mechanical properties: HV=1550 (Tiziloque, CERATIZIT cutting tool catalogues, 2003). Tool holder PCLN/R 2525 M12-T with Kr = 95º.

2.3 Methodology

The method of data collection was by Collecting the data in cutting process of 15 samples, i.e.: cutting time, product dimension, surface roughness (Kir *et al.*, 2016). The data collected was then analyzed to see the performance of Small and Medium Metall Enterprise from quality and quantity side by using conventional machine, and then a testing was made against several variation of cutting condition to obtain the data as follows: machining time (t), tool wear (VB), length of machining (L), material removal rate (MRR), surface roughness (Ra) of machining workpiece (Lin *et al.*, 2016)

3 RESULT AND DISCUSSION

3.1 Cutting Condition in Small and Medium Enterprise

The cutting process toward 15 samples obtained data that average cutting time per product = 6.78 minute s with lower control limit LCL = 6.32 minute dan upper control limit UCL = 7.25 minute and deviation standard = 0.16. Based in figure 1, shown with clearly the significant variation cutting time found in conventional machining process, and even there is some data staying out of control limit. This indicated inconsistency of machining time to complete a product because the machining process is largely effected by performance of machine operator (Steel, Potong and Hss, no date).

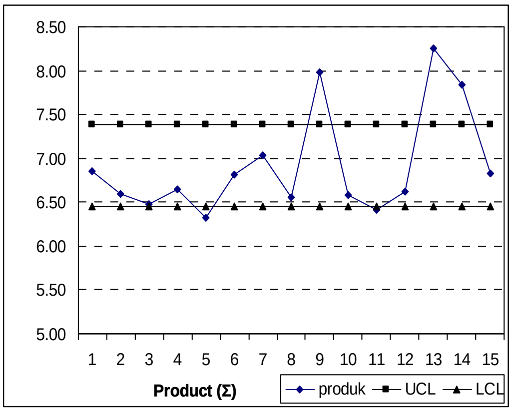

Figure 1: Machining time of 15 product with conventional lathe.

From the result of measurement of surface roughness by using Surface Roughnes Profillometer in figure 2. it was informed that the value of surface roughness in conventional machine is also very variuos with a verage = 4.00 and deviation standard = 1.55. The reason of the coarse surface finish is possible by:

1. Cutting tool factor (geometry and material)
2. Feeding (f)
3. Cutting speed (V)

This case also indicates the inconsistency of surface roghness that obtained of conventional machining (Teknik *et al.*, no date).

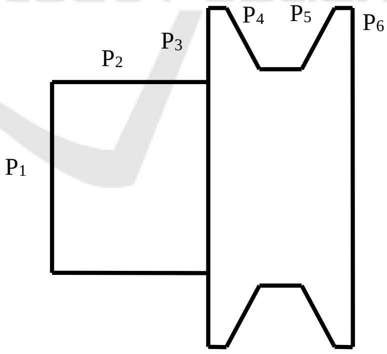

Figure 2: Product surface measured.

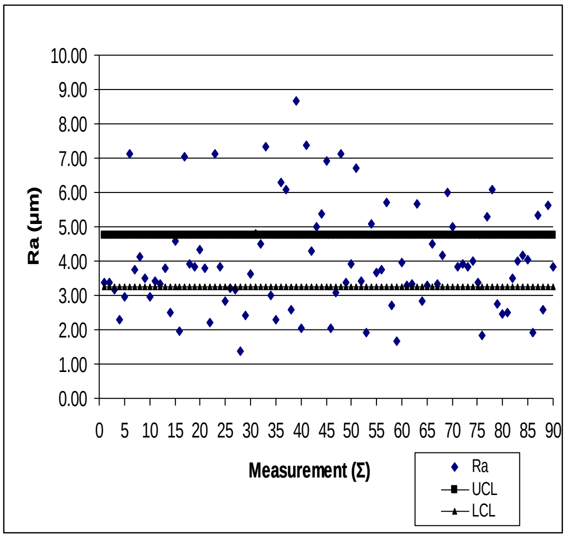

Figure 3: Surface Roughness by Conventional Machining.

The measuring data result of product dimension in table 1. shown inconsistency dimension that obtained by conventional machining.

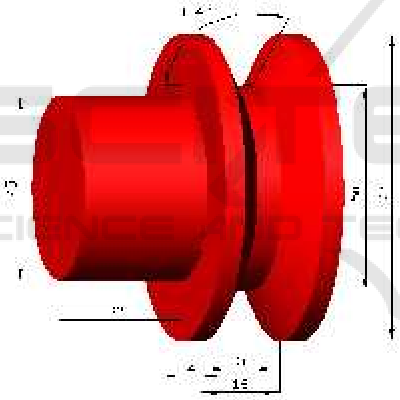

Figure 4: Product Dimension Expected.

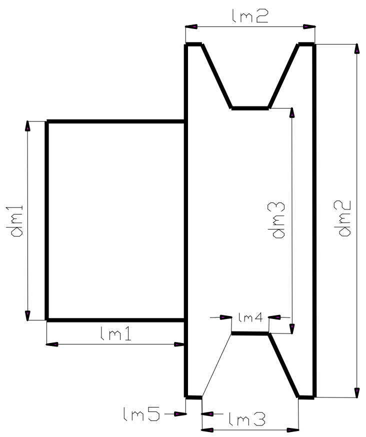

Figure 5. Product Dimension.

3.2 Cutting Condition used Uncoated Carbide Insert

Below is the new Cutting Condition test toward 9 (nine) variation of cutting condition variation, i.e :
CC1: v = 50 m/min ; f =0.04 mm/rev ; a =0.5 mm;
CC2: v = 50 m/min ; f = 0.1 mm/rev ; a = 0.5 mm;
CC3: v = 100 m/min ; f = 0.1 mm/rev ; a = 0.5 m;
CC4: v = 250 m/min ; f = 0.1 mm/rev ; a = 0.5 mm;
CC5: v = 300 m/min ; f = 0.1 mm/rev ; a = 0.5 mm;
CC6: v = 400 m/min ; f = 0.1 mm/rev ; a = 0.5 mm[
CC7: v = 500 m/min ; f = 0.1 mm/rev; a = 0.5 mm;
CC8: v = 300 m/min ; f = 0.2 mm/rev ; a = 0.5 mm;
CC9: v = 400 m/min ; f = 0.2 mm/rev ; a = 0.5 mm

3.2.1 Tool Wear

Figure 6 shows that each cutting process is done about five minutes, and the faster worn-out occur on the tool with cutting condition of CC5, CC6 and CC7, but the resulting worn-out is still under 0.3 mm, it means it is still in allowable condition.

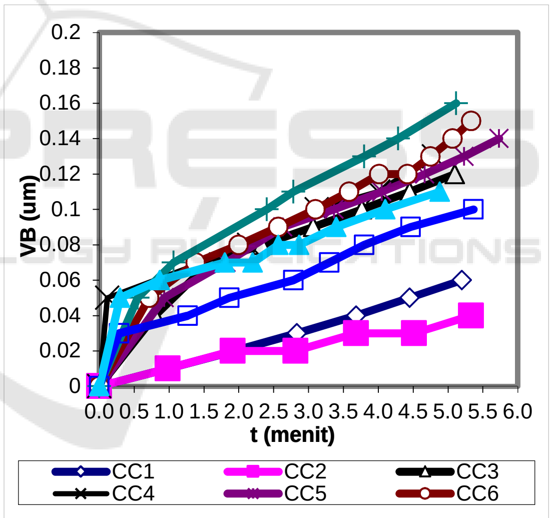

Figure 6: Machining Time and Tool Wear.

From figure 7, it shows that length of machining done on Small and Medium Enterprise , CC1, is very short, it means the productivity is very low compared to CC2,CC3,CC4, CC5, CC6, CC8 and CC9.

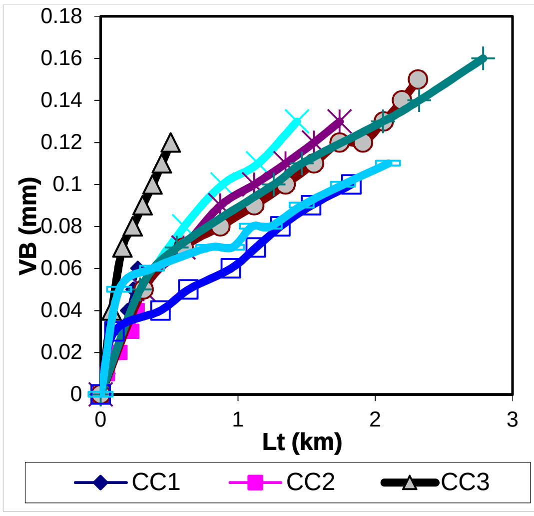

Figure 7: Length of Machining VS Tool Wear.

3.2.2 Surface Roughness

The expected limit of Surface Roughness is 2.4 µm, from graph of Surface Roughness in figure 8, that all of cutting conditions obtained athe suitable surface roughness as expected, except cutting condition of CC2.

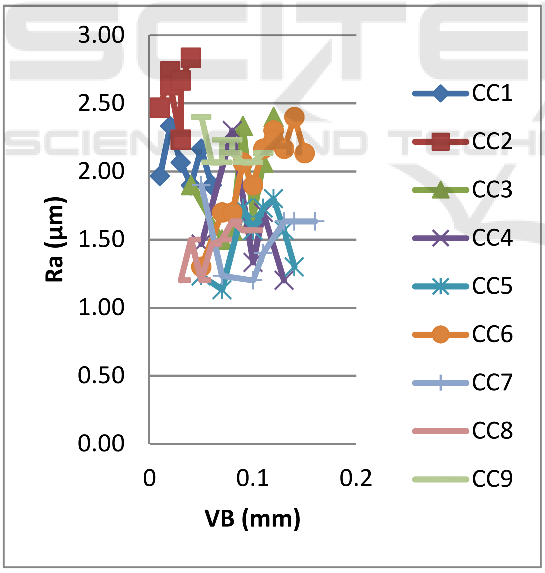

Figure 8: Tool Wear VS Surface Roughness.

3.2.3 The Removal Material

From figure 9. it can be seen that the most machining volume is in CC9, with v = 400 m / min, f= 0.2 mm/ rad ; a = 0.5 mm, however the lower machining volume on CC1, CC2, CC3 and CC4.

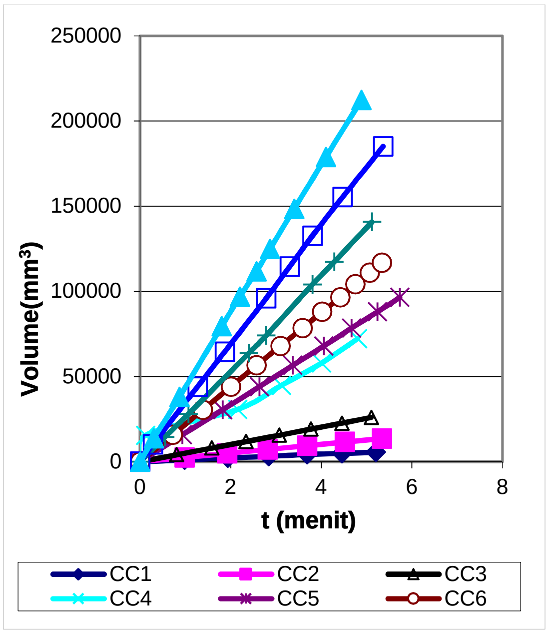

Figure 9: Relationship Between Cutting Time VS Machining Volume.

In perspective of tool wear, it can be seen clearly in figure 10 that the cutting volume obtained of CC1, CC2, CC3, CC4, CC5, CC6 and CC7 are lower than CC8 and CC9. However, tool wear on CC8 and CC9 is still permitted because it is below 0.3 mm

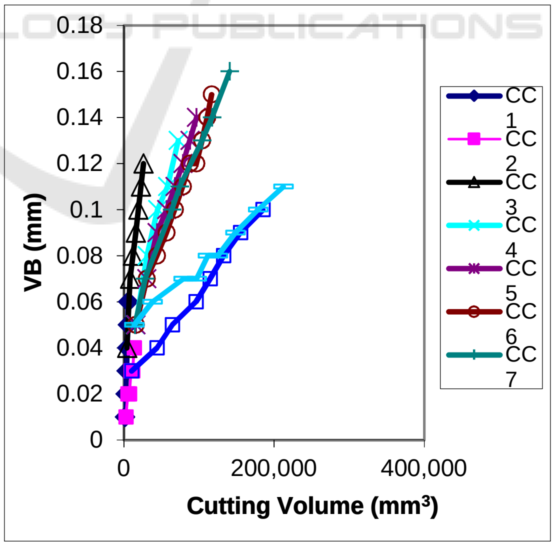

Figure 10: Cutting Volume VS Tool Wear.

Figure 11 Shows that Material Removal Rate (MRR) on Small and Medium Enterprise (CC1) is very low, about 1 cm^3/menit, and then the significant MRR increase from CC4 to CC9. This means that the best productivity in terms of quantity is the CC9 cutting condition.

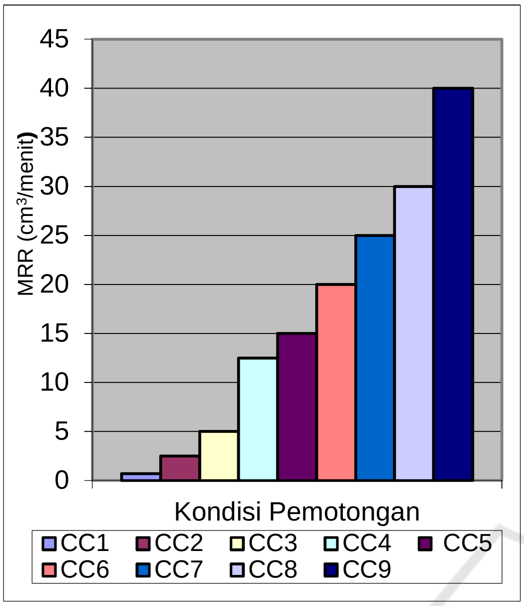

Figure 11: MRR VS Cutting Condition.

4 CONCLUSIONS

4.1 Product Quality Produced by Using Earlier Technology

1. The conventional lathe and the old machining process technology obtained the machining time in wide because of machining process with conventional machining process depends on operator and lowest cutting velocity.
2. Surface roughness is not as expected (average 4,00 µm).
3. Product dimensions are not consistent.
4. Material Removal Rate (MRR) is lowest i.e: 1 cm^3/menit, thus machining time is slower than new cuting conditon.

4.2 Expected Product Quality by New Technology and New Cutting Condition

New cutting conditions is obtained from the result of analysis on machining process of cast iron by using carbida insert tool. Those cutting conditions produced the far higher productivity and better machining quality, i.e. cutting condition of CC7, CC8, CC9.

In relation to presentation above, the cutting conditon recomended from the result of data analysis above will be:
V= (300 - 500) m/min ; f = (0.1 – 0.2) mm/rad ; a = 0.5 mm

Thus, Quantity and quality of products expected have been achieved, including as follows:

1. The shorter machining time.
   This is seen clearly from figure 11, in which material removal rate (MRR) in CC9 is 40 times as speed as of CC1, it is relevant to cutting volume produced by CC9 more than another cutting conditions.
2. In perspective of tool wear shown that the wear occurs on CC7, CC8 dan CC9 still in allowable limit.
3. The average surface roughness is under 2.5 µm.
4. Together with to increase in quality and quantity of machining process by new technology, it will be increase the profit of enterprise.

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