Faculty of Mechanical and Manufacturing Engineering Technology

ESTABLISHMENT OF AUTONOMOUS MAINTENANCE PROGRAMME TO ENHANCE EFFICIENCY OF EDM MACHINES

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DECLARATION

I declare that this project entitled "ESTABLISHMENT OF AUTONOMOUS MAINTENANCE PROGRAMME TO ENHANCE EFFICIENCY OF EDM MACHINES" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : TANG LAI EE

Date : 17 / 01 / 2022

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 Manufacturing Engineering Technology (BMMW) with Honours.

Signature : .....

Supervisor Name : PROF. MADYA TS. DR. WAN HASRULNIZZAM BIN WAN MAHMOOD

Date : 18/1/2022

DEDICATION

To my beloved family especially to my parents :

Mr. Tang Chee Khuan and Mrs. Voon Mee Leng

To my respected supervisor :

Prof. Madya Ts. Dr. Wan Hasrulnizzam Bin Wan Mahmood

To my supportive friends in UTeM :

Especially for my coursemates from BMMW and housemates

ABSTRACT

Electric Discharge Machining (EDM) is a broadly utilized machining method in the industry as it can cut complicated pieces and hard materials. It is a method of controlled material removal in which a high frequency electric spark is utilized to erode the work piece. Repetitive routines are often carried out on the EDM machines in the industry, but this project focuses on the EDM machines employed in the FTKMP laboratory where the machines are often use for different processes with different parameters and materials. This project studies and investigates the *Fuguai* or abnormalities found on the EDM machines and develop an ideal AM programme to enhance the functionality and safety of EDM machines. The implementation of AM is to eliminate *fuguai* on the machine by involving both operators and maintenance activities. AM improves overall machine efficiency and simulates higher consciousness on machine maintenance among machine operators. The process of identification of *fuguai* is applied by *fuguai* tagging using f-tags. The *fuguai* are divided into three categories which are physical, safety and function. 8 types of fuguai are identified in this project which are dust, dirt, leftover items, disorganized items, rusty parts, broken parts, missing components and loosen components. The results show the most critical machine area is the machine bed and the highest occurrence *fuguai* is rusty parts. 34 out of 42 identified *fuguai* are tagged in blue f-tags which indicates most of the *fuguai* can be resolve by operators. Almost all *fuguai* are eliminated, however, there are a few *fuguai* which are not eliminated as they require higher technical knowledge to resolve. Elimination of *fuguai* are presented through One Point Lesson (OPL) and the steps are layout in detail.

ABSTRAK

Pemesinan Nyahcas Elektrik (EDM) ialah kaedah pemesinan yang digunakan secara meluas dalam industri kerana kaedah ini boleh memotong kepingan yang rumit dan bahan keras. EDM adalah kaedah penyingkiran bahan terkawal di mana percikan elektrik frekuensi tinggi digunakan untuk menghakis bahan kerja. Rutin berulang sering dijalankan pada mesin EDM dalam industri, tetapi projek ini memfokuskan pada mesin EDM yang digunakan di makmal FTKMP di mana mesin sering digunakan untuk proses yang berbeza dengan parameter dan bahan yang berbeza. Projek ini mengkaji dan menyiasat *Fuguai* atau keabnormalan yang terdapat pada mesin EDM dan membangunkan program AM yang ideal untuk meningkatkan fungsi dan keselamatan mesin EDM. Pelaksanaan AM adalah untuk menghapuskan *fuguai* pada mesin dengan melibatkan kedua-dua operator dan aktiviti penyelenggaraan. AM meningkatkan kecekapan mesin secara keseluruhan dan mensimulasikan kesedaran yang lebih tinggi tentang penyelenggaraan mesin di kalangan pengendali mesin. Proses pengecaman *fuguai* diaplikasikan dengan penandaan fuguai menggunakan tag-f. *Fuguai* dibahagikan kepada tiga kategori iaitu fizikal, keselamatan dan fungsi. 8 jenis fuguai dikenal pasti dalam projek ini iaitu habuk, kotoran, barang tertinggal, barang tidak tersusun, bahagian berkarat, bahagian pecah, komponen hilang dan komponen longgar. Keputusan menunjukkan kawasan mesin yang paling kritikal ialah tempat tidur mesin dan kejadian fuguai paling tinggi ialah bahagian berkarat. 34 daripada 42 fuguai yang dikenal pasti ditandakan dalam tag-f biru yang menunjukkan kebanyakan fuguai boleh diselesaikan oleh pengendali. Hampir semua *fuguai* dihapuskan, bagaimanapun, terdapat beberapa *fuguai* yang tidak dihapuskan kerana ia memerlukan pengetahuan teknikal yang lebih tinggi untuk menyelesaikannya. Penghapusan *fuguai* dibentangkan melalui One Point Lesson (OPL) dan terperinci dengan langkah-langkah.

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LIST OF SYMBOLS AND ABBREVIATIONS

AM	-	Autonomous Maintenance
EDM	-	Electrical Discharge Machining
F-tags	-	*Fuguai* Tags
FTKMP	-	Faculty of Mechanical and Manufacturing Engineering Technology
JIPM	-	Japan Institute of Plant Maintenance
OPL	-	One Point Lesson
TPM	-	Total Productive Maintenance
UTeM	-	Universiti Teknikal Malaysia Melaka

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CHAPTER 1

INTRODUCTION

1.1 Background

In the field of manufacturing, there are a great deal of machinery with different functions are employed to complete relative tasks. From the available variety of machineries, Electrical Discharge Machining (EDM) machines are of the machines that are widely utilized in the manufacturing industry. Electric discharge machining (EDM) is one of the most widely used machining technologies today because it can cut complicated pieces and hard materials (Ming et al., 2021). Although the usage of EDM machines is emerging in the manufacturing industry but the cost of owning one is still costly. To own EDM machines, a big amount of initial investment capital is required and consistent cost for maintaining the components and parts of the machine are also needed. In returning to the high investment cost on the EDM machine, maintenance plays an important role for the upkeep of machine performance. Breakdown on machines might occur after a long run if proper maintenance is not carried out.

A range of consequences from simple replacement of components to fatal accidents that may cost millions in production losses, injuries or environmental pollution can be caused by malfunctioning of machines (Li et al., 2017). The company or owner of the machine may encounter high maintenance cost when severe machine breakdown occurs as it requires highly skilled personal for the repair activity. The case study by Bengtsson and Kurdve (2016) points out that tools cost are higher than labour cost and the aim to work with a lower cost and minimum losses while aligning

with the production goals is important in the industry. Maintenance is important as it can extend the lifespan of the machine, improves availability and retain the optimum machine performance (Asjad & Khan, 2016). Proper maintenance implementation is introduced to preserve the tool life of the components of machine and to make full use of the expected lifespan of machine.

The concept of maintenance is drawn deeper in autonomous maintenance. Autonomous maintenance carries the concept whereby relatively simple maintenance task are carried out by machine operators to keep the machine at its best functional condition. The main aim of autonomous maintenance is to eliminate abnormalities on the machine by involving both operators and maintenance activities (Kosicka et al., 2019). Furthermore, the implementation of autonomous maintenance is to perform daily maintenance to reduce deterioration of machine, ensure machine at ideal functional state and to educate operators on basic maintenance activities (Sun, 2019). The deployment of autonomous maintenance is important for the overall improvement of machine efficiency and to simulate a higher consciousness among machine operators in the concept of maintenance on the machine. By maintaining the condition of equipment, machine operators will be able to prevent mechanical accidents under a safe working environment. A successful implementation of autonomous maintenance leads to the goal of zero breakdowns, zero accidents and zero defects.

1.2 Problem statement

Electrical Discharge Machining (EDM) machines are regularly operated in the laboratory of Faculty of Mechanical and Manufacturing Engineering Technology also known as FTKMP in Universiti Teknikal Malaysia Melaka (UTeM). In the industry, repetitive routines are often carried out on the EDM machines but in the FTKMP laboratory, the machines are used for different processes with different parameters and materials. The functionality of the machine will be affected if maintenance is not carried out regularly. It is important to carry out proper maintenance on the EDM machines to restore the optimum performance of the machine and for the safety of machine users. The accumulation of problems on the machine over a period will lead to severe machine breakdown and this will cause the authority to bare a large cost for machine repairing fees. On the other hand, the breakdown of the machine may lead to severe consequences such as explosion and fatal accidents when proper actions are not treated at instance. These situations are dangerous to the students who are frequently using the machine. Consequently, it is critical to develop an autonomous maintenance programme for the EDM machines so that early detection of abnormalities on the machine can be investigated to prevent unfortunate situations.

1.3 Objectives

The main objectives of this study are:

a. To study an ideal autonomous maintenance programme for the EDM machines.

b. To investigate *fuguai* (abnormalities) on the EDM machines as a preventive measure before machine failure occurs.

c. To enhance the functionality and safety of EDM machines.

1.4 Scope of Project

This project focus on the development of autonomous maintenance programme for EDM machines in the FTKMP laboratory in UTeM. This project is conducted under the guidance of laboratory assistant who expertise in the EDM machines. The project mains on the application of steps in autonomous maintenance. The project is started from March 2021 to January 2022. The findings from this project are based on laboratory job shop for academic purpose and not for industrial application. Hence, the results may not be applicable for other types of EDM machines.

1.5 Importance of Project

The importance of the project are:

a. To establish a suitable machine maintenance routine for early detection of abnormalities and be able to prevent burdensome repairing fees.

b. To commence a favourable workplace which is clean and safe to minimize the occurrence of accidents.

c. To improve the machine availability and extends the life span of machine.

d. To enhance the consciousness of students towards importance of machine maintenance for academical purposes.

e. To prepare students for future industrial working environment by strengthening their machine maintenance knowledge.

1.6 Outline of the Project

This project started with chapter 1 introducing the background of the project, stating the problem statement and objectives, defying the scope of project and stating the importance of project.

Chapter 2 mains on the literature review. Literature review on the concept related to maintenance specifically on autonomous maintenance and review on the EDM machines are described in this chapter.

Chapter 3 depicts the research methodology. This chapter shows the details in designing of the project and the method for data collection. The details of the project design flow are demonstrated with the aid of flowcharts and gantt charts while data collection methods, analytical methods and *Fuguai* investigations are described further in this chapter.

Chapter 4 shows the analysis and discussion on the results obtained. This chapter displays the data obtained and visualize the data through tables, charts and graphs. The countermeasures towards each identified *fuguai* are demonstrated and described through OPL and detailed steps.

Chapter 5 draws the conclusion of this project by summarising the data and countermeasures throughout the project. Future recommendations for improvements are also described in this chapter.