ENVIRONMENTAL IMPACT ASSESSMENT OF THE MILLING PROCESS ON CNC 3D ROUTER

MOHD NAZRIN BIN ZAKARIA

B091910128

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (PRODUCT DESIGN) WITH HONOURS

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical and Manufacturing Engineering Technology

ENVIRONMENTAL IMPACT ASSESSMENT OF THE MILLING PROCESS ON CNC 3D ROUTER

Mohd Nazrin Bin Zakaria

Bachelor of Mechanical Engineering Technology (Product Design) with Honours

2023

ENVIRONMENTAL IMPACT ASSESSMENT OF THE MILLING PROCESS ON CNC 3D ROUTER

MOHD NAZRIN BIN ZAKARIA

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Product Design) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this thesis entitled "Environmental Impact Assessment of the Milling Process on CNC 3D Router" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : *Mohd Nazrin Bin Zakaria*

Date : 10/1/2023

APPROVAL

I hereby declare that I have checked this thesis, and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Product Design) with Honours.

Signature	:	
Supervisor Name	:	Mrs Umi Hayati Binti Ahmad (Supervisor) Dr. Hambali Bin Boejang (Co-supervisor)
Date	:	10/1/2023

DEDICATION

This work is wholeheartedly dedicated to all my valuable treasures:

For my beloved parents:
Zakaria Bin Awang Ahmad
Ramlah Binti Hj Hossen

For my supportive siblings:
Mohd Nazri Bin Zakaria
Nadzariah Binti Zakaria
Nazimah Binti Zakaria
Nazarina Bnti Zakaria
Mohd Nazmi Bin Zakaria

Thank you always provide me moral, emotional, financial support and gave me strength when I thought of giving up.

For my respective supervisor and co-supervisor:
Mrs Umi Hayati Binti Ahmad & TS. Dr. Hambali Bin Boejang

For all UTeM lecturers, Engineer Assistance, and my treasured friend:
Who shared their word of advice and encouragement to finish this study.

ABSTRACT

The existing problem is that the machining process has a significant impact on the environment without anyone realize. Therefore, the objective of this project is to construct the life cycle assessment (LCA) to obtain the environmental impact assessment of the milling process on the CNC 3D router and to analyze the relation of environmental impact assessment with the CNC 3D router. To achieve the objective, the literature review is very important to gain as much knowledge and information as possible to help carry out this project. The concept of sustainable development, eco-design, product and sustainability, and life cycle assessment will help generate environmental impact assessment using the GaBi software. Therefore, this GaBi software can help industries to detect what environmental impact of its manufacture. In addition, GaBi software also helps the researchers to get to know extra knowledge regarding the input and output for the LCA process. According to the findings of the study, compressed air consumption during the milling process has an impact on the sustainability of the environment since it scores highly for each possible environmental impact. Controlling environmental sustainability also heavily depends on the materials chosen during component production. In conclusion, modelling life cycle inventories is a reliable and possibly unique method for assessing the environmental effects of items holistically together with the life cycle impact assessment stage—as required by sustainable development.

ABSTRAK

Objektif projek ini adalah membina penilaian kitaran hayat (LCA) untuk mendapatkan penilaian kesan alam sekitar proses pengilangan pada penghala 3D CNC dan untuk menganalisis hubungan penilaian kesan alam sekitar dengan penghala 3D CNC. Untuk mencapai objektif, kajian literatur adalah sangat penting untuk mendapatkan sebanyak mungkin pengetahuan dan maklumat untuk membantu melaksanakan projek ini. Konsep pembangunan mampan, reka bentuk eko, produk dan kemampanan, dan penilaian kitaran hayat akan membantu dalam menjana penilaian kesan alam sekitar dengan menggunakan perisian GaBi. Oleh itu, objektif kajian dihasilkan berdasarkan masalah. Masalah yang wujud ialah proses pemesinan telah menyumbang impak yang besar kepada alam sekitar tanpa disedari oleh sesiapa. Oleh itu, perisian GaBi ini boleh membantu industri untuk mengesan kesan alam sekitar daripada pembuatannya. Di samping itu, perisian GaBi juga membantu penyelidik untuk mengetahui pengetahuan tambahan mengenai input dan output untuk proses LCA. Menurut penemuan kajian, penggunaan udara termampat semasa proses pengilangan mempunyai kesan ke atas kemampanan alam sekitar kerana ia mendapat markah tinggi untuk setiap kemungkinan kesan alam sekitar. Mengawal kemampanan alam sekitar juga sangat bergantung pada bahan yang dipilih semasa pengeluaran komponen. Kesimpulannya, pemodelan inventori kitaran hayat ialah kaedah yang boleh dipercayai dan mungkin unik untuk menilai kesan alam sekitar item secara holistik bersama-sama dengan peringkat penilaian kesan kitaran hayat seperti yang diperlukan oleh pembangunan mampan.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my main supervisor, Mrs Umi Hayati Binti Ahmad, Faculty of Mechanical and Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka (UTeM) for all her support, advice and inspiration. Her constant patience for guiding and providing priceless insights will forever be remembered. Also, to my co-supervisor, Assoc. Dr. Hambali Bin Boejang, Universiti Teknikal Malaysia Melaka (UTeM) who constantly supported my journey. My special thanks go to Prof Dr. Lau Kok Tee and En. Faizal Bin Halim for all the help and support I received from them.

Last but not least, from the bottom of my heart a gratitude to my beloved parents, Zakaria Bin Awang Ahmad and Ramlah Binti Hj Hossen for their endless support, love and prayers. Finally, thank you to all the individual(s) who had provided me the assistance, support and inspiration to embark on my study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
LCA	-	Life Cycle Assessment
EIA	-	Environmental Impact Assessment
CNC	-	Computerize Numerical Control
GWP	-	Global Warming Potential
D4S	-	Design for Sustainability
IAIA	-	International Association for Impact Assessment
CSR	-	Corporate Social Responsibility

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, the sub-topic that is included are, the project background regarding the environmental impact assessment, sustainable development, life cycle analysis, and computer numerical control (CNC). This chapter also include the problem statement of this research, research objective, the scope of research, and summary for all sub-topics.

1.2 Background

Up to 1970, technical performance and economic costs and benefits were included while evaluating development initiatives. The environmental ramifications were not being carefully looked into. Due to the growing public concern about the quality of the human environment, several development projects that were built and operated that caused significant environmental harm was extensively covered in the media. The unintended negative effects of non-profit initiatives, including spraying DDT to control insect vectors and save valuable crops, were also being apparent at the time. Due to these conditions, there is now an increasing call for decisions about such measures to take into account any potential environmental effects.

Environmental impact assessment (EIA) combines art and science in one process. While technical analysis in the process is founded on scientific concepts, management parts of EIA are an art. EIA offers a methodical analysis of the environmental effects of suggested actions and alternatives to aid in decision-making. The decision-makers are helped in making choices that are more likely to result in projects that are sustainable by the cost-benefit and trade-off evaluations between the implementation of the project and associated environmental expenses. EIA also serves as a foundation for discussions between regulators, public interest organizations, and developers in order to strike a balance between development and the environment. For attaining sustainable development, EIA has been regarded as a crucial management tool. Figure 1 below shows an example of steps taken to conduct environmental impact assessment.

The previous study regarding the environmental impact assessment was conducted in Nepal. Although development initiatives are crucial to Nepal's economic development, some of the earlier initiatives have undermined the basic foundation of sustainable development by overusing natural resources without regard for the preservation of environmental quality. Without adequate management and the replenishment of Nepal's environmental basis, economic progress cannot be sustained. It must be understood that conservation and development go hand in hand. EIA is likely the most straightforward and efficient method of merging the goals of conservation and development in the current scenario in Nepal, where development is mostly project-led. This was acknowledged in HMG's National Conservation Strategy and Nepal's seven five-year plans, which foresaw the future construction of an EIA system and required the completion of an EIA for any significant development before receiving the appropriate government department's permission. A thorough assessment of the environmental implications of development projects is another requirement of the eight five-year plans (NPC/HMG/IUCN, 1993).

Sustainable development, according to the Brundtland Commission (1987), is "development that satisfies the demands of the present generation without jeopardizing the ability of the future generation to satisfy their own needs." This means that in addition to human and human-made wealth, we should also leave behind natural capital like trees and clean air for future generations. EIA may positively affect the development of the nations' sustainability by assisting in ensuring that projects are planned in ecologically and sensitive manner.

Life cycle assessment on the other hand, also known as cradle-to-grave or cradle-to-cradle analysis, is a method for evaluating the environmental effects of all phases of a product's life, from the extraction of raw materials to their processing, manufacture, distribution, and consumption (Environmental Management, 2017). The study of the life cycle phases' contributions to the total environmental load, often with the goal of prioritizing changes to goods or processes, and the comparison of products for internal use are the most crucial applications. Figure 1.2-1 below shows the example of life cycle assessment framework.

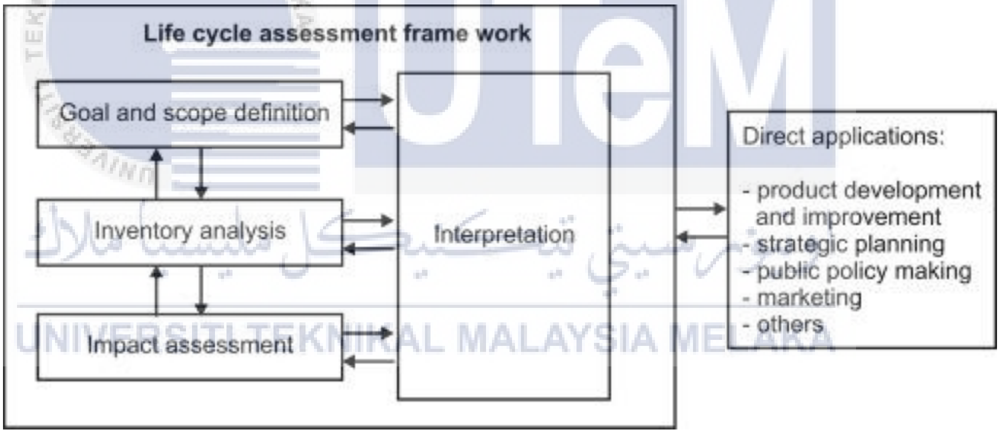

Figure 1.2-1 : Example of life cycle assessment framework

The LCA community learned in the 1990s that data documentation is just as important as data itself. Rarely was meta information supplied on the geographic, temporal, or technical validity of LCI data (neither in a structured way nor otherwise). The creation of a data documentation format was started by the Society for the Promotion of Life Cycle Assessment Development (SPOLD) (Weidema, 1999), which enables thorough documenting of LCI data for processes and services. To promote acceptability and data format compatibility, many significant LCA software suppliers were involved in the creation of SPOLD. The SPINE data reporting and interchange format was the outcome of a concurrent, largely compatible development (Carlson et al., 1995). This allows for the documenting of meta information using text data fields and was developed concurrently with the construction of the SPINE database. To establish the data documentation format for life cycle inventory data, the International Standards Organization (ISO) decided to produce a technical standard in 2001, (ISO 14048, 2001). The format is divided into three sections namely, modelling and validation, process [Process description, Inputs and outputs (environmental exchanges)], and administrative information.

On the other hand, Computerized Numerical Control (CNC) machines are broadly used all over the world. There are many different types of CNC machines on the market such as CNC Milling Machine, CNC Router, CNC Plasma Cutting Machine, CNC Lathe Machine, CNC Laser Cutting Machine, CNC Waterjet Cutting Machine, CNC Electrical Discharge Machine, and CNC Grinder.

Figure 1.2-2 shows the CNC 3D router made by a group of students developed by Talent Development Program to enhance their design and machining skills as a preparation to face the real-world industry.

Figure 1.2-2 : V2 CNC 3D router

1.3 Problem Statement

Nowadays, industrial which are using machine as processing is very wide across the world. As the technologies growing rapidly, machines are created to ease the job in many ways. From manufacturing to processing to packaging, machines have been the most reliable things that ever created. On the negative side, the machining process has contributed a large impact on the environment without anyone realized. There are many types of environmental issues that happened nowadays such as air pollution, global warming, deforestation, water pollution, etc. This study could help detecting the type of environmental impact assessment from using the milling machine.

1.4 Research Objective

This research aims to study the type of environmental impact assessment (EIA) from fabricating the aluminum part by using the milling machine. Specifically, the objectives are as follows:

a) To construct the life cycle assessment (LCA) and obtain the environmental impact assessment of milling process on CNC 3D router.

b) To analyze the relation of environmental impact assessment with CNC 3D router.

1.5 Scope of Research

To identify and review the inputs needed to conduct appropriate environmental impact assessment at different stages of the product lifecycle. The scope of this research is as follows:

i. Approach to conducting environmental impact assessment to identify the environmental issues.

ii. Environmental impact assessment will be conduct by using Gabi software as analysis.
iii. The assessment is only focusing on fabricated part using the milling process.
iv. The result will be only focusing on Global Warming Potential (GWP).

1.6 Summary

To summarize, having an industry with high technology machining is very important but the technology used need to be parallel with good health environment because a true futuristic industry is the one who care with social, economic, and environmental health. Other than that, Computerized Numerical Control (CNC) is an important course that needs to be discovered and learned by every level of students. Usually, the most student knows about CNC machine when they are at the college level. This need to be improved so that even in high school, students are exposed to these particular courses to get a brighter future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is a thorough summary of prior research on a particular area of research. The literature review examines academic papers, books, and other materials that are pertinent to a certain study topic. This past study should be included, described, summarized, objectively evaluated, and clarified in the review. This chapter includes the sub-topic about the environmental impact assessment together with its classification which is life cycle assessment. Other than that, this chapter also discusses the environmental impact assessment's benefits and its guideline for the user.

2.2 Milling Machine

Activities related to manufacturing account for 31% of global energy consumption (T. Herzog, 2005) and 19% of global greenhouse gas emissions (Annual energy review, 2008). Due to its magnitude and significance, machining is a manufacturing process that has been heavily targeted for energy reduction. Global machine tool sales alone were predicted to reach \$82 billion in 2008 and \$71 billion in 2007 (S. Kalakjian, 1997). A workpiece or work (the manufactured item), a tool (which removes material), and a machine can all be thought of as components of the machining process, which is broadly defined as all material removal operations (Metalworking Insider's Report, 2009). A machine tool is the collective term for the machine and the tool. While numerous machine tool types are employed for varied tasks, milling machine tools represent a significant subset.

The cutting technique known as milling involves moving the tool in relation to the workpiece in a predetermined volume while rotating on one axis. The parts of a typical vertical milling machine tool are shown in Figure 2.2-1. In this illustration, the workpiece is fixed to a table that swivels in a horizontal plane. The tool is rotated by the spindle, and both are moved vertically. A lead or ball screw that is coupled to motors or axis drives, is guided by ways, and is controlled by the machine control unit or controller to give translational motion. The machine tool frame, which offers rigidity and damping, is made up of the bed/base and column. The thermal control unit (reduces thermal errors), the lubrication lines (lubricates the moving elements), and the cutting fluid system (delivers cutting fluid to the workpiece) are additional parts that are not included in Figure 2.2-1.

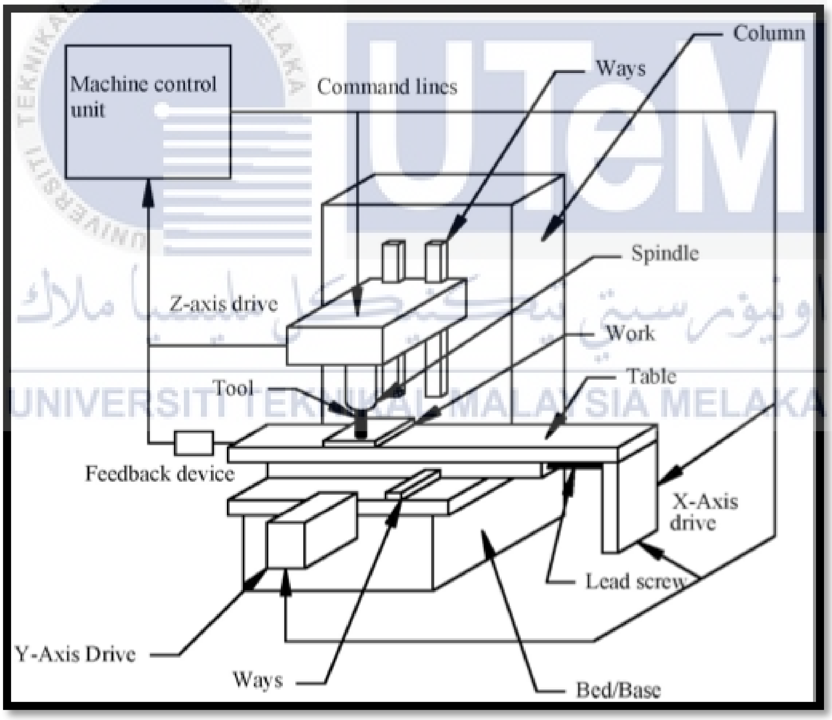

Figure 2.2-1 : Typical vertical milling machine

A machine tool must have a source of energy or relative motion, a way to secure the workpiece, secure and orient the tool, and the ability to regulate the source of energy or motion, the workpiece's orientation, and the tool's orientation (Domfeld & Lee, 2008).