Faculty of Mechanical and Manufacturing Engineering Technology

QUALITY RECOGNITION AND COST EVALUATION BASED ON ACTIVITY BASED COSTING (ABC) FOR ALUMINUM ALLOY USING CNC LASER CUTTING AND WATER JET MACHINE

Noor Suhaili Binti Mohd Asri

Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

2018

© Universiti Teknikal Malaysia Melaka

QUALITY RECOGNITION AND COST EVALUATION BASED ON ACTIVITY BASED COSTING (ABC) FOR ALUMINUM ALLOY USING CNC LASER CUTTING AND WATER JET MACHINE

NOOR SUHAILI BINTI MOHD ASRI

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

© Universiti Teknikal Malaysia Melaka

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Quality Recognition and Cost Evaluation Based on Activity Based Costing (ABC) for Aluminum Alloy using CNC Laser Cutting and Water Jet Machine**

SESI PENGAJIAN: **2018/2019 Semester 1**

Saya **NOOR SUHAILI BINTI MOHD ASRI**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD	

Disahkan oleh:

Cop Rasmi: NUR AIMAN HANIS BINTI HASIM
Pensyarah
Jabatan Teknologi Kejuruteraan Pembuatan
Fakulti Teknologi Kejuruteraan (FTK)
Universiti Teknikal Malaysia Melaka

Alamat Tetap:

No.55 A KAMPUNG BINJAI
BANGGU 16150 KOTA BHARU
KELANTAN

Tarikh: 4/1/2019

Tarikh: 4/1/2019

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

© Universiti Teknikal Malaysia Melaka

DECLARATION

I declare that this thesis entitle "Quality Recognition And Cost Evaluation Based On Activity-Based Costing (ABC) for Aluminum Alloy using CNC Laser Cutting and Waterjet Machine" is the results of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidate of any other degree.

Signature : .....

Name : NOOR SUHAILI BINTI MOHD ASRI

Date : 4 JANUARI 2019

© Universiti Teknikal Malaysia Melaka

APPROVAL

I hereby declare that I have read this thesis and my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor Degree in Manufacturing Engineering Technology (Product Design) with Honours.

Signature : .....

Name : NUR AIMAN HANIS BINTI HASIM

Date : 4TH JANUARY 2019

© Universiti Teknikal Malaysia Melaka

DEDICATIONS

I am dedicating this thesis to beloved people who have meant and continue to mean so much to me. Specially dedicated to my beloved father, En. Mohd Asri bin Mat Daud and my beloved mother, Pn.Noriah binti Saamah who taught me the value of hard work, understanding, patient and supportive. Special thanks to my supervisor Pn. Nur Aiman Hanis bintit Hasim for the encouragement, constructive guidance and patient in fulfilling my aspiration in completing this project. Do not forget to my Co-Supervisor, Mr Soufwhee with a great help in preparing this project. To my brother, my sister and entire friends, will never achieve without all of you.

© Universiti Teknikal Malaysia Melaka

ABSTRACT

Nowadays, the cutting machine can cut many different materials in terms of different quality and cost. CNC Laser cutting and Water jet machine have been used in UTeM to cut the workpiece or produce the product based on cost and quality with the variety material and thickness. The CNC laser cutting and water jet have a different parameters that will be produce different cost and quality. This research is about quality recognition and cost evaluation based on Activity Based Costing (ABC) for aluminum alloy using CNC laser cutting and water jet machine. This project will focus the cost evaluation based on Activity Based Costing which is a direct cost for the machine and indirect cost for the overall process when cut the aluminum alloy. The problem faced is to estimated cost for CNC laser cutting and water jet machine when industry come to UTeM for the purpose of materials cutting using CNC laser cutting and water jet machine. The framework Activity Based Costing can guide the process of how to calculate the cost based on Activity Based Costing with correct cost. Lastly, for quality recognition the quality of each work piece tested using surface roughness tester and process capability. The surface roughness tester is based on the value of Ra, Rq and Rz. The value was observed to identify the comparison of quality work piece using CNC laser cutting and water jet machine. In surface roughness tester the water jet machine depicts a better quality with the lowest value of Ra, Rq, and Rz compare to CNC laser cutting value. Process capability is a specification limits for a specific process or products to meet customer requirements. The value of Cpk in CNC laser cutting is higher than water jet machine, so it becomes the best requirement meet for the process capability.

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Pada masa kini, mesin pemotong boleh memotong banyak bahan yang berbeza dari segi kualiti dan kos. Pemotong laser CNC dan mesin jet air telah digunakan di UTeM untuk memotong bahan kerja atau menghasilkan produk berdasarkan kos dan kualiti dengan pelbagai bahan dan ketebalan. Pemotong laser CNC dan mesin jet air mempunyai parameter yang berbeza yang akan menghasilkan kos dan kualiti yang berbeza. Kajian ini adalah mengenai pengiktirafan kualiti dan penilaian kos berasaskan Kos Berdasarkan Aktiviti (ABC) untuk aluminium aloi dengan menggunakan pemotong laser CNC dan mesin jet air. Projek ini akan menumpukan pada penilaian kos berdasarkan Kos Berdasarkan Aktiviti yang merupakan kos langsung untuk mesin dan kos tidak langsung untuk proses keseluruhan apabila memotong aluminium aloi. Masalah yang dihadapi adalah untuk anggar kos pemotong laser CNC dan mesin jet air ketika industri datang ke UTeM untuk tujuan pemotongan bahan menggunakan pemotong laser CNC dan mesin jet air. Kerangka kos berdasarkan aktiviti dapat membimbing proses bagaimana untuk mengira pembayaran berpandukan kos berdasarkan aktiviti dengan tepat. Akhir sekali, untuk pengiktirafan kualiti untuk setiap potongan bahan kualiti diuji menggunakan penguji kekasaran permukaan dan keupayaan proses. Penguji kekasaran permukaan adalah berdasarkan kepada nilai Ra, Rq dan Rz. Nilai yang diperhatikan untuk mengenal pasti perbandingan setiap bahagian yang di potong menggunakan pemotongan laser CNC dan mesin jet air. Dalam penguji kekasaran permukaan mesin jet air menggambarkan kualiti yang lebih baik dengan nilai terendah Ra, Rq, dan Rz berbanding dengan nilai pemotong laser CNC. Keupayaan proses adalah had spesifikasi untuk proses atau produk tertentu untuk memenuhi keperluan pelanggan. Nilai Cpk dalam pemotongan laser CNC adalah lebih tinggi daripada mesin jet air, jadi ia menjadi memenuhi keperluan terbaik untuk keupayaan proses.

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGEMENTS

First and foremost, I thank Allah (SWT) for His help and guidance for letting me live to see this project through. I am grateful and thankful to my supervisor, Pn. Nur Aiman Hanis bt Hasim for the encouragement, advice and unwavering support in the completion of the project. I can never pay you back for all the experience you have helped me to make sure my thesis is always on track. Thank you so much.

Not forget to En. Soufhwhee bin Abd Rahman, En. Basri and En. Syafiq because gave a lot of guidance and new knowledge to me in providing readership and ideas to the realization of this project. Thank you for your support and helpful suggestions, I will be forever thankful to you.

I also would like to thank all my friends who have been really helpful to complete this project. With a little help of ideas from them, I can complete this report. Not least of all, I owe so much to my whole family for their support that I can achieve so much.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENT

		PAGE
DECLARATION		
APPROVAL		
DEDICATION		
ABSTRACT		**i**
ABSTRAK		**ii**
ACKNOWLEDGEMENTS		**iii**
TABLE OF CONTENTS		**iv**
LIST OF TABLES		**viii**
LIS OF FIGURE		**x**
LIST OF GRAPHS		**xii**
LIST OF SYMBOLS		**xiii**
LIST OF APPENDICES		**xv**
CHAPTER		
1.	**INTRODUCTION**	**1**
1.1	Background of Study	1
1.2	Problem Statement	2
1.3	Objective	3
1.4	Scope	3
1.5	Expected Result	4
1.6	Thesis Frame	4
1.7	Summary of Chapter	5
2.	**LITERATURE REVIEW**	**6**
2.1	Introduction	6
2.2.1	CNC Laser Cutting	6
2.2.2	History and development of CNC Laser Cutting	6

© Universiti Teknikal Malaysia Melaka

2.2.3 Process of CNC Laser Cutting 9
2.2.4 Features of CNC Laser Cutting 10
2.2.4.1 Optics 10
2.2.4.2 Assists Gas 10
2.2.4.4 Material Quality 11
2.2.4.5 Cutting parameters 12
2.2.5 Methodological of CNC Laser Cutting 13
2.3 Water Jet Machine 14
2.3.1 History and development of water jet 14
2.3.2 The Principles of Water Jet Cutting 16
2.3.2.1 Water jet cutting with pure water 17
2.3.2.2 Water jet cutting with abrasive 18
2.3.2 Water Jet Cutting Parameters 19
2.3.3 Application of Water Jet 20
2.4 Quality and Cost Analysis based on CNC Laser Cutting and Water Jet Machine 21
2.4.1 Quality Analysis 21
2.4.1.1 Aluminium Plate 21
2.4.2 Cost Analysis 22
2.4.2.1 Operation cost of CO2 laser system 22
2.4.2.1.1 Hourly equipment cost 23
2.4.2.1.2 Cost of consumables 23
2.4.2.2 Operation cost for water jet system 25
2.5 Activity Based Costing (ABC) 26
2.6 Summary of Chapter 28

3. METHODOLOGY 29
3.1 Flow Chart 29
3.2 Part Selection and 2D design 32
3.2.1 Design part 33
3.3 CNC Laser Cutting 34
3.3.1 Process of CNC Laser Cutting 36

© Universiti Teknikal Malaysia Melaka

	3.3.2	Assists Gas	37
	3.3.3	Cutting Parameters	38
3.4	Water Jet Machine		39
	3.4.1	Process of water jet	40
	3.4.2	The principles of water Jet	41
	3.4.3	Cutting speed of water Jet	42
	3.4.4	Pressure of water jet	43
	3.4.5	Pumps of water jet	43
	3.4.6	Cutting parameters of water jet	45
3.5	Material Selection		45
3.6	Costing		46
3.7	Activity Based Costing (ABC) Formula		47
3.8	Quality		48
4.	**RESULT AND DISCUSSION**		**50**
4.0	Introduction		50
4.1	Result		50
	4.1.1	CNC Laser Cutting	50
	4.1.2	Water Jet	52
4.2	Discussion		53
	4.2.1	Cost Evaluation	53
		4.2.1.1 CNC Laser Cutting	54
		4.2.1.2 Water Jet	56
		4.2.1.3 Activity Based Costing (ABC)	58
	4.2.2	Quality Recognition	62
		4.2.2.1 Surface Roughness Tester	62
		4.2.2.2 Process Capability	69
5.	**CONCLUSION AND RECOMMENDATION**		**75**
5.0	Introduction		75
5.1	Conclusion		75
5.2	Recommendation		78

© Universiti Teknikal Malaysia Melaka

REFERENCES 79

APPENDICES 83

© Universiti Teknikal Malaysia Melaka

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Cutting Parameters	12
2.2	Methodological Of CNC Laser Cutting	13
2.3	Cutting Parameters	19
2.4	Cost of Consumables Co2 Laser Cutting	24
2.5	Operation Cost for Water Jet System	25
2.6	ABC Formula	27
3.1	Dimensions	32
3.2	Specification of AMADA FO MII 3015 NT	35
3.3	Cutting Parameters	38
3.4	Specification of Flow Mach 2	40
3.5	Cutting Speed Flow Mach 2 for Metals	42
3.6	Cutting Parameters of Aluminium Alloy	45
3.7	Costing	46
3.8	ABC Formula	47
4.1	Cutting Condition and Cutting Time of CNC Laser Cutting Machine	54
4.2	Indirect Labour Cost or Operating Cost of CNC Laser Cutting	55
4.3	Fundamental Information of CNC Laser Cutting	56
4.4	Cutting Condition and Cutting Time of Water Jet Machine	57
4.6	Indirect Labour Cost or Operating Cost Of Water Jet Machine	57
4.6	Cost Data of CNC Laser Cutting and Water Jet Machine	58
4.7	ABC Formula	58

© Universiti Teknikal Malaysia Melaka

4.8	Cost Based On ABC Formula	59
4.9	Activity Based Costing (ABC)	60
4.10	Value the Surface Roughness Tester of CNC Laser Cutting	64
4.11	Value the Surface Roughness Tester of Water Jet Machine	65
4.12	Formula To Calculete The Cp And Cpk Value	69
4.12	Dimensions of Alumium Alloy Cut using CNC Laser Cutting	71
4.13	Dimensions of Alumium Alloy Cut using Water Jet Machine	72
4.14	Data of Cp and Cpk for Both Machines	73

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	CNC Laser Cutting	7
2.2	CO2 Laser	8
2.3	Process of Laser Cutting	9
2.4	Aluminium Alloy	13
2.5	Water Jet Machine	14
2.6	Water Jet Cutting System	16
2.7	Section View of Water Jet	17
2.8	Water Jet Cutting With Abrasive	18
2.9	Cut Surface Textures of 2 Mm Thick Aluminium Plate	21
3.1	Flow Chart	31
3.2	Part Selection	32
3.3	Design Part Using SolidWorks	33
3.4	CNC Laser Cutting	34
3.5	Process of CNC Laser Cutting	36
3.6	Nitrogen Gas, N2	37
3.7	Flow Mach 2 Water Jet Machine	39
3.8	Process of Water Jet	41
3.9	Principles of Abrasive Water Jet	42
3.10	Pressure Comparison of Water Jet	43
3.11	Schematic of Direct Drive Pump	44
3.12	Schematic of Intensifier Drive Pump	44

© Universiti Teknikal Malaysia Melaka

3.13	Plate of Aluminium Alloy	45
3.14	Surface Roughness Tester	48
4.1	Parameters of Aluminum Alloy Using CNC Laser Cutting	51
4.2	Part of CNC Laser Cutting	51
4.3	Parameters of Aluminum Alloy Using Water Jet Machine	52
4.4	Part of Water Jet Machine	53
4.5	Framework of Activity Based Costing (ABC)	61
4.6	Part Set Up at Surface Roughness Tester	62
4.7	Quality Of Aluminum Alloy Cut CNC Laser Cutting And Water Jet Machine	63
4.8	Exact Dimensions Using SolidWorks	70

© Universiti Teknikal Malaysia Melaka

LIST OF GRAPH

GRAPH	TITLE	PAGE
4.1	Arithmetical Deviation of Assessed Profile (Ra)	66
4.2	Root Mean Square Deviation of the Assessed Profile (Rq)	67
4.3	Maximum Height of Profile Expresses (Rz)	68

© Universiti Teknikal Malaysia Melaka

LIST OF SYMBOLS

CNC	-	Computer Numerical Control
ABC	-	Activity Based Costing
Ra	-	Arithmetical Mean Deviation of the Assessed Profile
Rq	-	Root Mean Square Deviation of the Assessed Profile
Rz	-	Maximum Height of Profile Expresses
mm	-	Micro Meter
Mm/Min	-	Milimeter per Minute
RM	-	Ringgit Malaysia
W	-	Watt
Kg	-	Kilogram
MPa	-	Megapascal
RMC	-	Raw Material Cost (Rmc)
MC	-	Machine Cost (Mc)
DC	-	Direct Cost (Dc)
IC	-	Indirect Cost ((Ic)
Hr	-	Hour
Sec	-	Second

© Universiti Teknikal Malaysia Melaka

USL	-	Upper Specification Limit
LSL	-	Lower Specification Limit

© Universiti Teknikal Malaysia Melaka

LIST OF APPENDICES

Appendices A - Gantt Chart

Appendices B – Drawing

Appendices C – Turnitin Checking

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.0 Background of Study

Activity Based Costing (ABC) is to address the problem of increasing the share that indirect fixed costs such as products cost structure, derived from the process of automatization of the production processes and industrialization. Activity Based Costing (ABC) estimates the costs of resources used consists of set activities to produce service and product. The functions cost estimating is to provide the standards for production efficiency and help control manufacturing cost when to produce or cut the workpiece or product.

This study is conducted in order to justify the quality recognition and cost evaluation based on Activity Based Costing (ABC) for aluminum alloy using CNC laser cutting and water jet machine. Quality recognition is quality based on the surface quality of workpiece by surface roughness and process capability. Cost evaluation is the cost of resources involves the cutting process which is direct labour and indirect labour. Water jet machine cutting used mechanical press cutter to cut the materials while for CNC laser cutting used the thermal cutter to cut the materials.

© Universiti Teknikal Malaysia Melaka

1.1 Problem Statement

Nowadays, the cutting machine can cut many different materials in terms of different quality and cost. The CNC laser cutting and water jet have been used in the industry to cut the workpiece or produce the product. CNC laser cutting and water jet machine is different types of machine. The CNC laser cutting is cut using laser while water jet using the water when cutting the materials that will produce the different cost and quality.

In UTeM, we have a problem to estimated cost for CNC laser cutting and water jet machine when other industry or company come to UTeM to cut the materials using CNC laser cutting and water jet machine. Also, UTeM has the problem to know the machine will produce the good quality between CNC laser cutting and water jet machine.

CNC laser cutting is a more advanced technology compare water jet machine which they have high energy of laser cut to the workpiece and technical gas of high purity that enables a laser to cut various materials of the cutting using the high point of the laser at the workpiece. Water jets use a high-pressure jet of water to cut the cutting metals or non-metals.

© Universiti Teknikal Malaysia Melaka

1.2 Objective

The objective of this project is:

1. To evaluate the quality of aluminum alloy using CNC laser cutting and water jet machine.
2. To calculate the operation cost based on Activity Based Costing (ABC).
3. To develop the framework based on Activity-based costing for aluminum alloy using CNC laser cutting and water jet machine.

1.3 Scope

The scopes of this thesis are to evaluate the quality of aluminum Alloy using CNC laser cutting and water jet machine Quality recognition is quality based on the surface quality of workpiece by surface roughness and process capability. Water jet machine cutting used mechanical press cutter to cut the materials while for Laser cutting used the thermal cutter to cut the materials.

This thesis are focused to calculate the operation cost based on Activity Based Costing (ABC). Cost evaluation is the cost of resources involves the cutting process which is direct labour and indirect labour. The operating cost of the CNC laser cutting and water jet machine was predicted the cost of consumable, accommodation or equipment and service will measure in hour condition during operation.

© Universiti Teknikal Malaysia Melaka