



Faculty of Manufacturing Engineering

**MONITORING SYSTEMATIC CONTROL SYSTEM FOR
ELECTRODES USAGE AT EDM SECTION**

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**Master of Manufacturing Engineering
(Manufacturing System Engineering)**

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**MONITORING SYSTEMATIC CONTROL SYSTEM FOR ELECTRODES USAGE
AT EDM SECTION**

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A thesis submitted

in fulfillment of the requirements for the degree of

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DECLARATION

I declare that this thesis entitle “Monitoring systematic control system for electrodes usage at EDM section”: 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 candidate of any other degree.

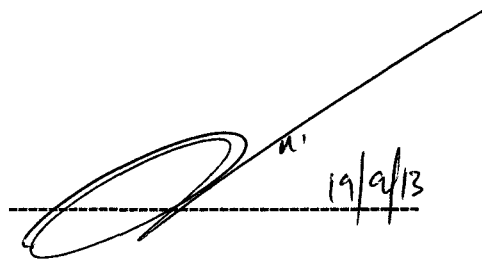
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Master of Manufacturing (Manufacturing System Engineering). The member of supervisory committee is as follow:

A handwritten signature in black ink, consisting of a large, stylized loop followed by a horizontal line and a diagonal stroke. To the right of the signature, the date '19/9/13' is written in a simple, handwritten style. The signature and date are positioned above a horizontal dashed line.

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ABSTRACT

EDM is a CNC machine that uses electrical energy to erode the workpiece material, which takes the form opposite electrodes. The type of electrode made of electrically conductive material such as copper and graphite. The study was conducted at a metal fabrication company seeks to control the use of copper electrodes in the production process. Thus the purpose of this study is to increase the productivity of EDM section and supported by three objectives: (i) identify factors in the loss of EDM electrodes, (ii) the data recorded on the use of EDM electrodes, (iii) clarify the relationship between time and costs in terms of new electrode and reused. Observations and interviews were used to identify problems in EDM. Ishikawa diagrams were selected to analyze the factors that contribute to this problem. Check sheet was used to record the use of electrodes to show the difference between the use of new electrode and reusable electrodes. The results indicate that there is no systematic system for recording data for electrodes in EDM section. Results also show that the use of time and cost differences between new electrodes and electrode reusable high impact in terms of production costs and production time. In conclusion, a systematic control system on the EDM will provide more benefits in terms of reducing the time and cost of the product.

ABSTRAK

EDM merupakan mesin CNC yang menggunakan tenaga elektrik untuk menghakis sekeping bahan kerja, yang mengambil bentuk bertentangan dengan elektrod. Jenis-jenis elektrod diperbuat daripada bahan konduktif elektrik seperti tembaga dan grafit. Kajian ini telah dijalankan di sebuah syarikat fabrikasi logam bertujuan untuk mengawal penggunaan elektrod tembaga dalam proses pengeluaran. Oleh itu tujuan kajian ini adalah untuk meningkatkan produktiviti pengeluaran di seksyen EDM dan disokong oleh tiga objektif : (i) mengenalpasti faktor kehilangan elektrod di bahagian EDM, (ii) merekodkan data penggunaan elektrod di bahagian EDM, (iii) menjelaskan hubungan antara masa dan kos dalam aspek elektrod baru dan digunakan semula. Pemerhatian dan temu bual telah digunakan untuk mengenal pasti masalah dalam EDM. Rajah Ishikawa telah dipilih untuk menganalisis faktor-faktor yang menyumbang kepada masalah ini. Lembaran semakan juga telah digunakan untuk merekodkan penggunaan elektrod untuk menunjukkan perbezaan diantara penggunaan elektrod baru dan elektrod yang diguna semula. Hasil daripada kajian menunjukkan bahawa tidak ada sistem yang sistematik untuk data rakaman untuk elektrod dalam seksyen EDM . Keputusan juga menunjukkan bahawa penggunaan perbezaan masa dan kos antara elektrod baru dan elektrod boleh digunakan semula memberikan impak tinggi dari segi kos pengeluaran dan masa pengeluaran. Kesimpulannya, sistem kawalan yang sistematik di bahagian EDM akan memberi lebih banyak manfaat dari segi mengurangkan masa dan kos produk.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

Cu	-	Copper
EDM	-	Electrical Discharge Machining
LM	-	Lean Manufacturing
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

This chapter presents the overview of the study including company background, problem statement, aim and objectives. All of that is explained in greater details later on.

1.0 Company Background

Impressive Edge is metal fabrication manufacturers involved in making high precision engineering and machining for mold, cavity, trim and form die sets, tungsten carbide precision parts and all kinds of precision spare parts for forgery. The main purpose in setting Impressive Edge is to isolate, manage and locally based customer service in Malacca and the surrounding area. Impressive Edge was appointed primarily to support and Infineon (Malaysia), Osram (Malaysia) and another company. Impressive Edge has begun to establish business relationship with Osram and Infineon's manufacturing site in Wuxi (China), Regensburg (Germany), Richmond (USA) and Osram (Germany).

This study will focus on Electrical discharge machining section. The process involves starting from customer requirement, the process to produce product and usage system. Basically the process involved at EDM section depends on requirements from the customer so Planning Department will identify the process involved in EDM section.

Process improvement is a systematic approach to improve the process. It will involve documentation, measurement, and analysis for the purpose of improving work processes. (Ismail, 2007).

There are several tools that organizations can be used to solve problems and improve processes. Seven QC tools are the basic tools that can be used to analyze production processes, identify problems, and provide solutions to prevent future disability. Seven QC tools used for the data collected and easy to understand and analyze (Douglas, 2005)

Seven QC tools known as(i)check sheet,(ii) Pareto charts, (iii)flow charts,(iv) histograms, (v)scatter diagrams, (vi)cause and effect diagram (vii) control chart. Check sheets can be used as an organized way to collect relevant data as a rough way to evaluate the process or as input to other studies (Stevenson, 2005).

1.2 Aim and Objectives

The aim of this study is to improve production productivity at EDM section. Thus, the main objectives of this study are:

- i) To identify root- causes of missing or misplaced electrodes at EDM section.
- ii) To monitor the control system for electrodes usage at EDM section.
- iii) To clarify the relationship between time and cost in the aspect of new and reused electrodes.

1.3 Summary

Impressive Edge which possessing productivity problem found it hard to improve the production productivity especially at the EDM section. Therefore, this study contributes improvements strategy towards higher production productivity achievement by using systematic control system as one of LM tools and techniques.

1.1 Problem Statement

Impressive Edge is one of a company that involved in the manufacture of high precision engineering mainly for the semiconductor industry committed to continuously improving their process and find better way to manage the production better every day. At EDM section many requirements for production depends on customer demands.

This study conducted at EDM section of the company. Based on the observation, there is no system for controlling the electrodes usage. In short, the EDM section doesn't have system to monitor and control the electrodes usage. As a result, the operators needs more time to search electrodes. In fact, the obsolete electrode also kept and causes more space needed for electrodes. Furthermore, there is no procedure to keep the electrodes.

Finally, these resulted in the operator incapability to complete the job on time. In the meant time, the production cost at EDM section has increased as more time needed to complete the job. Most of times a new electrode will be used of reuse electrodes due to missing or misplaced electrodes.

CHAPTER 2

LITERATURE REVIEW

This chapter embodies with the description of the literature relevant to EDM machine electrodes and the concept of lean manufacturing and it's in order to improve productivity at EDM section.

2.1 EDM process

Electrical discharge machining is CNC machine that uses electrical energy to erode the work piece, which takes a shape opposite to the electrode. The type of electrode is made of electrically conductive material such as copper and graphite. The die sinking electrode made in the form required and when discharge happened, electrode and work piece will be immersed in the dielectric fluid. This dielectric fluid should be a non- conductor.

Simao (2003) reported that a servo mechanism maintains a gap of 5-100 μm between an electrode and the work, preventing them from coming gap contact with each other. It is important that there be no physical contact between the electrode and the work piece. A direct current of low voltage and high amperage is delivered at the rate of approximately 20,000 hertz. These electrical energy impulses vaporize the oil at this point.

This permits the spark to jump the gap between the electrode and the work piece through the electric fluid. Intense heat is created in the localized area of the spark impact the metal

Habib (2009) reported a spark will bring about the melting of the metal work piece and the process is running continuously through a set of speed. The eroded particles will be carried away by the electric fluid, which is constantly being circulated and this process continues at the rate of over 2,000 cycles per second.

2.2 Copper Electrodes

Jaharah (2008) reported that tungsten copper alloy is a pseudo –alloy of one metal dispersed in a matrix of the other one. The microstructure is therefore, rather a metal matrix composite alloy material alloy. Copper true can be resulting in a heat-resistant, resistant to ablation, highly conductive of heat and electricity and is easy to machine. Figure 2.1 shows the differences of types of cooper. She reported that commonly copper electrode was used in the industry due to its good conductor, low electrode wear rate, machinability and good surface roughness.

Amorin and Weingaetner (2007) observed the effect of graphite and copper on the surface finishing using EDM machine and AISI P20 material. He reported that using copper electrodes with negative polarity, input parameter peak current and pulse ON-time will give the best result in surface roughness compared to graphite electrode.



Figure 2.1: Copper Electrodes

2.3 Lean Manufacturing

Lean Thinking is described as an antidote to waste as it can be used to reduce or eliminate waste. Lean Manufacturing is accepted and widely used by the vast majority of the world's major manufacturers. It comes in many forms and has many names (e.g., Toyota Production System, Nissan Production Way).

The implementation of lean strategy can improve the company's competitiveness which can results in the productivity improvement (Oliver et al., 1996; Doolen and Hacker, 2005).Some of research studies show that implementing of lean strategy will produce higher levels of quality and productivity and better response of customer (Krafcik, 1998; Nicholas, 1998).

2.3.1 Production Waste

Lean Principles in manufacturing can improve operating performance by focusing on the uninterrupted flow of products and materials through the value stream. To begin with, the various forms of manufacturing waste must be identified and eliminated. Waste can include any activity, step or process that does not add value for the end user or customer.

Waste is defined as anything that does not add value to the process or product from customer's perspective. Waste as identified by Ohno (1988) and Shingo (1989) in manufacturing and business is consists of seven major type of wastes.

According to Melton (2005), the elimination of waste will result in an improvement in manufacturing, but the key is to start with identifying both waste and value. The identification of value is originated by Ohno.

Wilson (2010) stated that the idea of creating value in product or service to customer is due to Ohno's perspective which reviews from the customer's perspective where he finally find the answer from this perspective, that was value. Table 2.1 shows the common wastes found in production as identified by Liker (2004).

Value as described by Ohno is as those things the customer is willing to pay for. The concept of value is basically to understand what a customer wants. As the value-added activities and non-value added activities from the customer's view can be identified, the wastes in a process can be easily defined (Sternberg, et al., 2012).

Table 2.1: The seven production waste (Liker, 2004)

NO	PRODUCTION WASTE	DESCRIPTION
1	Overproduction	Manufacture of products in advance or in excess of demand wastes money, time and space.
2	Waiting	This usually occur when a worker have to wait or watching or having to stand around waiting for the next process step, tool, supply, part, etc. This also may be due to no work to be done because of stock outs, lot processing delays, equipment downtime, and capacity bottleneck .
3	Transportation	Moving product between manufacturing processes adds no value, is expensive and can cause damage or product deterioration.

NO	PRODUCTION WASTE	DESCRIPTION
4	Unnecessary movement	Waste occur in term of employee's motion during performing the course of their work, such as looking for, reaching for, or stacking part, tools, walking and etc.
5	Excess Inventory	Excess raw material, WIP, or finished goods which lead to longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay.
6	Incorrect processing	Performing unneeded steps to process the parts.
7	Defects	This is due to the defective parts or correction that produces during production.

2.4 Root causes analysis

2.4.1 Ishikawa Diagram

Problem solving is a systematic process of reaching a solution or solutions to a concern or difficulty. The chosen process of problem solving is often determined by the degree of complexity of the concern presented. When the concern is relatively simple, an informal process occurs. However, as the concern grows in complexity, a more formalized, systematic process is followed. (Groover, 2007)

A proposed classification scheme for problem-solving tools allows the user to identify the correct tool at the proper time in the problem-solving process (Hagemeyer, C et al, 2006)

Based on study Salvador (2006), Ishikawa diagram fundamental diagrams created by Kaoru Ishikawa indicate that the source of certain events. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing the overall effect. Quality improvement is a continuous process, and it can always be taken one step further.

Hagemeyer, C (2006) reported that the systematic process of reaching a solution or solutions to a concern or difficulty is one way of problem solving step. The chosen process of problem solving is often determined by the degree of complexity of the concern presented. When the concern is relatively simple, an informal process occurs.

The technique uses a diagram-based approach for thinking through all of the possible causes of a problem. There are four steps to using Cause and Effect Analysis included are:

- (i) Identify the problem.
- (ii) Work out the major factors involved.
- (iii) Identify possible causes.
- (iv) Analyze the diagram.

Figure 2.2 shows that there are six of causes of Causes in the diagram are often based on a certain set of causes, such as the 6 M's, described below: Cause-and-effect diagrams can reveal key relationships among various variables, and the possible causes provide additional insight into process behavior (Salvador,2006).

- (i) People: Anyone involved with the process
- (ii) Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- (iii) Machines: Any equipment, computers, tools, etc. required to accomplish the job
- (iv) Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- (v) Measurements: Data generated from the process that are used to evaluate its quality
- (vi) Environment: The conditions, such as location, time, temperature, and culture in which the process operates

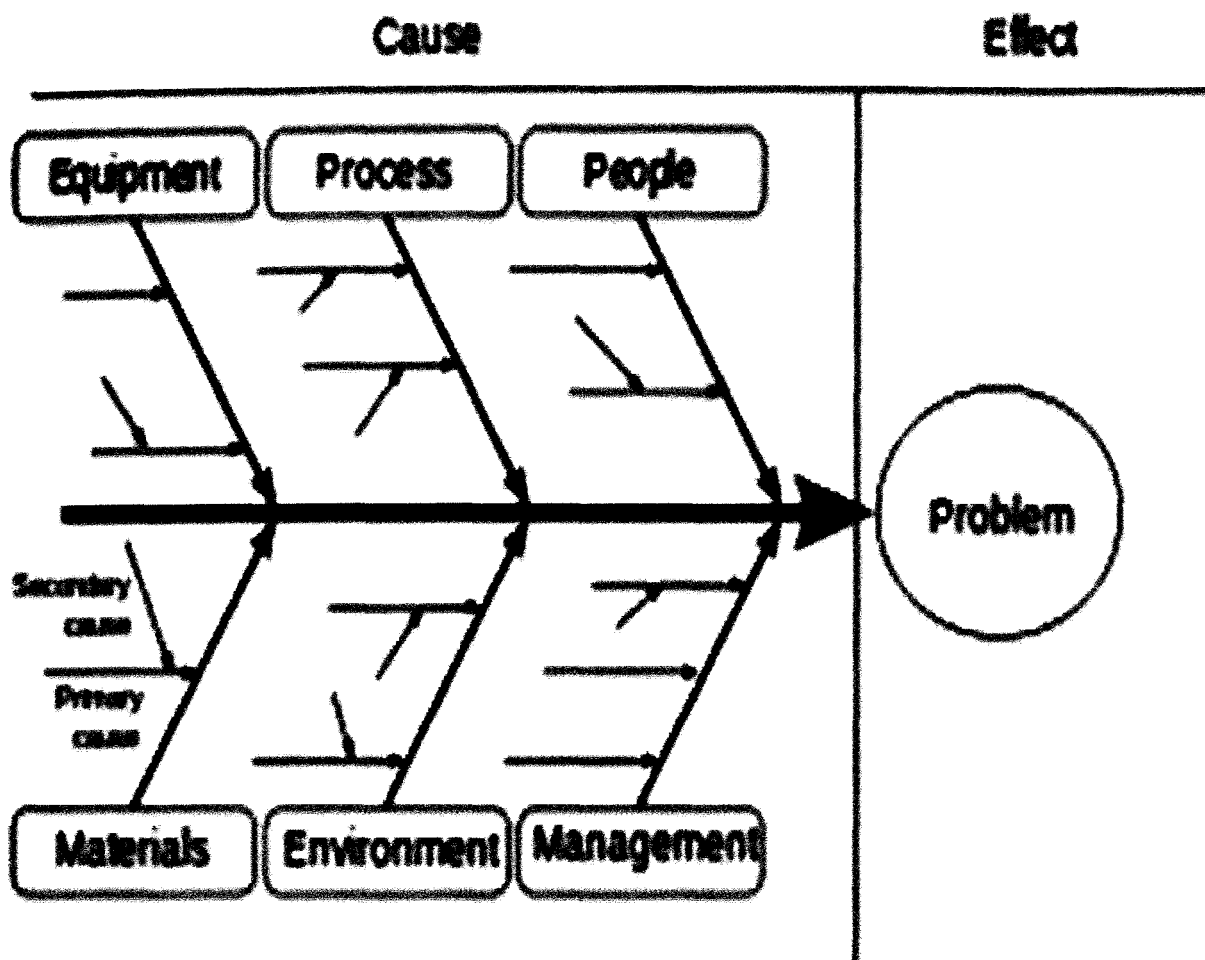


Figure 2.2: Fishbone Diagram (Salvador, 2006)

2.5 Inventory Control

A business enterprise can be successfully improving its operations by recognizing its critical operations which affect production, quality, and delivery capabilities of the organization (Kumar, 2003). To lead the profit losses in company the inaccurate inventory records are one of causation. Since of transaction errors, misplacement, shrinkage and various reasons the inventory records will not be correct. In order to eliminate inventory inaccuracy, companies may standardize the standard operation procedure (Gel, 2010).

The process and decisions make in the inventory is one of the key factors that can be influenced the production process. Types of electrodes that be used in the process are copper and tungsten. Both raw materials cannot be there long term because the raw material will turn to the increasing the cost. So the demand for the material only required depends on the increasing of order from customer (Anderson, 2009).

2.6 Manufacturing cost

Time is one of the key factors that can influence the cost of the production process. The use of time as a measure of value added in production performance (Stevenson, 2010). In such study, Novoa (2009) mentioned that reducing production time is a combination of eliminating unnecessary processing steps, reducing production defects and changing the current conditions so the steps which are currently necessary, but not valued added can be eliminated.

Many companies promote quality as the central customer value and consider it to be a critical success factor for achieving competitiveness. Any serious attempt to improve

quality must take into account the costs associated with achieving quality since the objective of continuous improvement programs is not only to meet customer requirements, but also to do it at the lowest cost (Groover, 2007).

Baines (1995) stated that companies must be competitive to sell their goods and services in the marketplace. Competitiveness is an important factor in determining whether a company prospers, barely gets by, or fails. Business organizations compete with one another in a variety of ways. These include price, quality, product or service differentiation, flexibility, time to perform certain activities, and service.

Value is a property of a product or service that the customer cares about and would be willing to pay for. Non value added is a property of a product or customer doesn't want to pay for such as the time losses in production line (Melton, 2005).

The cost of a product made by a manufacturing company is normally composed of three categories: direct materials, direct labor, and manufacturing overhead. Direct material is can explained as raw materials (Groover, 2007).

Materials are referred to as direct materials once they are put into production, Labor the cost of wages paid to factory workers involved in hands-on contact with the products being manufactured and Overhead cost indirect materials used in the production process may not appear in the finished product (Robbin, 2009).

2.7 Productivity improvements

Jagoda.K (2008) stated that to improve productivity there are several factors that must be considered and integrated. The most critical issue is identifying exactly what needs to be accomplished, and then through a series of steps discover methods that can be executed to achieve the desired goal.

Productivity can be defined as the application of the various resources which means the inputs of an organization, industry, or country in order to achieve certain planned and desired results or outputs (Baines, 1997). In other terms, productivity can be defined as value divided by time. By this definition, there are two primary ways to increase productivity, first is by increased the value created and second is decreased the time required to create that value (Pavlina, 2005).

Productivity depends, in a great extent, on technology and management. The main target of manufacturing activities is to increase value added. Once these duties are discharged, the companies produce their product and present it to the customers (Sumanth, 1995).

Management should review the meaning of the productivity itself before developing the strategy by Stevenson and Sum (2010). As the meaning of productivity can refer as creating more value, there is one great method a management can use in creating that value and yet it is the cheapest and easiest method to use. Its effectiveness has been proven in many industries which implement it. The method that is proven can helps to improve productivity is through lean strategy.

2.8 Summary

In general, systematic control system has numerous benefits and advantages to the organization which applied the concept. For an organization which desired to improve their productivity, this cheap and easiest method can be implemented successfully if one understands how to apply and when to apply the concept. Some of research studies show that implementing lean strategy will produce higher levels of quality and productivity and better response of customer. That is why systematic system practices are introduced in an attempt to solve the productivity problem at the manufacturing industry.

CHAPTER 3

METHODOLOGY

This chapter consists of a series of stages formulated in order to achieve the aim and objectives stated in Chapter 1. There are three stages that need to be implemented in this study. The descriptions and the flowcharts on how these stages are carried out are also included in this chapter. The data analysis in this chapter explains how the data is analyzed. The details on how it is being analyzed will be explained further in Chapter 4.

3.1 Planning and Activities

The planning and activities that have been carried out in the study are presented by the flow chart in Figure 3.1. Master project activities are divided into two phases; the master project I and the master project II. The Gantt chart shows the development of all the planning and actual activities that are conducted during the master project I and master project II from time to time (refer to Appendix A and Appendix B). Throughout master project I, the activity involved in the study is to identify the critical factors that significantly contribute to the problems faced by the company. Next, the second stage of this study which is carried out in master project II, focused on analyzed the data that was derived from the data collected during master project I. The successfulness of the method is presented in the result and discussion section.

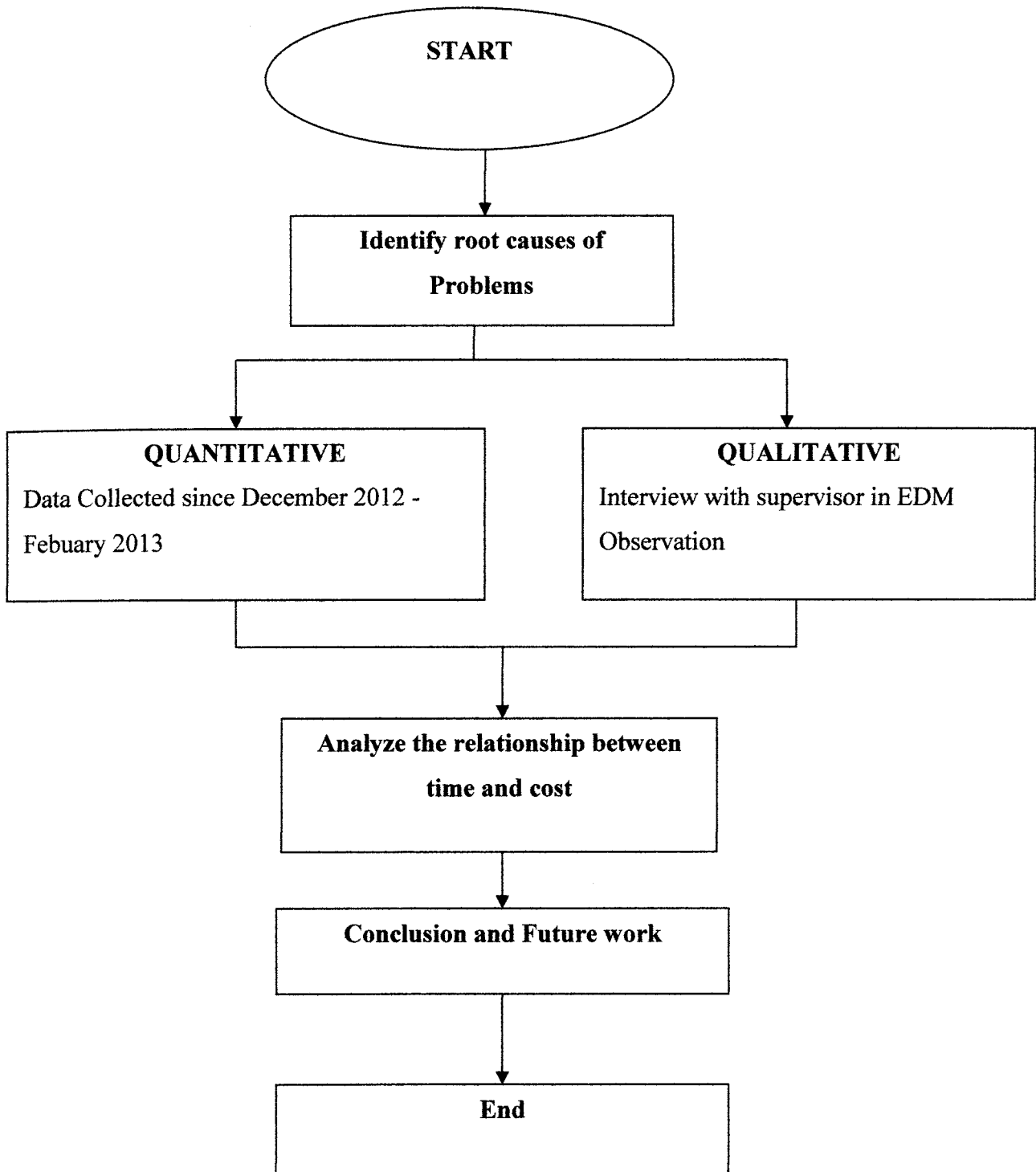


Figure 3.1: Flow process Chart

3.2 Project Methodology

This study is to develop a systematic control system for electrode usage at EDM section. In order to achieve the objective, there are following methodology will follow as a guideline of the study.

3.3 Data collection

Data collection is divided into two categories, which are the qualitative and quantitative data. These data were collected from several visits made to Impressive Edge. The frequency of the visit is planned for twice per month. However, it depends on the availability of the supervisor in charge and the management of the company. Table 3.1 shows the classification of the two types of data.

Table 3.1: The quantitative and qualitative data

Quantitative Data	Qualitative Data
<ul style="list-style-type: none">• Daily production records	<ul style="list-style-type: none">• Interview• Observation

3.3.1 Quantitative Data

The sample size for quantitative data is collected for three consecutive months starting from December 2012 until February 2013, which is the period to monitor the electrodes system in EDM section.

3.3.2 Qualitative Data

Qualitative data is collected through interviews with the staff of the company. Besides that, the process flow and the way the workers perform the job are always observed and monitored.

a. Interview

An open interview has been conducted with EDM section. This type of interview does not restrict the number or type of questions asked. The purposes of conducting the interview are to find out:

- i) The problem that the EDM section has faced recently
- ii) The current production strategies in an attempt to tackle the problem
- iii) The process flow to keep the electrodes
- iv) The details about the data collected

b. Observation

The objectives of the observations are:

- i) to study the process flow in EDM section
- ii) to observe on how the workers carry out the work

3.4 Identifying root and causes of missing and misplaced at EDM section

The first stage of the study focused on identifying the critical factors which contribute to the uncontrolled electrodes usage. The process flow in this stage is represented in Figure 3.2.

3.4.1 Data Collection

The data required in this stage are:

- i) Interview
- ii) Observation

3.4.2 Data Analysis

Problem solving and decision making are important skills for business and life. Problem-solving often involves decision-making, and decision-making is especially important for management and leadership. Harrington (1991) stated that problem-solving tools assist the problem solver to efficiently and effectively.

The Ishikawa Diagram is used to analyze the major factors which affect the uncontrolled electrodes usage in EDM section. Ishikawa diagram has been used to identify the root causes at EDM section.

The four categories have been identified are:

- i) **Man Power:** Machinist that operated machine must have the skill to produce electrodes. Machinist has also had to follow standard operation procedure in EDM section.
- ii) **Methods:** In EDM section, there is no systematic system to store the electrodes. According to misplaced and missing, by developing systematic recording system time consuming by searching electrodes in EDM section can be reduced. A check sheet has been prepared to record the electrodes in EDM section. The records of electrodes have been categories new and reuse.
- iii) **Machines:** In this study, machine that involved is EDM machine.
- iv) **Materials:** Data recorded only cover for utilization of copper electrodes

However this study focuses only on method to monitor the electrodes records in EDM section. The collected data are from December 2012 to February 2013.