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JUDUL: PRODUCTIVITY IMPROVEMENT USING INDUSTRIAL ENGINEERING TOOLS (SME COMPANY)

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PRODUCTIVITY IMPROVEMENT
USING INDUSTRIAL ENGINEERING TOOLS (SMEs COMPANY)

MOHD SHAFIE BIN SULAIMAN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
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EXAMINERS APPROVAL DOCUMENT

UNIVERSITI MALAYSIA PAHANG

FACULTY OF MECHANICAL ENGINEERING

I certify that the thesis entitled "Productivity Improvement using Industrial Engineering Tools (SME Company)" is written by Mohd Shafie bin Sulaiman. I have examined the final copy of this thesis and in my opinion, it is fully adequate in terms of language standard and report formatting required for the award of the degree of Bachelor of Engineering. I herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering.

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I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

Special dedication to my family members and that always inspire, love and stand beside me, my supervisor, and ex-supervisor, my beloved friends, my fellow colleagues, all Faculty of Mechanical lecturers and members.

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ABSTRACT

The aim of this study is to study the implementation of industrial engineering tools in selected manufacturing company to identify the highest defects occurred at the company production lines and propose new methods to the selected manufacturing company for defects reduction and thus improve the productivity of the company. The chosen company is Global Factor Sdn Bhd and the product being analyzed is marker pen. The production process of marker pen is studied to understand the overall process flow before the studied can be starts. The study mainly focuses on 7 Quality Control but not all of the tools are used in this study research. The selected tools used are Check Sheet, Pareto Diagram, Cause and Effect Diagram, and Flowchart. The main product in this company is marker pen which are almost totally the process is in house production. Every product defects is jotted down into check sheet. Next, the data is arranged in descending from the highest frequency to the lowest frequency defects to form a pareto chart. So, the highest frequency can be determined to analysis purpose. Miss printing shots has the highest frequency thus selected to be analyzed. Then, the cause and effect diagram is drawn as the miss printing shots is the effect while the cause of effect is determined by 4M (Machine, Man, Method, and Material). From cause and effect diagram, only a few causes that contributes the most to defects is selected to be discussed with the operator of the machine. The solution to the problems is suggested to the company to apply. One of the solutions is combine the used printing film with the new printing film using cellophane tape. The cost involved in the implementation of new method is calculated. The result of the new and the original method is compared to review the performance of the company. The result of comparison of the new and the original method is the answer of the improvement of the productivity.

ABSTRAK

Tujuan utama kajian ini dijalankan adalah untuk melaksanakan teknik industri di syarikat di industri kecil dan sederhana (IKS) yang dipilih untuk mencari kecacatan tertinggi yang berlaku di pemprosesan di kilang tersebut dan mencadangkan penyelesaian terbaik untuk mengurangkan kecacatan yang akan berlaku di syarikat IKS yang dipilih sehingga meningkatkan produktiviti syarikat. Syarikat yang dipilih untuk menjalankan kajian ini ialah Global Factor Sdn Bhd milik bumiputera. Penyelidikan ini tertumpu pada "7 Quality Control Tools" yang merupakan teknik yang digunakan dalam teknik industri. Proses pengeluaran produk di kilang tersebut haruslah difahami untuk melancarkan kajian penyelidikan keatas produk yang ada di kilang tersebut. Produk utama di kilang Global Factor Sdn Bhd ialah marker pen yang dihasilkan sepenuhnya di kilang tersebut. Setiap frekuensi kecatatan produk di kilang tersebut direkodkan ke dalam check sheet yang disediakan. Kemudian, data-data yang direkod itu disusun mengikut turutan dari frekuensi kecatatan yang paling tinggi ke frekuensi yang paling rendah untuk diterjemahkan ke dalam pareto chart. Dengan secara langsung, kecatatan yang paling banyak berlaku dapat dikenali dan dipilih untuk dijalankan analisis secara lebih mendalam. Tembakan percetakan yang terlepas memiliki frekuensi kecatatan yang tertinggi dan dipilih untuk dianalisis. Seterusnya, cause and effect diagram dilakar untuk tembakan percetakan yang terlepas dan sebab-sebab berlakunya kecacatan harus dicatatkan melalui 4M iaitu "Methods","Machines","Mans" dan "Materials". Melalui cause and effect diagram ini, hanya beberapa sebab yang terbesar yang menyumbang kepada frekuensi kecacatan tertinggi sahaja akan dipilih untuk dibincangkan. Melalui kaedah ini, beberapa penyelesaian telah dicadangkan kepada Global Factor Sdn Bhd. Antara penyelesaiannya ialah mencantumkan gulungan film yang baru dengan gulungan film yang lama menggunakan pita selofan. Pengurangan kos untuk penyelesaian yang dicadangkan dikira untuk meningkatkan produktiviti syarikat.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview of The Project

Many organisations are nowadays interested to adopt lean manufacturing strategy that would enable them to compete in this competitive globalisation market. Lean manufacturing is becoming lean enterprise by treating its customers and suppliers as partners. This gives the extra edge in today's cost and time competitive markets (Hudli and Inamdar, 2010).

To compute in competitive world, the SME, have the alternative to strike for world class performance through implementation of Lean Manufacturing (Rose, 2009). Various industrial engineering technique and tools is implementing in this study in order to investigate and solve the problem that occurs in the company. The tools selected to used in this company is industrial engineering tools.

Data for the selected department are collected, studied and analyzed. The defect with the highest frequency will be the main target to be improved. Various causes of the defect will be analyzed and various solving method will be present. The best solving method will be chosen and propose to the company and will be compared to the previous result or production. The improvement of productivity is the result of comparing the previous result with the new result after the implementation of the new method proposed.

1.2 Problem Statement

Nowadays, the most important goal for almost all company whether small or medium size of business is to increase the productivity in order to fight the competitiveness challenge. They are many strategies and methods exist by which productivity could be analyzed and improved.

Simulation software such as Quest, ProModel, and WITNESS allow users to build several layout of the company and identify the problems faced and hence improve the productivity of the company. Another method that can be used in this study is industrial engineering tools. Many industrial engineering tools can be used to improve the productivity of production, services and management. However, the analysis of problems consume of longer time compare with the simulation software.

This study tries to identify the defects occurs on products, and hence overcome to reduce the defect that occurred during the productivity process. The existance of defect could affect the production costs. The reduced cost could be increase the sales hence increase the profit to the company.

1.3 Objectives

Objectives of this study are to achieve the following:

(i) To implement industrial engineering tools in selected SMEs company.
(ii) To identify the highest frequency defects existed in the selected SMEs company.
(iii) To propose the best solution to overcome the problem to the company.
(iv) To improve the productivity of the company.

1.4 Scope

The scope of this study are:

(i) Research was done at Global Factor Sdn Bhd, a SMEs company fully owned by Malaysian citizen.

(ii) The study mainly focuses on 7 Quality Control tools but only selected Quality Control tools are applied. They are Check Sheet, Pareto Chart, Cause and Effect Diagram and Flow Chart.

(iii) This project evaluate the effectiveness of company production performance based on the current company achievement using the industrial engineering tools.

1.5 Expected Outcome

At the end of this study, the findings could identify the main cause and possible solutions for the studied SME. Therefore, the new process or system could increase productivity and also will eliminates identified defect.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the tools in the industrial engineering to be applied to small and medium sized companies. Productivity, performance and quality is always focused on business development. There are many techniques available in problem solving, ranging from simple and easy to use methods to relatively complicate and advance statistical tools. TQM tools are the popular techniques used by small and medium companies to improve their management quality of business. Although the methods used to analyze the data seem simple, but effective way to identify, analyze and solve problems faced by the company. Disseminate information on IE tools and SMEs obtained through articles, journals and books.

2.2 Introduction to Productivity

Productivity is a very important measure in manufacturing operations. Besides turnover and profit, it provides insight into the efficiency and effectiveness of any operations. Productivity improvement will have a positive impact on the direct costs of the products, as the same output is produced with less input or as the same inputs are producing more output. This can create new opportunities and improve the competitiveness in manufacturing operations.

Productivity is one of the key factors affecting the overall competitiveness of a company. Productivity can be managed in different levels – on national, sector or enterprise level. In the enterprise level there are also different possibilities for productivity management, e.g. different measures of productivity can be used or different levels regarded. At a cluster level, knowing the real-time functionality expectations and evaluating the experience on speed performance and limits of data interaction amount of commercial solutions drive the cluster to build up a new system (Behjat, 2003).

According to Tangen (2002), The concept of productivity, generally defined as the relation between output and input, has been available for over two centuries and applied in many different circumstances on various levels of aggregation in the economic system. It is argued that productivity is one of the basic variables governing economic production activities, perhaps the most important one.

According to Riikka and Antti (2007), Productivity is a key determinant for the success of any organisation. This holds true also in the case of knowledge-intensive organisations. Traditional productivity measures are based on measuring the quantities of outputs (i.e. products and services) produced as well as the inputs used in the production process. However, these quantitative methods cannot usually be applied to knowledge work because of, e.g., the qualitative nature of the output of knowledge work. Therefore, there is a need for a new measurement method that knowledge-intensive organisations could use in managing their productivity.

Productivity is defined as a relationship (usually a ratio or an index) between output (goods and/or services) produced by a given organizational system and quantities of input (resources) utilized by the system to produce that output. In economics, productivity is often measured as ratio output changes over input changes. However, at the field of management accounting, productivity is usually defined as the ratio of output over input. This definition can be directly connected to the financial effects of productivity changes. For example, the cost effect of input changes can be directly calculated when the amount and the unit cost of the input are both known. From the managerial perspective operating with output and input levels instead of changes seems to be more relevant (Mika, 2000).

The main purpose of implementing lean manufacturing is to increase productivity, reduce lead time and cost and improve quality thus providing the up most value to customers. There are many descriptions regarding lean manufacturing. It is most frequently associated with the elimination of the seven important wastes to make the effects of variability in supply, processing time or demand. The seven wastes mentioned are: over production, waiting, unnecessary transport or conveyance, over processing or incorrect processing, excess inventory, unnecessary movement and defects (Hudli and Inamda, 2010).

Productivity has become a household word as almost everyone talks about it. Yet, the term 'productivity' means different things to different persons. As a phenomenon, it ranges from efficiency to effectiveness, to rates of turnover and absenteeism, to output measures, to measure of client or consumer satisfaction, to intangibles such as disruption in work flow and to further intangibles such as morale, loyalty and job satisfaction (Oyeranti, 2000).

A productivity measure, until recently, was a measure of the average product of some class of productive services. When they began to be calculated on a large scale it was already a basic proposition of economics that one should never look at average products, only at marginal products (Stigler, 1961).

Jergeas (2009) conducted another research based on Hewage (2007) fifty one factors affecting productivity. These factors were prioritized and clustered into nine categories. These categories are: design and changes, worker motivation, inadequate communication, worker skills, non-availability of information, lack of planning, congested work areas, inadequate supervision, and adverse weather conditions. University of Calgary research identified the relative importance of 51 productivity factors which were classified into three groups: Human, External, and Management.

According to Jergaes (2009), There were some of the significant situations that create congestion and reduce the productivity of resources in the work area. Some of the critical situations were over stacking of trades, improper activity sequencing, excessive on-site prefabrication & storage of material in the work area and improper planning of the activities with regards to movement of resources in the work area with the progression of the work.

According to Dubelaar, Bhargava and Ferrarin (2002), based on research Good (1984) provides a list of outputs such as number of transactions, physical units sold, value added, sales, etc., and inputs such as hours of labour employed, number of employees, wages, salaries, etc. Given the use of multiple outputs and inputs, it would be easy to develop a number of simple ratios that measure different facets of productivity.

The overall performance of a company is comprised of seven criteria: effectiveness, efficiency, quality, productivity, quality of work life, innovations, and profitability. Productivity is thus an important success factor for all organizations. Improvements in productivity have been recognized to have a major impact on many economic and social phenomena. Companies must continuously improve productivity in order to increase the business profit.

2.3 Introduction to Industrial Engineering

Industrial engineering was originally founded as a discipline that focused on the study and design of work (Bailey and Barley, 2002). Industrial engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.

At the turn of the century, Frederick Taylor revolutionized the design and improvement of work with his ideas on work organization, task decomposition and job measurement. Taylor's basic aim was to increase organizational productivity by applying to human labor the same engineering principles that had proven so successful in solving technical problems in the workplace. The same approaches that had transformed mechanical activity could also be used to structure jobs performed by people. Taylor, rising from worker to chief engineer at Midvale Iron Works, came to symbolize the ideas and practical realizations in industry that we now call industrial engineering (IE), or the scientific school of management. In fact, though work design remains a contemporary IE concern, no subsequent concept or tool has rivaled the power of Taylor's mechanizing vision (Davenport and Short, 1990).

One of the important Industrial Engineering activities is to analyze the job or workplace. This is to be used for quality and productivity improvement specially the workers activity, working space, materials, machines, jigs and fixtures, tools and other equipment in the furniture production department.

Today, many production systems are so complex that relevant knowledge has become differentiated and distributed across the organization. Under these conditions, advocating worker autonomy may cause unanticipated problems while not necessarily achieving productivity gains, as Bailey and Barley (2002) discovered among team programs in semi-conductor manufacturing. She found that as production operators took on preventative maintenance and gained greater autonomy, they threatened the job security of equipment technicians.Thus, the field needs new theories and methods tailored to a highly educated work force and to a variety of sophisticated workplaces.

2.4 Seven Quality Control Tools

To solve any problem, one should know the root of the problem, and know how to solve the problem. Sometimes, somebody does not know even figured out whether he or she is actually facing a problem. Then, how could he or she find the solution? In business management, it is worse if a company does not noticed the problem exist in their company. There are the techniques to identified the problem occur. One of the techniques is TQM tools or in popular term known as 7QC tools. The 7 QC tools are easier to apply and understand and yet proven scientific management tools.

According to Zakuan, Yusof and Shamsudin (2007), based on the study conducted by Woon (2004) among Singaporean companies found that the service organizations generally showed a lower level of TQM implementation than the manufacturing organizations in the elements quality information and analysis.

7 QC tools can be used in all process phases, starting from the beginning of a product development up to management of a process, on day to day basis, and in systematic manner. They form the fundamental foundation for all problem solving and quality control activities.

The list of tools in 7 QC tools are check sheet, Pareto chart, flowchart, cause and effect diagram, histogram, scatter diagram and control chart (Ishikawa, 1985). These 7 QC tools also known as Total Quality Management (TQM) tools (Jay and Barry, 2008).

2.5 Check Sheets

Check sheets also known as data collection sheets and tally charts (Ishikawa, 1982). Check sheets are used to collect data that will be used towards solving the problem selected. Data represent inputs which will be used to provide information that will enable the right decisions to be made. Check sheets are important as it provides the facts and present information in an efficient, graphical format. This may be accomplished with a simple listing of items.

The data that should be collect is the process data which is under investigation. The design of the check sheet has to allow valuable information to be obtained. It is important to keep the check sheet as simple as possible so that the entire investigation effort is put towards collecting the right type of information. The sheet should also be designed so that data is collected over a certain time scale. The analysis of information will only become meaningful if enough data has been collected.

2.5.1 Who Should Collect The Data

The person who collects the data must fully understand the process, perhaps those who are responsible for the problem, are asked to collect the information. The data collected must be precisely attributing to the right cause so that the analysis gives accurate outcomes (Mohamed, 2005).

2.5.2 Check Sheets Procedure

Nancy (2004), stated that, first, decide what event or problem will be observed and develop operational definitions. After that, decide when data will be collected and the period of the data that will be collected. Next, design the form so that data can be recorded simply by making check marks or tick or similar symbols and so that data do not have to be recopied for analysis. Label all spaces on the form. Test the check sheet for a short trial period to be sure it collect the appropriate data and is easy to use. Lastly, each time the targeted event or problem occurs, record the data on the check sheet.

2.6 Pareto Chart

Pareto Chart also known as Pareto Diagram or Pareto Analysis. Pareto Chart are important tools in quality improvement process. They were created by Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards. Alfredo Pareto, an Italian economist (1848-1923) found that 80% of the property in Italy was owned by 20% of the population. This observation had leaded him to formulate the Pareto Principles. Pareto Principle supports the 80/20 rule, which states that 80% of problems (nonconformities or defects) are created by 20% of causes (Boon, 2010).

Pareto Chart is a bar graph. It also graphically summarizes and clearly show the differences between groups of data-often those provided within check sheet. By drawing out the Pareto Chart, the frequency of the problem can clearly stated and focused to achieve improvement. Besides, 80% problem and 20% of the causes also can be identified. Normally, the graph will be arranged in order of longest bars on the left and the shortest to the right. By this arrangement, the chart visually depicts which situations are more significant and helps prioritize the problems by arranging them in decreasing order of importance. In environment with limited resources, these diagrams will help the companies decide on the order in which they should address problems (Boon, 2010).

2.6.1 When to Use Pareto Charts

Based on Nancy (2004), Pareto Chart normally being produce when there are too many problems and causes appeared and the most significant need to be focusing. It also can be use to analyze data about the frequency of problems and the causes that appeared in a process. It also very useful and easy to be interpreted the data to others.

2.6.2 Pareto Charts Procedure

According to Nancy (2004), first, decide what categories that will use to group items than decide what measurement is appropriate. Those common measurements are frequency, quantity, cost and time. Next, decide what period of time the Pareto chart will cover, either one work cycle, 1 day or 1 week. After that, collect the data, recording the category each time or assemble data that already exist. Subtotal the measurements for each category and determine the appropriate scale for the measurements that have been collected. Mark the scale on the left side of the chart and make sure to construct and label bars for each category. Place the tallest at the far left, then the next tallest to its right and so on. If there are many categories with small measurements, they can be grouped as "other."

Calculate the percentage for each category where the subtotal for that category divided by the total for all categories. Draw a right vertical axis and label it with percentages. Be sure the two scales match. Calculate and draw cumulative sums. Add the subtotals for the first and second categories, and place a dot above the second bar indicating that sum. To that sum add the subtotal for the third category, and place a dot above the third bar for that new sum. Continue the process for all the bars. Connect the dots, starting at the top of the first bar. The last dot should reach 100 percent on the right scale.

2.7 Flowcharts

Flowcharts shows the sequences of event in a process which are used for manufacturing and service option (Amitava, 2008). It is not statistical, but is used to piece together how the real process is run. Seeing it visually makes identifying both inefficiencies and potential improvements easier.

A series of shapes are used to depict every step of the process; mental decisions are captured as well as physical actions and activities. Arrows depict the movement through the process. Flowcharts vary in complexity, but when used properly can prove useful for identifying bottlenecks, redundant steps, and non-value-added activities. A relistic flowchart can be consturcted by using the knowledge of the person who carried out or incharge the particular process (Amitava, 2008).

2.7.1 Flowchart Procedures

First, familiarize the participants with the flow chart symbols. After that, draw the process flow chart and fill it out in detail about each element. Analyze the flow chart. Next, determine which steps can be combined, simplified, or eliminated. Lastly, finalize the flow chart (Boon, 2010).

2.7.2 Flowchart Symbols

Flowcharts usually built by using six symbols which shown in Figure 2.1. The symbols can lead to an accurate and up to date representation of the process being considered and are the best means by which complex aspects can be simplified and communicate.

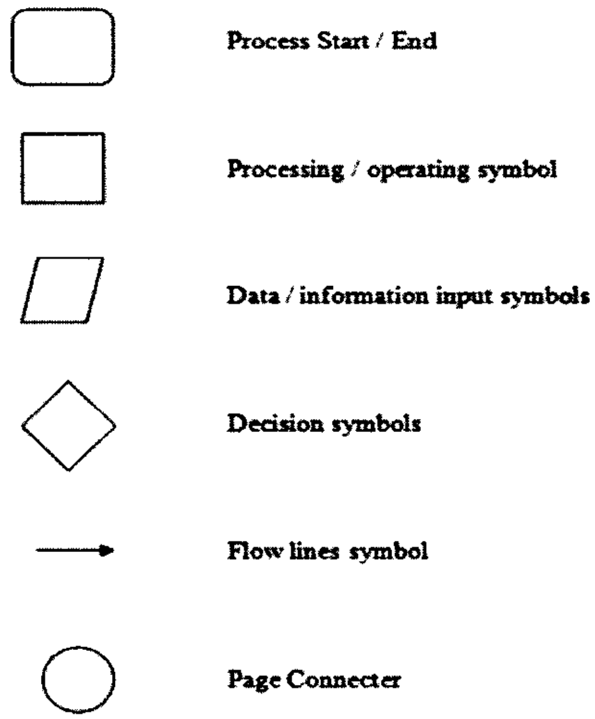


Figure 2.1: Flowcharts symbols

Source: Boon (2010)

2.8 Cause and Effect Diagram

Cause and effect diagram also known as Fish bone diagram. It's also called as Ishikawa diagrams because Kaoru Ishikawa developed them in 1943. This tools is called fishbone diagrams because they resemble one with the long spine and various connecting branches.The fishbone diagram organizes and displays the relationships between different causes for the effect that is being examined. This chart helps organize the brainstorming process. The major categories of causes are put on major branches connecting to the backbone, and various sub-causes are attached to the branches. A tree-like structure results, showing the many facets of the problem (Nelson, 1985).

2.8.1 When to Use Cause and Effect Diagram

Cause and effect diagrams used to identify possible causes in quality problem. When a production team is about to launch a new product, the factors that will affect the final product must be recognized. The diagram can depict problems before they have a chance to begin. It is also very usefull when a team's thinking tends to fall into ruts. (Nancy, 2004)

This is another tool that can be used in focused brainstorming sessions to determine possible reasons for the target problem. The brainstorming team should be diverse and have experience in the problem area. A lot of good information can be discovered and displayed using this tool (Nelson, 1985).

2.8.2 Cause and Effect Diagram Procedure

Nancy (2004), stated that clearly identify and define the problem or effect for which the causes must be identified at the very first. Then, place the problem or effect at the right or the head of the diagram and identify all the broad areas of the problem. Write in all the detailed possible causes in each of the broad areas. Normally, the causes will be 4M which is methods, machines, manpower and materials. Each cause identified should be looked upon for further more specific causes. Next, view the diagram and evaluate the main causes. Set the goals and take action on the main causes. When the group runs out of ideas, focus attention to places on the chart where ideas are few.

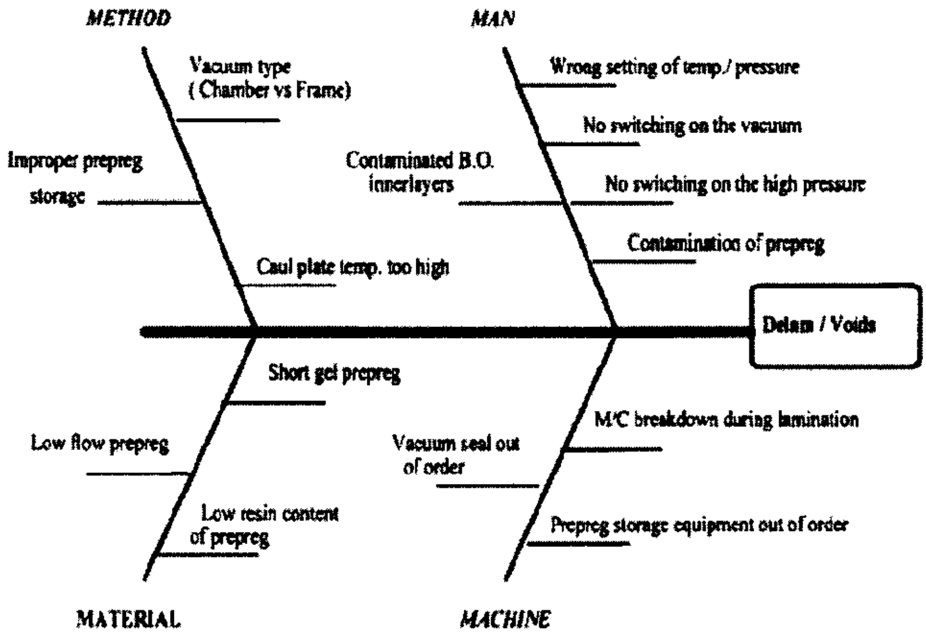


Figure 2.2: Cause and Effect Diagram of delamination / voids

Source: Card (2006)

From Figure 2.2, the effect is the delamination or voids and the causes of voids is the 4M which are Method, Man, Material and Machine. There are 3 causes from Method which is improper prepreg storage, vacuum type and high temperature of caul plate. Causes that cause by Man is the error of setting of temperature or pressure, didn't switch on the vacuum and the high pressure when using the machine, contaminated B.O. inner layers and contamination of prepreg. Material which cause voids are short gel prepreg, low flow or prepreg and low resin contect of prepreg. Last but not least, the causes that made by Machine are vacuum seal out of order, machine breakdown during lamination and prepreg storage equipment out of order.

2.9 Small and Medium Enterprises (SMEs)

2.9.1 Overview

SMEs have been the backbone of economic growth of an economy in driving industrial development. Due to their sheer numbers, size and nature of operations, this segment of the economy in promoting endogenous sources of growth and strengthening the infrastructure for accelerated economic expansion and development in Malaysia has been recognised.

The National SME Development Council approved the use of common definitions for SMEs in the manufacturing, manufacturing-related services, primary agriculture and services sectors (Classification of economic activities is based on the Malaysian Standard Industrial Classification (MSIC) 2000 codes). These definitions are applied by all Government Ministries and Agencies involved in SME development, as well as by the financial institutions.The use of common definitions for SMEs will strengthen government efforts to create effective policies and support programmes for specific target, make it easier to provide technical and financial assistance to SMEs, and allow for the identification of SMEs in the various categories and levels.

2.9.2 Definition

Based on Secretariat to National SME Development Council (2005), SMEs define as a small and medium enterprise in services is an enterprise with full-time employees not exceeding 50 or annual sales turnover not exceeding RM5 million. Malaysian SMEs can be grouped into three categories which are micro, small, or medium. These groupings are decided based on either the numbers of people a business employs; or on the total sales or revenue generated by a business in a year.

The table below summarises the approved SME definitions based on number of full-time employees:

Table 2.1: Summarises of the approved SMEs definitions based on number of full-time employees.

	Primary Agriculture	Manufacturing (Including Agro-Based) & Manufacturing-Related Services	Services Sector (Including ICT)
Micro	Less than 5 employees	Less than 5 employees	Less than 5 employees
Small	Between 5 & 19 employees	Between 5 & 50 employees	Between 5 & 19 employees
Medium	Between 20 & 50 employees	Between 51 & 150 employees	Between 20 & 50 employees

Source: Secretariat to National SME Development Council (2005)

The table below summarises the approved SME definitions based on annual sales turnover:

Table 2.2: Summarises of the approved SME definitions based on annual sales turnover

	Primary Agriculture	Manufacturing (Including Agro-Based) & Manufacturing-Related Services	Services Sector (Including ICT)
Micro	Less than RM200,000	Less than RM250,000	Less than RM200,000
Small	Between RM200,000 & less than RM1 million	Between RM250,000 & less than RM10 million	Between RM200,000 & less than RM1 million
Medium	Between RM1 million & RM5 million	Between RM10 million & RM25 million	Between RM1 million & RM5 million

Source: Secretariat to National SME Development Council (2005)

2.9.3 Importance of SMEs

Developing a group of diverse and competitive small and medium enterprises (SMEs) is a central theme towards achieving sustainable economic growth. SMEs are crucial to the economic growth process and play an important role in the country's overall production network. Some advanced economies have succeeded because SMEs form a fundamental part of the economy, comprising over 98% of total establishments and contributing to over 65% of employment as well as over 50% of the gross domestic product. Although the numbers might be lower in Malaysia, SMEs have the potential to contribute substantially to the economy and can provide a strong foundation for the growth of new industries as well as strengthening existing ones, for Malaysia's future development.

The potential of SMEs to promote domestic-led growth in new and existing industries and to strengthen the resilience of the economy in a competitive and challenging environment are inarguable. Economic growth in developed countries such as Japan, Korea, Taiwan and many others, were significantly generated by SME activities. The percentage contribution of SMEs to GDP/total value added range from 50% in Korea, 55.3% in Japan, 57.0% in Germany, 60% in China compared to 47.3% attained by Malaysia. In order to determine the role of SMEs in the economic growth of Malaysia, it will be meaningful to assess their contribution in the three (3) main sectors of the economy, manufacturing, services and agriculture. Data for this analysis is obtained through a baseline Census conducted by the Department of Statistics in 2005 (Normah, 2006).

SMEs have played tremendous role in manufacturing sector all over the world. In the year 2007, Malaysia has 96% of establishments of SMEs which contributed 30.7% of total manufacturing output and 26.3% of total value added. In addition more than 400,000 or 31% of total Malaysian workforce were employed by SMEs. The new economy age on globalization has influence foreign products penetrate the Malaysian market, especially from China and India which offered lower cost compared to local product. Many Chinese companies have taken the market share from stronger manufacturers in Asia, Europe and the United States. Nowadays, the suppliers are no longer in the same region with customer. One of the approaches which are considered best management practice to all industries is Lean Manufacturing (Rose, 2011).

2.10 Previous Case Study

Productivity Improvement Through Monitoring Of Human Resources Competence Level (Otto, 2007).

Online resource databases allow production enterprises to cooperate effectively. The elaborated system concept supports the strategic planning of technology transfer, it also could be used as a basis for the industrial enterprises in elaborating co-operation networks and developing towards extended enterprises. Description and evaluation of innovation capacity through human resources development is a novel solution taken into consideration in the building of the model. Results at this phase are used to develop the technological and human resources database test version. The workshop productivity increasingly depends on skills and knowledge of whole workshop team. Different equipment and competencies are needed depending on complexity of production. The humans' impact on productivity and the methods for enhancing the productivity and efficiency of working the machinery workshop environment are described in this paper. The data covering 75 Estonian metal working and machinery companies has been analyzed. A novel expert tool is introduced, where during the evaluation guess values are assigned onto machinery, products, and staff members of the workshop, reflecting existing and needed levels of competence and machinery, thus helping further process planning.

Knowledge Work Productivity Assessment (Riikka and Antti, 2007).

Subjective productivity measurement (SPM) is a measurement approach that collects information about productivity through a questionnaire or an interview targeted to an interest group. This paper introduces a specific SPM method, "Knowledge Work Productivity Assessment" (KWPA). It is especially designed for measuring productivity in knowledge-intensive organisations. KWPA can be used to identify possible problems in factors of productivity as well as targets for development. It consists of a combination of a questionnaire and several employee interviews. The results of the questionnaire provide an overall description of various factors related to productivity while the interviews provide more in-depth information of specific issues. The implementation of KWPA has contributed to the verification of its applicability. The method has been gone through a change from something usable in research also to a practical tool that can identify problems in drivers of production as well as indicate lower levels of productivity. KWPA has also passed the weak market test of the constructive research approach, when one of the participant organisations adopted it as a part of their continuous productivity assessment.

Small and Medium Enterprises and ICT (Vadim, 2007).

It is common place for governments to have policies to encourage the growth of local small and medium enterprises (SMEs) as they can help to directly alleviate poverty by increasing income levels and creating jobs. However, as the global economy becomes increasingly reliant on information and communications technology (ICT) to receive, process, and send out information, the small businesses within the Asia-Pacific region – which form a significant portion of their developing economies – have yet to reap these benefits evenly. SMEs can benefit either as producers of ICT or as users of ICT for purposes such as increased productivity, faster communications and reaching new clients. However, it must be noted at the outset that not all SMEs need to adopt ICT tools to the same degree of sophistication. The most basic ICT tool is having communication capabilities through fixed lines or mobile phones, whichever is more cost effective. SMEs may then use a personal computer (PC) with basic software for simple information processing needs such as producing text or keeping track of accounting items. Internet access enables SMEs to have advanced communication capabilities such as email, web browsing and launching a website. SMEs in manufacturing can benefit from more advanced ICT tools such as Enterprise Resource Planning (ERP) or inventory management.

Manufacturing Productivity Improvement Using Effectivenes Metrics and Simulation Analysis (Huang et. al, 2003).

Traditional productivity metrics, such as through put and utilization rate, are not very helpful for identifying the underlying problems and opportunities for productivity improvement in a manufacturing system. In this study, a systematic methodology is presented for productivity measurement and analysis at the factory level. Metrics of Overall Equipment Effectiveness (OEE) and Overall Throughput Effectiveness (OTE) are introduced and developed, respectively, forrigorous and quantitative measurement of equipment and system productivity. These metrics are integrated with computer simulation to facilitate rapid analysis of equipment and manufacturing system productivity, and the investigation of productivity improvement opportunities. The results of this research make possible the representation of factory level productivity or overall factory effectiveness by OTE, and the use of OTE for quantitative benchmarking and comparison of the productivity of various factories. A real-world manufacturing case study is reported to demonstrate how to employ these techniques to improve manufacturing productivity.

Introduction To Continuous Quality Improvement Techniques For Healthcare Process Improvement (Nelson, 1985).

As we enter the new millennium, healthcare organizations are facing new challenges and must continually improve their services to provide the highest quality at the best cost. Pressures to increase the quality and lower the cost of healthcare are coming from accreditation boards, the media, and comparisons with other facilities, HMOs and government agencies. Accountability with hard data, not fuzzy opinions, is being demanded. Existing processes must be examined and new ones discovered. The good news is that improved quality inherently lowers costs as it provides better service. CQI provides accountability and is an essential ingredient in this quality effort. CQI is not an abstract theoretical exercise for mathematicians. It is a hands-on endeavor by people who care about their work and strive to improve themselves and their productivity every day. CQI charts are a tool to assist in the management of this endeavor. The decisions about what needs to be improved, the possible methods to improve it, and the steps to take after getting results from the charts are all made by humans and based on wisdom and experience.

Selection Of Quality Improvement Initiatives: An Initial Conceptual Model (Mohamad, 2009).

There are numerous quality improvement initiatives that can be used by organisations to improve quality, productivity and sustainability towards achieving excellence, such as Six Sigma, Lean, Business Process Reengineering, ISO9000, and Benchmarking. Nevertheless, in reality, no single initiative can solve all problems effectively in the organisation. The right initiatives to be used may vary depending on several contextual factors, for instance, the current maturity level of the organisation, areas in which the initiatives are implemented, organisation type and size, and the capabilities of the workforce. Moreover, there is a lack of clear understanding by people regarding when, where and how to implement initiatives. Due to this situation, many organisations face difficulties in selecting suitable improvement initiatives according to the context. This paper discusses issues of selecting initiatives and proposes an initial conceptual model to select suitable quality improvement initiatives on the journey towards achieving organisational / business excellence (BE). The proposed initial conceptual model focuses on the critical factors that should be considered in selecting suitable quality improvement initiatives as well as some examples of the main initiatives to implement to improve performance according to the level of BE maturity and areas of implementation.

Business Performance of Small Medium Enterprise: Strategic Planning and Customer Focus (Karia et. al, 2004).

Business performance of small medium enterprises has been a vital issue to the management. Moreover in today's economic climate, small medium enterprises competitions are greater than ever may in local or global. This study will focus on the small medium enterprises adoption of strategic planning and customer focus as the total quality management practices toward the small medium enterprises business performance. The results indicate that total quality management implementation has high correlation with business results. The purpose of this study was to investigate the relationship between strategic planning and customer focus towards business performance. Moreover the study discovered that strategic planning and customer focus a positive and significant impact on the business performance of organization and all the hypotheses formulated. The findings shown that the important implication for managers and in order for Malaysian SMEs to improve on their business performance, the SMEs needed to focus on customers so that they were satisfied with the products and services offered by the organization. Moreover it is recommended that SME should implement TQM practices in order to enhance their competitiveness in the local as well as the global market, and to provide products and services that meet or exceed customers' expectations.

Small Business and Industrial Engineering Tools (Behjat, 2009).

UltraMed, a small distribution company located in the United Arab Emirates, faces high operations cost due to inefficiency in methods and concepts implemented in their business. Through the use of basic Industrial Engineering techniques, UltraMed and other small businesses can succeed in reducing their operational costs through the implementation of three major concepts of Industrial Engineering: Operations Research, Database Management, and Engineering Economic Modeling. To succeed in implementing the design, it is important to have the right data and a cohesive foundation for the design; else, the results generated by the techniques will be invalid and could cause further complications to the operations of the small business. Therefore, it is essential for the small business manager, and examiners, to first identify what elements in the business needs to be improved, and later, once the needs are identified, implement the concepts that can be beneficial in reducing their costs. The model is configurable and hangeable as it provides room for managers to use any platform as long it can support the techniques used, reduce training time, and reduce additional cost derived from purchasing expensive and complicated software. The outcome of the implementation of the model displayed a significant potential of growth – represented by the profits generated by UltraMed. The factors contributed to the increase in profits were the combination of effective utilization of the model and marketing momentum to sustain an efficient, and growing, business environment.

Technical Efficiency of Small and Medium Enterprise in Malaysia: A Stochastic Frontier Production Model (Alias, Abu and Abdullah, 2008).

Small and medium enterprises (SMEs) play a vital role in the Malaysian economy and are considered as the backbone of industrial development in the country. However, SMEs' value added is very much lower than that of large scale enterprises. The low productivity of physical inputs or factors efficiency may be attributed to the low level of value added. The objective of this study is to determine the technical efficiency of 7360 small and medium enterprises for the year 2004 using stochastic frontier model. Results show that the number of firms considered technically efficient is only 3.06 percent of the total firms, while total technical inefficiency varies from 0.30 to 97.10 percent. Thus, policy makers have to play an important role in promoting economies of scale and developing technical skills of labors, which will lead to higher efficiency levels among SMEs.

Productivity, efficiency, scale economies and technical change: A new decomposition analysis of TFP applied to the Japanese prefectures (Nemoto and Goto, 2005)

This paper aims to examine the productivity change of the Japanese economy using the data pertaining to the 47 prefectures during the period 1981–2000. The decomposition analysis of the Hicks–Moorsteen– Bjurek productivity index is conducted to explore the sources of the productivity change. In summary, technical change and efficiency change are two of the most important components driving procyclical productivity. We find that relative their importance varies over periods. Supply shocks captured by technical change component caused upturns in productivity in the mid and late 1980s and in 1999 and 2000. Supply shocks also caused downturns in the early and mid 1990s. On the other hand, demand shocks captured by efficiency change component drove upturns of productivity in 1984, 1990 and 1996, when supply shocks were not detected.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter provides a review of the methodology in conducting this study from starting until it is completed. Starting with the design of the study, where as methodology used in conducting this study is overview discussed. Then, the discussion of the industrial engineering tools is discussed in general.

3.2 Design of Study

This study begins with the tittle selected and approved by program coordinator. The project proceed with a discussion with the supervisor to detailed out the project objectives, scopes of study and the problem statement of the project. For further discussion about the project, a weekly appointment with the supervisor was arranged.

Before the project is conducted, a preliminary research on previous existing cases which is similar and related to this study should be done. All information's were gathered, so that it will give a clear view in order to understand the basic concept regarding to the topic chosen. All the related and useful information gained through reading journals, books and other source will be used in the future for the analysis part.

The importance source for this study is the selected company. The selected company should be listed in the small and medium industries (SMEs). All the data collection regarding to this study is collected from the selected company for further data analysis.

This study mainly focused on improvement of productivity by using the industrial engineering tools. Basically there are 7 quality tools reviewed in industrial engineering tools. However, not all the tools will be used in this study. The selected tools are Check Sheet, Pareto Diagram, Cause and Effect Diagram and Flow Chart.

The selected company for this study is Global Factor Sdn Bhd (GFSB). As the agreement approved from GFSB, the research was started by visiting the company. The data regarding to product defects exist in the company listed down for screening and analysis purpose. From the record of the company, the highest product defect should be selected to be the case of the study.

The types of defects discussed in detail from the selected product defects. A discussion with supervisor and operator of the machine is held in order to discuss the root of the problem and how to overcome the existed problem. A suggestion to solutions will be made to reduce the defects in order to improve the productivity.

Solution is suggested to the manager to overcome the existence of defects. However, it is depends on the company either want to apply the new solution or not. The study is proceeding with the study of the effectiveness of the suggested solution.

The new data is collected from the same previous study of product to identify the existence of the defect after the implementation of the new method. The existed defect is discussed in detail to compare to the previous existence of the previous defects. A conclusion is a summary of the findings and the recommendation is suggested in this study.

3.3 Methodology of Data Collection

The data of product defects is collected from three to six month before. The GFSB record of performance is needed in this study. The data collection is converted into a check sheet to summarize the data and to get the actual frequency of product defects.

The highest frequency of the product defects is occurring in production of marker pen. The main product in GFSB is marker pen that is fully manufactured by in house production. The marker pen is selected to be the case of the study because of the majority of the machine in GFSB is totally used for manufacturing process.

Before proceed to the detail data collection at GFSB, the production flow for the company is clearly understand and identified by doing some interview with the supervisor and the manager of the company. Besides, observation of the company also need to take to account in order to know more about the product of the company and also the production flow lines of the company.

3.3.1 Production Flow of GFSB

Basically, to complete a marker pen, there is two different workstations need to go through. The figure 3.1 showed the production flow of marker pen:

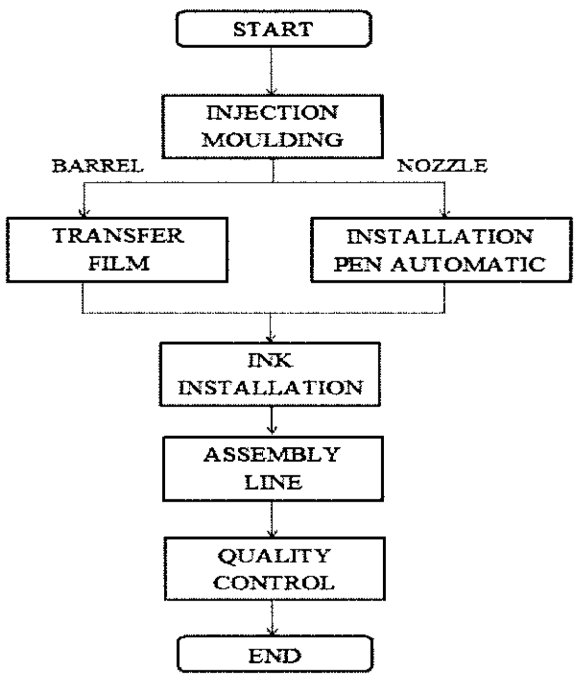


Figure 3.1: Production flow of marker pen

3.3.2 Data Collection

This is the most time consuming and most important of all the steps involved. Relevant information is gathered regarding to the system that is studied. There are various ways to collect data. Figure 3.2 shows the flow chart for data collection in GFSB.

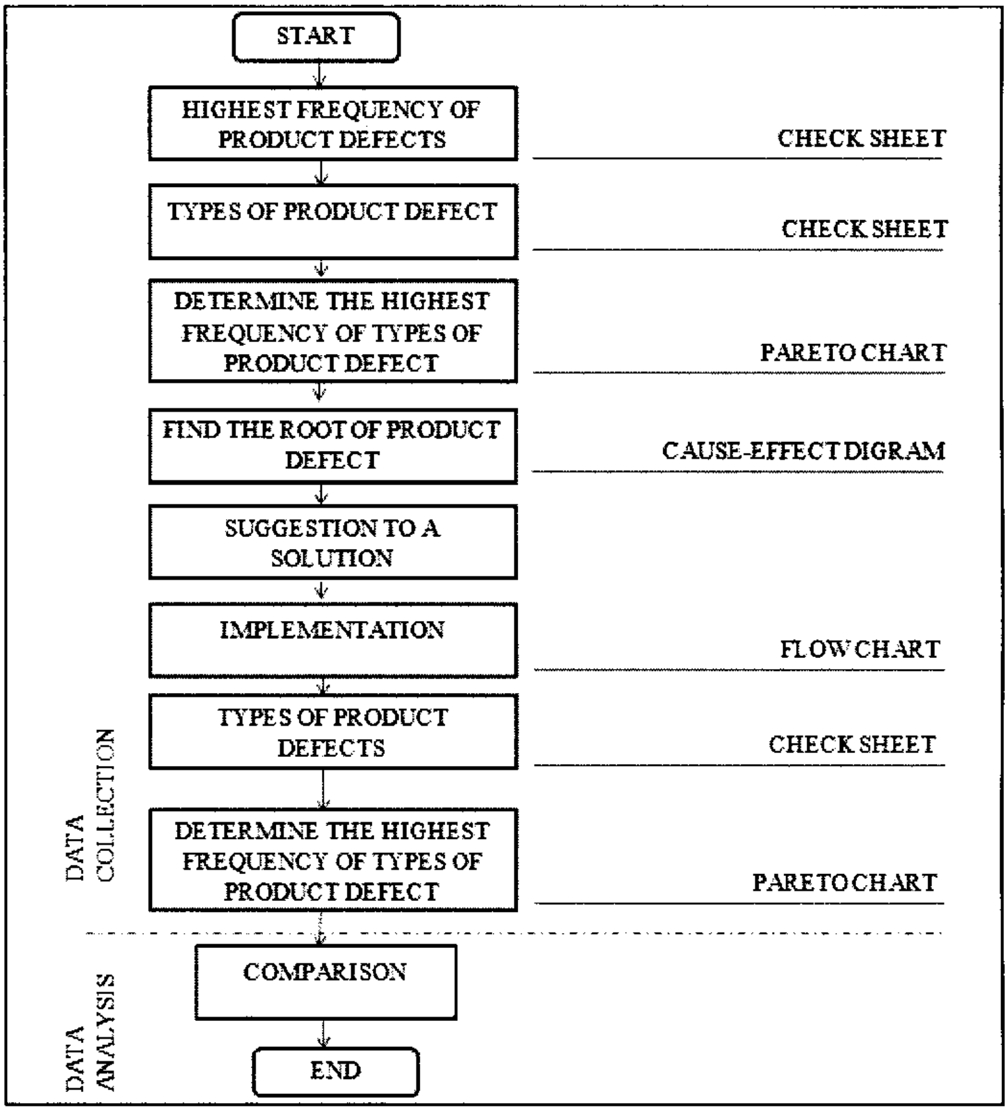


Figure 3.2: Flow chart for data collection

3.3.3 How to Collect Data

This study is started by collecting the previous data from the company. The data collection should be three to six month performance of the company. The data composed of the product defects produced by the company. By using the check sheet, the frequency of defect is composed and the data is transferring into Pareto Chart.

In Pareto Chart, the highest frequency data and the lowest frequency data would be determined. The highest data should be used to be the case of study. The highest frequency of product defect could be the cause of the problem, and the root of the problem would be discussed in the Cause and Effect Diagram. The discussion to find the solution of defects is discussing with operator of the machine.

Flow chart of the process would be made regarding to the suggestion that be made before. This flow chart reviews the new strategies for the company to reduce the defects. As the new method is applied, the data collection for the new performance of the company is collected in the Check Sheet. This time the Check Sheet is filled by operator of the machine. The data composed in the Check Sheet is transferring to the Pareto Chart.

The analysis of the data collection is done by comparing the previous performance with the new method applied by the company. Calculation would be made to compare the value of the data from the new and the previous one.. The percentage of product defect decreased means the productivity is improved.

3.4 Summary

In this study, the company that listed in Small and Medium industries (SMEs) is selected. The method of this study is comparing the previous performance of the company with the new implementation suggestion to the company. The industrial engineering tools that involved in this study are only five tools, which are Pareto Chart, Check Sheet, Flow Chart, and Cause and Effect Diagram.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

As mentioned in the objectives, this study is about to improve the productivity of the Global Factor Sdn Bhd (GFSB) by using the industrial engineering tools. The chosen industrial engineering tool is 7 Quality Control tools.Check sheet, pareto chart, cause and effect diagram and flow chart werechosen by applying quality knowledge and the reviews on journal, article and book.

The analysis was carried out based on last three months data to identify and determine the product defects. The marker pen was selected in this study as it is main product of company GFSB.

In this chapter, the selection of defects are discussed comprehensively. Then, the identification of root causes is also discussed in cause and effects topic.

The possible solutions are suggested to the company in order to overcome the identified defects. The details of analysis were performed to compare the production productivity, before and after the implementation of suggested solutions.

4.2 Defects in Marker Pen Parts

The defects of marker pen were considered as the production waste. The reduction of defects could improve the company's productivity. Every month, GFSB produces about 70,000 pcs of marker pen. There are two main processes for producing marker pen. First process is producing four parts of marker pen such as cap, nozzle, barrel and nibs.

The next process is printing the barrel by using Heat Transfer Film Machine. This process is considered very tough process because the defects occur while printing, which could affect the barrel part. The defects in printing film could reduce the rate of production and also increase the number of rejection quantity.

The assembly could contribute the lowest defects in production of the marker pen. An average of defects per month as tabulated in Table 4.1.

Table 4.1: The defects of the marker pen parts.

Parts	Average defects in a month (pcs)	Average usage/production in a month (pcs)	Percentage defects/per month (%)
Cap	95	35,000	0.271
Nozzle	67	35,000	0.191
Barrel	83	35,000	0.237
Nibs	70	35,000	0.200
Printing Film	458	70,000	0.654
O-Ring	26	70,000	0.037
Filter	13	70,000	0.019
			1.609

Source: Global Factor Sdn Bhd

As the part of printing film is the high percentage of defects, the printing film would be discussed in detail in this study.The data from check sheet above is composed and reconstructed into a new table as showed in Table 4.2, based on arrangement of the highest frequency to the lowest frequency of pecentage defects /per month. The data in this table is calculated and being used to construct the Pareto Chart.

Table 4.2: Data for Pareto Chart (The defects of the marker pen)

Part	Frequency (Percent defect per month)	Rrelative %	Cumulative Frequency (Percent defect per month)	Cumulative Frequency %
Printing Film	0.654	40.65	0.654	40.65
Cap	0.271	16.84	0.925	57.49
Barrel	0.237	14.73	1.167	72.22
Nibs	0.200	12.43	1.362	84.65
Nozzle	0.191	11.87	1.553	96.52
O-Ring	0.037	2.30	1.590	98.82
Filter	0.019	1.18	1.609	100.00

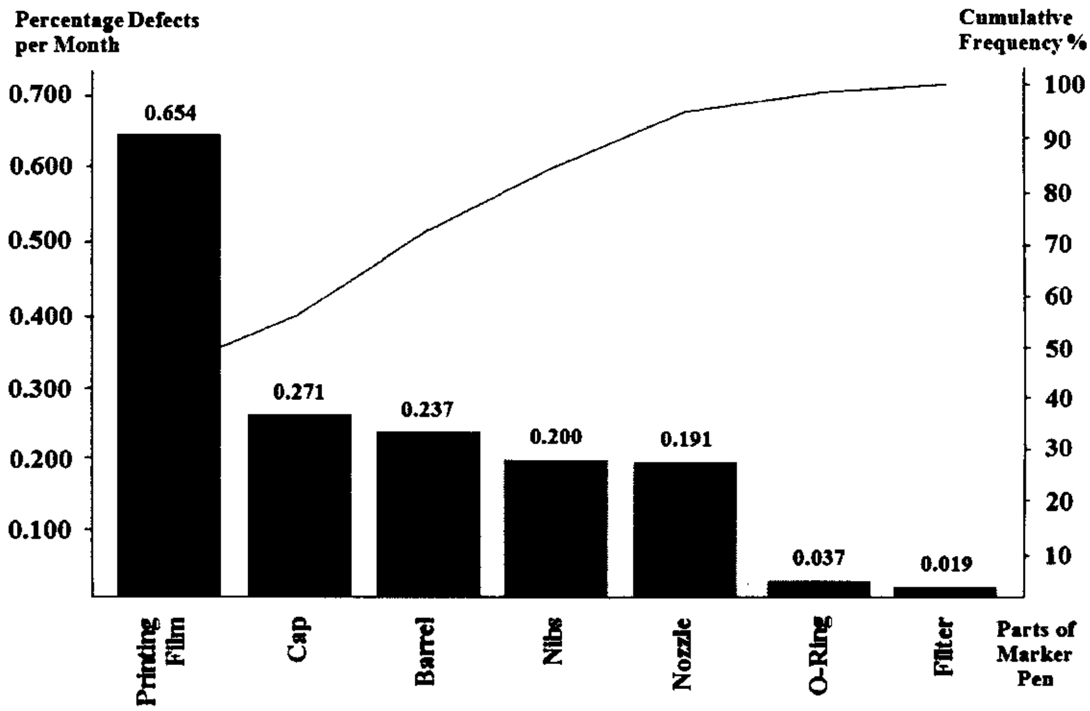


Figure 4.1: Pareto Chart for the defects of the marker pen

Figure 4.1 shows the printing film is the highest defects of the marker pen while the lowest defects of the marker pen in GFSB is the filter part. The discussion for highest defects of marker pen part is reviewed by studying the process of the printing film.The study of the heat transfer film machine, the problem identification of defects and the analysis of defects is reviewed in this chapter.

4.3 Study of Printing Film Process

4.3.1 Heat Transfer Film Machine

Heat Transfer Film Machine is used to print the barrel component of marker pen. The printing process is operated only after stamp pad of the machine is heated to its optimal temperature (195 C -200 C) to get the best printed quality. This machine is required about three to four hours to complete a roll of film.

The Heat Transfer Film machine is operated 2 weeks in a month. In the first week and the third week of the month, only four days used to print the barrel.In a day, the optimal printing barrel is two rolls of printing film.

A roll of film is contains about 6250 pieces of shots which are a roll could be inject four to five injections to print the barrel.Each of the injection is taken about 30 minutes to 35 minutes to print the 1200 pieces of the barrel. Figure 4.2 show the Heat Transfer Film Machine:

Figure 4.2: Heat Transfer Film Machine

Source: Global Factor Sdn Bhd

4.3.2 Process of Printing Barrel

The Figure 4.3 to Figure 4.8 show the flow of the printing barrel using the Heat Transfer Machine. The first step is to ensure there is no defect products on the machine. The roll of printing film is hooked up into the foil dropped. The foil dropped is tightening up to ensure the film is not moving. Then, the film is pulled up to the bobbin. The machine is not started yet for precaution purposes. The machine is started only if machine is ready to operate.

When the machine is "ON", the machine is left for the heating of the roller to its optimal temperature. The heating of the roller is taken two hours to be ready to use. The setting of the counter shots is set to "NIL" to count the production of the printing barrel.

The empty barrel is placed into the provided container in the machine. The machine is ready to start printing the barrel. The rejection of the film is recorded into the Check Sheet. Every first 15 shots of the roll is the reject of the printing film. The last 15 shots is also the reject of the printing film which means every roll of printing film should exist at least 30 shots of rejection film.

1st Process:

Figure 4.3: The film is pulled up to the bobbin

2nd process:

Figure 4.4: The machine setting

3rd process:

Figure 4.5: The barrel is placed into the container

4th process:

Figure 4.6: The finish print of barrel

5th process:

Figure 4.7: The printed barrel

6th process:

Figure 4.8: The defects of the printing barrel in a row of printing film

4.3.3 The Finish Good Products

The Figure 4.9 shows the good finishing products of marker pen.

Figure 4.9: Finish good product

4.3.4 Defects of Printing Film

The production of the printing film process requires a careful observation. The machine shutdown or the machine problem will affect the barrel and the printing film quality. Figure 4.10 to Figure 4.13 shows the defects of the printing barrel.

Figure 4.10: The defects of the miss printing shots

Figure 4.11: The defects of incomplete printing

Figure 4.12: The defects of poor printing alignment

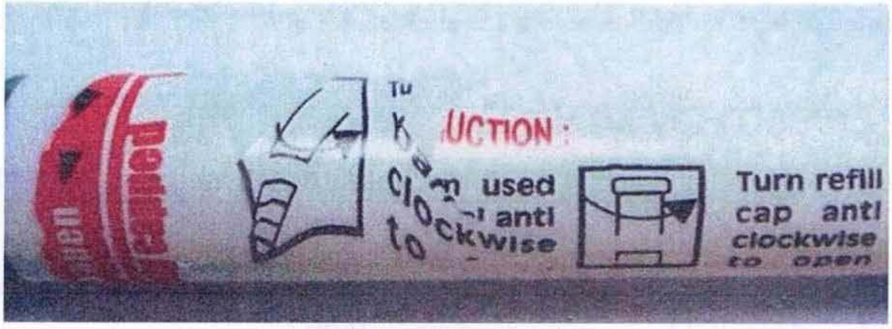


Figure 4.13: The defects of wrong setting

4.4 Problem Identification

The number of defects were collected based on previous three month of production of the printing film from the company at the printing process. A check sheet for their company is used for data collection and to record the defects exists in their printing film production. Check sheet is recorded by a machine operator. Table 4.3 shows the data collection of three month at printing film production in GFSB.

Table 4.3: Defects in printing film for three month

Types of Defect	Defects of Printing Film (pcs)						Frequency (pcs)
	June 2012		July 2012		August 2012		
	Week 1	Week 3	Week 1	Week 3	Week 1	Week 3	
Miss Printing Shots	120	120	120	120	120	120	720
Incomplete Printing	80	85	94	98	86	89	532
Poor Printing Alignment	12	10	13	11	12	12	67
Others (Wrong Direction, Incorrect Film)	15	16	16	14	13	15	89
Total	458		486		464		1,408

Source: Global Factor Sdn Bhd

The data from check sheet is composed and reconstructed into a new table as showed in Table 4.4, based on arrangement of the highest frequency to the lowest frequency of defects. The data in this table is calculated and being used to construct the pareto chart.

Table 4.4: Data for Pareto Chart (Defects in Printing Film for three month)

Types of Defects	Frequency (pcs)	Relative %	Cumulative Frequency	Cumulative Frequency %
Miss Printing Shots	720	51.14	720	51.14
Incomplete Printing	532	37.78	1252	88.92
Others (wrong direction, incorrect film)	89	6.32	1341	95.24
Poor Printing Alignment	67	4.76	1408	100.00

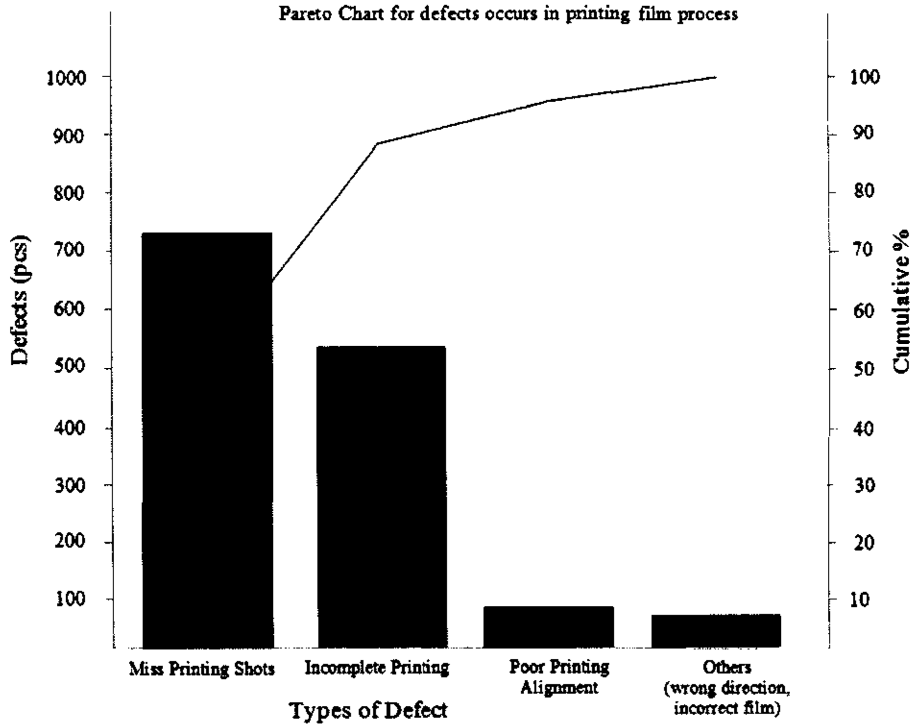


Figure 4.14: Pareto Chart for defect occurs in printing film process

Figure 4.14 shows the defect occurs in printing film process in GFSB. The highest defect is the miss printing shots. In this company, the miss printing shots is the rejection of the first 15 shots of films and the 15 shots of the films in the end of a roll.

These defects exist for every times of production the printing film process. The miss printing shots is the main subject to be discussed in the next step.

4.5 Problem Analysis

In this part of study, the miss printing film is the main defects in this company. The root causes are discussed in the Cause and Effect Diagram. The problem is discussed with the operator who is handling the machine and knows the overall process of printing film. Figure 4.15 shows the cause and effect diagram of the miss printing film:

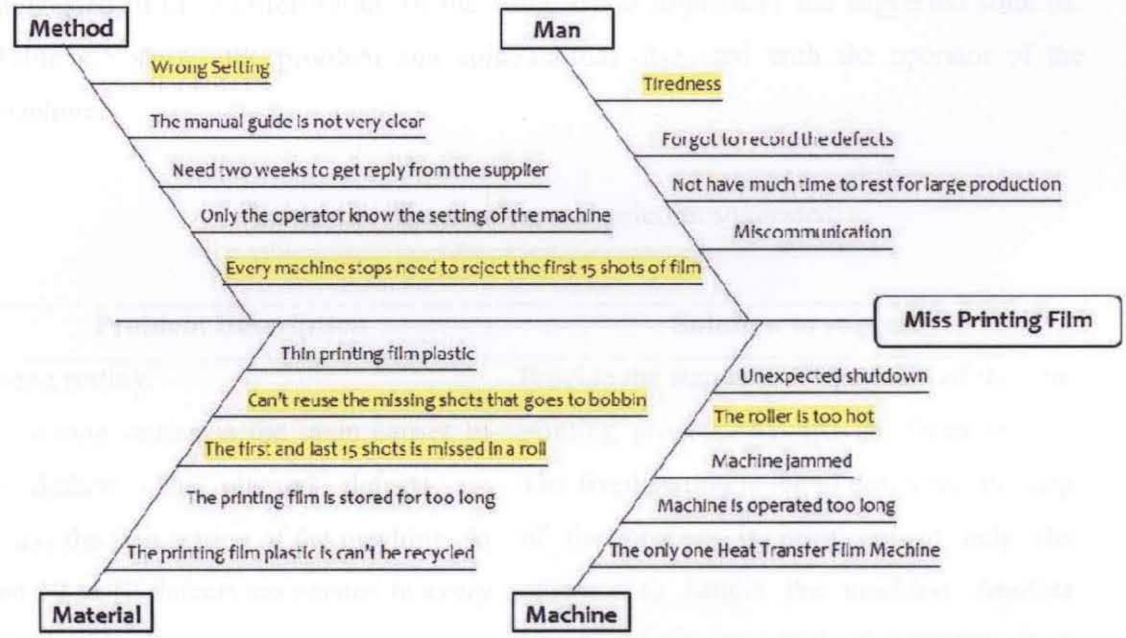


Figure 4.15: Cause and effect diagram of the miss printing film

From Figure 4.15, there are various possible roots of the problem that contribute to the defects of miss printing film. Not all of the causes discussed in this study. Only a few causes that contribute the defects will be discussed for the solution. The selected causes are highlighted and discussed in detail to find the reasonable solution for the existing defects.

From the discussion, the causes that contribute the most defects of miss printing film are chosen. The roots of causes are studied and the solution is to overcome the defects is brainstormed. The causes that contribute the most to the defects of miss printing film are the wrong setting, every time machine stops need to reject the first 15 shots of film, the missing shots that goes to bobbin is cannot be reused, the first and the last 15 shots is missed in a roll, the tiredness of the operator and the roller is too hot.

4.6 Problem Solutions

From the causes and effects diagram as showed in Figure 4.15, the further discussion is held to find the solution of the problem. Then, the solution will be suggested to the administration of the company to implement the suggested solution. Table 4.5 shows the problem and solution that discussed with the operator of the machine.

Table 4.5: The problem and solution suggested

Problem Description	Solution to suggest
Wrong setting. The wrong setting is the main causes of the defects. The obvious defects are always the first setting of the machine. At least 10 to 12 defects are existed in every started of the process.	Provide the standard of operation of the film printing process. Record the fixed setting. The fixed setting is jotted down and the step of the process is print out to help the operator to handle the machine. Another benefit of the standard of operation is if another person, who are not involved in heat transfer film machine before is asked to operate the machine, the fixed machine setting can help him to follow the setting. This method can reduce the defects on try-and-error process.

Table 4.5: The problem and solution suggested (continue)

Problem Description	Solution to suggest
Cannot reuse the miss printing shot that goes to bobbin. The miss printing that rolled into bobbin is cannot be used to print the barrel because of only a new roll of printing roll is used to print the barrel. The used printing film is labelled as a rejection.	Keep the used printing film to recycle to a new innovation of product. While the printing film plastic is not accepted to recycle, the innovation of the product defects need to think to reduce the storage space and the involve cost.
The first and last 15 shots are missed in every roll. A large frequency of defect is wasted every year. This defect is fixed and somehow more than 30 shots in a roll of film.	Combine the used printing film with the new printing film. Cut down the still good shots of miss printing film and combine to the new printing film. This action is taken a few minutes to implement while the machine needs two hours to get ready to operate. Use that time to combine the film with cellophane tape. The cost of cellophane tape is cheap and easy to get.
Every times machine stops, operator need to reject the first 15 shots of printing film. Usually the stop of the machine is caused by the printing film is ripped off from the roll. Every starting of the process required to reject 15 shots of the printing film to pull up to the bobbin.	As the suggestion of combination of the new printing film with the used printing film, the suggestion for this problem is actually the same. A purpose of this action is to reduce the defect.
Tiredness. The machine operator is only a person. The operating machine is handled by him alone. When the large production required short amount of time, the operator should be very tired. The tiredness affects the effectiveness of handling machine.	Ensure the working movement is in the right posture. The right posture while doing work is reduced the tiredness and the health of the operator is more guaranteed to be safe. The clean workspace helps the operator to feel comfortable doing work.

Table 4.5: The problem and solution suggested (continue)

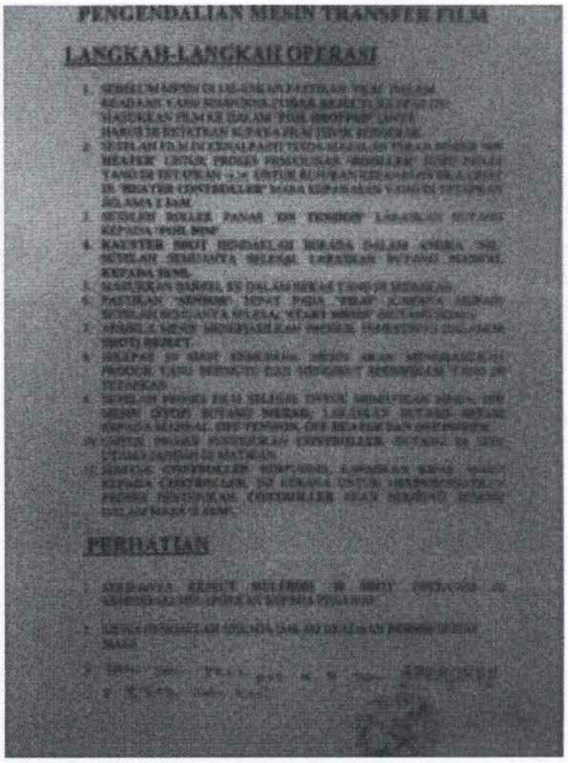
Problem Description	Solution to suggest
The roller is too hot. The machine is operated in the open room environment. The unexpected weather is the factor of the roller is being too hot. The overheat roller could affect the material of the printing film while printing the barrel. Too hot of roller is the cause of the printing film is ripped off.	Adjust the setting of the temperature of the roller, synchronize with the environment temperature. The best workplace for printing barrel is in air condition environment. This is because, the temperature of the air condition environment is fixed, and the setting of the machine is not influenced by the room temperature.

4.7 Implementation of the Solution

As the solution of the miss printing film is suggested to the administration of the Global Factor Sdn Bhd, the implementation of the solution is applied to the printing film production process. Not all of the suggestion is approved based on the cost rising for the improvement of the workplace. The small action takes to reduce the defects of the company while the existing defect is only 1.609% from the total production.

The approved of the suggestion are the standard of the operation prepared by the operator, the combination of the used printing film with the new roll of printing film and the working postures.

The standard of operation is prepared and reviewed in Figure 4.16. The standard of operation helps the operator to handle heat transfer film machine when the person in charge is absent. The standard of operation contains the fixed setting should be used to operate the heat transfer film machine.


PENGENDALIAN MESIN TRANSFER FILM

LANGKAH-LANGKAH OPERASI

PERHATIAN

Figure 4.16: The standard of the operation

The combination of the film using cellophane tape is implemented in the company. The data collection of the implementation applied is recorded for the purpose of comparing the result. The comparison of the results is reviewed by the calculation.

4.8 Problem Identification after the implementation of solution

The data is collected as the same term of the studied before. The three month of the data is collected after the implementation of the solution of the previous company performance to compute the productivity improvement of the company. Table 4.6 shows the data collection of the defect in printing film for three month after applied the solution of the miss printing film.

Table 4.6: Defects of printing film (after implementation)

Types of Defect	Defects of Printing Film (pcs) Sept 2012 Week 1	Sept 2012 Week 3	Oct 2012 Week 1	Oct 2012 Week 3	Nov 2012 Week 1	Nov 2012 Week 3	Frequency (pcs)
Miss Printing Shots	16	16	16	16	16	16	96
Incomplete Printing	78	82	82	79	77	81	479
Poor Printing Alignment	14	11	12	13	10	9	69
Others (Wrong Direction, Incorrect Film)	13	9	10	11	15	13	71
Total	239		239		237		715

Source: Global Factor Sdn Bhd

The data for Pareto Chart is constructed as Table 4.7. The data from table from Table 4.6 is reconstructed descending from the highest frequency defects to the lowest frequency defects.

Table 4.7: Data for Pareto Chart (Defects of printing film after implementation)

Types of Defects	Frequency (pcs)	Relative %	Cumulative Frequency	Cumulative Frequency %
Incomplete Printing	479	67.00	479	67.00
Miss Printing Shots	96	13.42	575	80.42
Others (wrong direction, incorrect film)	71	9.93	649	90.35
Poor Printing Alignment	69	9.65	715	100

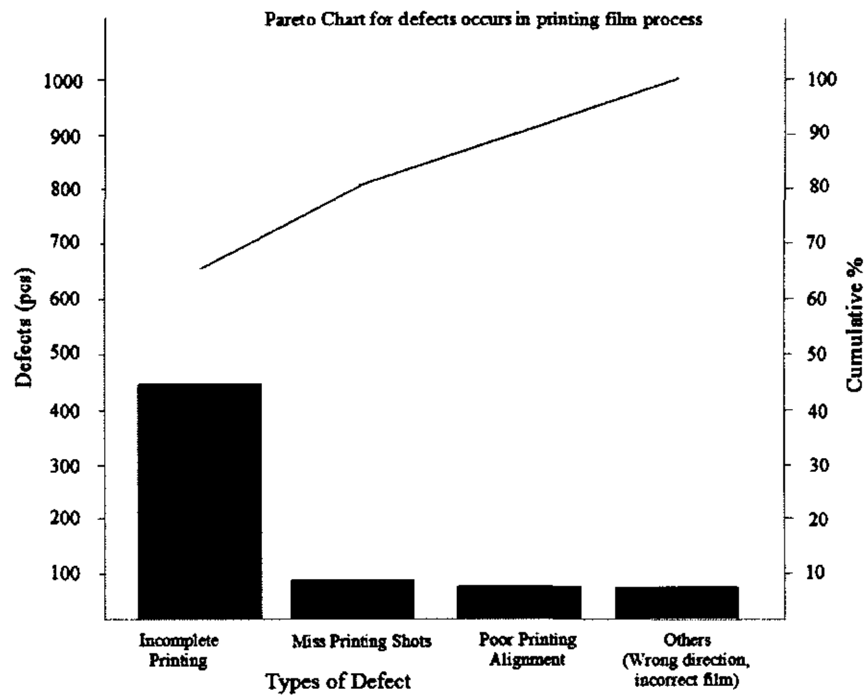


Figure 4.17: Pareto Chart for defect occurs in printing film process

Figure 4.17 show that the highest frequency of the defects is the incomplete printing film which is the total defect is 497 pcs over 715 pcs of defects. The miss printing shots, the poor printing alignment and the others defects are below than 100 pcs of rejection.

Compared to the previous three month of study, the miss printing shots is totally decreased. Based on the previous Pareto Chart, the highest frequency of the defects is selected to be the case of the study. For the further improvement, the incomplete printing should be selected to be the case of the study.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study was carried out in order to solve the existed defect in Global Factor Sdn Bhd. It was identified that the miss printing shots is the highest defects that contribute to low productivity and low efficiency to the process of printing film. The industrial engineering tools involved in this study were check sheet, pareto chart, cause and effect diagram and flow chart.

The objectives of this project are successfully achieved by implementing industrial engineering tools in Global Factor Sdn Bhd. The defect with the highest frequency was determined at the process of printing film. New methods were produced to the selected SMEs company thus improve the productivity of the company.

The analysis shows the highest defect for miss printing film which caused by wrong setting of the machine, the miss shots of printing film, the miss printing shots cannot be reused, the roller is too hot and the man operated the machine is tired. The comprehensive study by cause and effects analysis slow thus phenomenom was caused by the existing causes. Therefore, the analysis discovered the best solution for this problem is the used printing film is combined with the new roll of printing film using cellophane tape.

As a result, the Global Factor Sdn Bhd could save RM745.80 per year for implementing the new method. The company could produce 838,848 pcs per year using the new method compared to 831,360 pcs of printing barrel per year using the original method. The labor productivity increased about 0.90%.

5.2 Recommendation

Based on the study carried out at Global Factor Sdn Bhd,there are several recommendations in order to improve the productivity in the future. Below are the recommendations for the future work:

(i) Enhance the analysis by using simulation method such as WITNESS, ARENA, PROMODEL, CIMFACTORY, and others.Nowadays, there are varieties of microcomputer-based simulation packages on the market. This will help to reduces the time spent experimenting, by automatically finding the optimum solution to satisfy chosen performance criteria which is fully customizable, by setting the parameters that are allowed to change and the optimizer will perform experiments intelligently to find the best solutions.

(ii) Enhance the safety stage and cleanliness of workplace. Practice 5S concept in workplace (Sorting, Straightening or Setting in Order, Sweeping or Shining, Standardizing and Sustaining the Practice). Practice the good manner in the workplace to avoid any accident or any injury.

(iii) Analyse the second highest defects is to identify the real problem exist in order to reduce the frequency of defects. Use the same concept in this study to the other existing defects to minimizing the defects and improving the productivity of the company.

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APPENDIX A1

GANTT CHART FOR FINAL YEAR PROJECT 1

ACTIVITY/WEEK		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discussion with supervisor & arrange weekly meeting	Planning	X														
	Actual	•														
Find suitable company to do research	Planning		X													
	Actual		•	•	•	•										
Read journal related to the tittle	Planning		X	X												
	Actual		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Select & giving confirmation to the company	Planning				X	X										
	Actual				•	•										
Determine the scope of the project	Planning					X	X									
	Actual				•	•	•									
Collect & analyzing data	Planning						X	X	X	X						
	Actual							•	•	•	•					
Built up model & analyze model	Planning									X	X	X	X	X		
	Actual											•	•	•	•	•
Suggest the solution	Planning														X	
	Actual															
Report content discussion	Planning		X													
	Actual		•													
Read books, journal related to the tittle	Planning		X	X												
	Actual		•	•	•	•										
Company backgroud & data collection from company	Planning			X	X											
	Actual			•	•	•										
Chapter 1 : Introduction to report writing	Planning			X	X	X										
	Actual			•	•	•										
Chapter 2 : Literature review of report writing	Planning				X	X	X	X								
	Actual				•	•										
Chapter 3 : Company background & report writing	Planning						X	X	X	X	X					
	Actual			•	•	•	•									
Chapter 4 : Analyzing data & discussion	Planning							X	X	X	X	X				
	Actual						•	•	•	•	•	•				
Compilation of report writing	Planning												X	X		
	Actual												•	•	•	
Planning on master project and presentation	Planning														X	X
	Actual													•	•	•
Project presentation	Planning															X
	Actual															•

APPENDIX A2

GANTT CHART FOR FINAL YEAR PROJECT 2

ACTIVITY/WEEK		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discussion with supervisor & arrange weekly meeting	Planning	X														
	Actual															
Read books, journal related to the tittle	Planning	X	X	X	X	X										
	Actual															
Collect data	Planning		X	X	X	X	X	X	X							
	Actual															
Analyze data	Planning				X	X	X	X	X							
	Actual															
Suggest the solution	Planning							X	X	X	X	X				
	Actual															
Report content discussion	Planning	X	X													
	Actual															
Chapter 5: Discussion and Result	Planning		X	X	X	X	X	X	X	X						
	Actual															
Chapter 6: Conclussion and Recommendation	Planning							X	X	X	X					
	Actual															
Compilation of report writing	Planning									X	X	X	X			
	Actual															
Planning on master project and presentation	Planning										X	X	X	X		
	Actual															
Project presentation	Planning														X	X
	Actual															

APPENDIX B1

FKM APPROVAL LETTER

Fakulti Kejuruteraan Mekanikal
Faculty of Mechanical Engineering

26600 Pekan, Pahang Darul Makmur.
Tel : (+609) 424 2201
Faks/Fax : (+609) 424 2202
Web : www.ump.edu.my

Universiti Malaysia PAHANG

RUJ. KAMI *(OUR REF.)* : UMP.14.02/14.20 (40)
RUJ. TUAN *(YOUR REF.)* :

21 November 2011

SESIAPA YANG BERKENAAN

Tuan,

PENGESAHAN PELAJAR MENJALANI PROJEK SARJANA MUDA (PSM) UNIVERSITI MALAYSIA PAHANG

NAMA	:	**MOHD SHAFIE BIN SULAIMAN**
NO MATRIK	:	**ME08067**
NO KAD PENGENALAN	:	**890908-11-5957**
PROGRAM	:	**SARJANA MUDA KEJURUTERAAN MEKANIKAL DENGAN KEJURUTERAAN PEMBUATAN**

2. Adalah dimaklumkan bahawa pelajar yang tersebut di atas merupakan pelajar Fakulti Kejuruteraan Mekanikal, Universiti Malaysia Pahang, Pekan, Pahang.

3. Pelajar tersebut sedang menjalankan kajian 'Productivity Improvement using Industrial Engineering Tool (SMES Company)' untuk Projek Sarjana Muda. Segala informasi yang akan diberikan oleh pihak tuan hanya akan digunakan untuk tujuan PSM sahaja.

4. Kerjasama dan bantuan pihak tuan amat dihargai.

Sekian. Terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan tugas,

MOHD SHAHRI BIN MOHD AKHIR
Penolong Pendaftar
b/p : Dekan
Tel : 09-424 2271

MSMA/Azreen_2011

MSC NIOSH

APPENDIX C1

COMPANY BACKGROUND

a) Company Profile of Global Factor Sdn Bhd

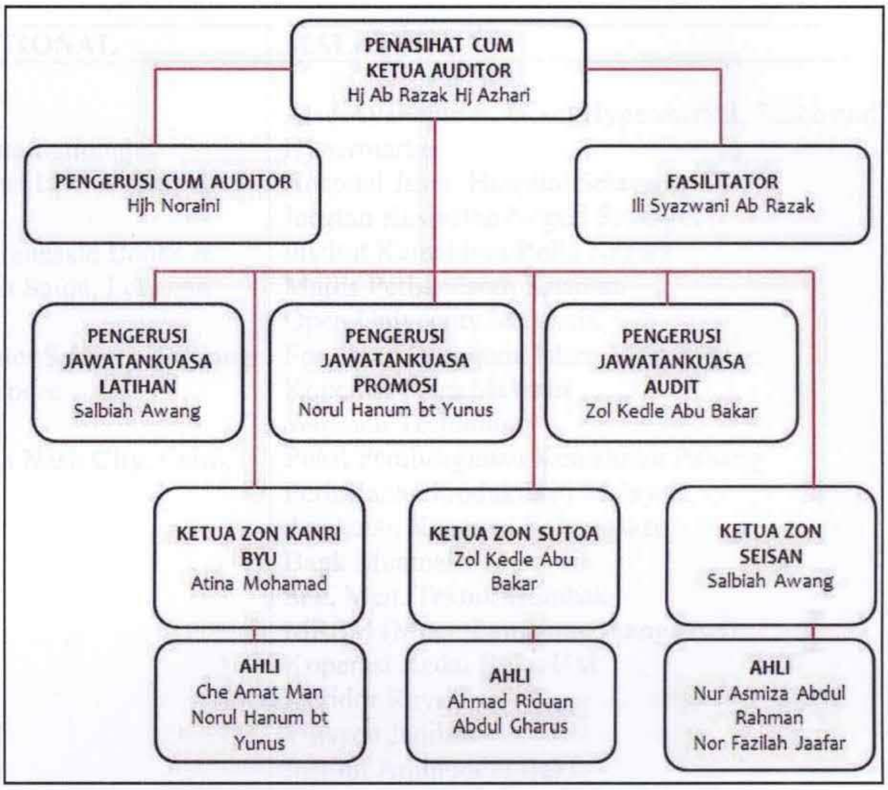
LATAR BELAKANG SYARIKAT		
Nama Syarikat	:	GLOBAL FACTOR SDN BHD
No Pendaftaran	:	254647-H
Alamat Perniagaan	:	Lot 9, Kawasan Industri Kecil dan Sederhana, Pertumbuhan Desa Kampung Soi, 25150 Kuantan, Pahang
No Telefon	:	09-5343191 / 09-5343180
No Faks	:	09-5343360
Email	:	globalf@dpro.com.my
Tarikh Beroperasi	:	1 Julai 1995
Modal Dibenar	:	RM 1000,000.00
Modal Berbayar	:	RM 1000,000.00
Taraf Syarikat	:	Bumiputera (No Rujukan Pendaftaran 357-00033981)
Aktiviti	:	Pembuatan Alatulis : Produk KEDIDI
Lembaga Pengarah	:	En Hj. Ab. Razak Bin Hj Azhari (Pengarah Urusan)
	:	Pn. Hjh. Nor'aini Binti Rusmin (Pengarah)

b) Products of Global Factor Sdn Bhd

The product list from Global Factor Sdn Bhd:

1. Kedidi Permanent Marker (didi BOLD)
2. Kedidi Click Point Ballpen
3. Kedidi Permanent Refill Ink (didi BOLD)
4. Kedidi Ring File (25mm, 40mm, 50mm)
5. Kedidi Whiteboard Marker (didi Touch!)
6. Kedidi Whiteboard Sheet(A4, A3)
7. Kedidi Whiteboard Refill Ink (didi Touch!)
8. Whiteboard Refill (Bottle)
9. Kedidi Blister Pack
10. Interchangeable Nibs

c) **Organization Structure of Global Factor Sdn Bhd**



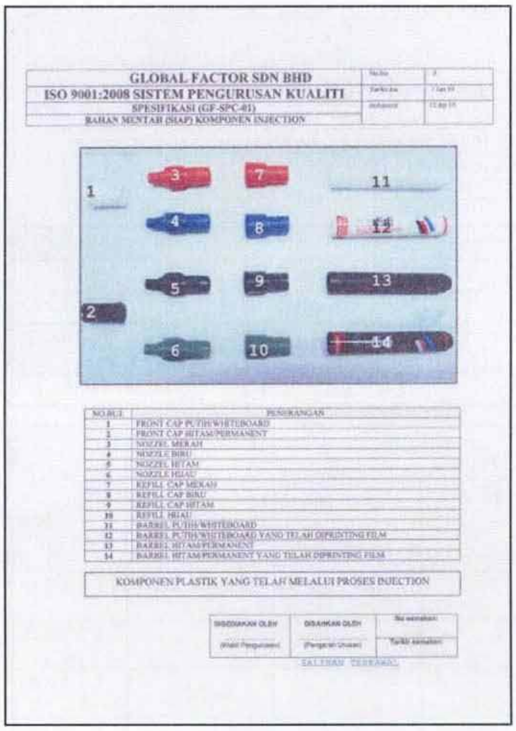
d) **Machine Technology in Global Factor Sdn Bhd**

e) Customers of Global Factor Sdn Bhd

INTERNATIONAL	MALAYSIA
Diamond International Consolidators LLC Dubai, UAE Osseiran Wholesale Books & Stationery St Saida, Lebanon Ace Computer Systems Geylang Road, Singapore Marco Grain Nash City, Cairo, Egypt	Also Available at: Giant Hypermarket, Tesco and Mydin Hypermarket Hospital Jasin, Hospital Selayang Jabatan Kesihatan Negeri Selangor Institut Kemahiran Belia Negara Majlis Perbandaran Kuantan Open University Malaysia Persatuan Pengguna Islam Malaysia Koperasi Putra Makmur Winsack Technology Pusat Pembangunan Kemahiran Pahang Perbadanan Produktiviti Malaysia Angkatan Koperasi Kebangsaan Bank Muamalat Malaysia Sek. Men. Teknik Gombak MRSM (Muar, Lenggong, Langkawi) Koperasi Kedai Buku UM Koridor Raya Tuisyen Jadibes Institut Aminuddin Baki Ambang Bumi Strategik Oil & Gas Lembaga Hasil Dalam Negeri, Melaka Koperasi SMART Kolej Matrikulasi Melaka Kolej MARA Kuala Nerang Kolej Kemahiran Tinggi MARA, Petaling Jaya Perbadanan Kemajuan Negeri Selangor Pesona Hias Sdn Bhd Quality Hotel City Centre Bahtreen Tuition Centre Institusi Kewangan seperti Bank-bank Perdagangan Pusat Pengajian Tinggi, Maktab Perguruan dan sekolah-sekolah

APPENDIX C2

QUALITY MANAGEMENT SYSTEM OF GLOBAL FACTOR SDN BHD



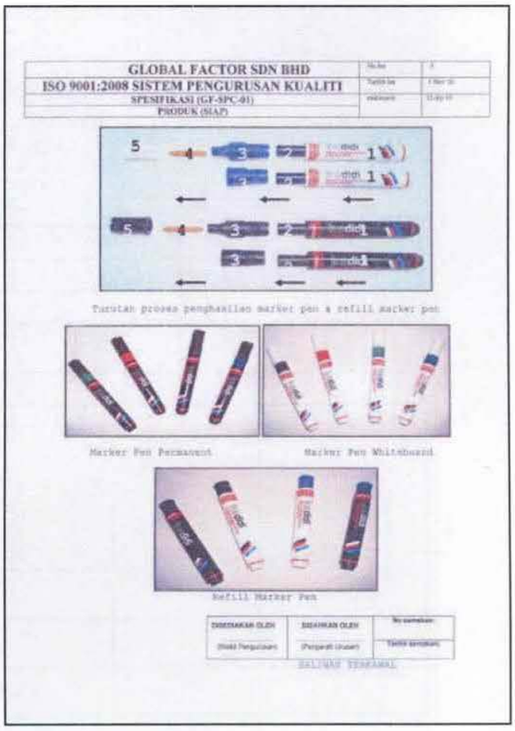
GLOBAL FACTOR SDN BHD
ISO 9001:2008 SISTEM PENGURUSAN KUALITI
SPESIFIKASI (GF-SPC-01)
BAHAN MENTAH (SIAP) KOMPONEN INJECTION

NO.BUT	PENERANGAN
1	FRONT CAP PUTIH/WHITEBOARD
2	FRONT CAP HITAM/PERMANENT
3	NOZZEL MERAH
4	NOZZLE BIRU
5	NOZZEL HITAM
6	NOZZLE HIJAU
7	REFILL CAP MERAH
8	REFILL CAP BIRU
9	REFILL CAP HITAM
10	REFILL HIJAU
11	BARREL PUTIH/WHITEBOARD
12	BARREL PUTIH/WHITEBOARD YANG TELAH DIPRINTING FILM
13	BARREL HITAM/PERMANENT
14	BARREL HITAM/PERMANENT YANG TELAH DIPRINTING FILM

KOMPONEN PLASTIK YANG TELAH MELALUI PROSES INJECTION

DISEDIAKAN OLEH	DISAHKAN OLEH	No semakan:
(Wakil Pengurusan)	(Pengarah Urusan)	Tarikh semakan:

SALINAN TERKAWAL



GLOBAL FACTOR SDN BHD
ISO 9001:2008 SISTEM PENGURUSAN KUALITI
SPESIFIKASI (GF-SPC-01)
PRODUK (SIAP)

Turutan proses penghasilan marker pen & refill marker pen

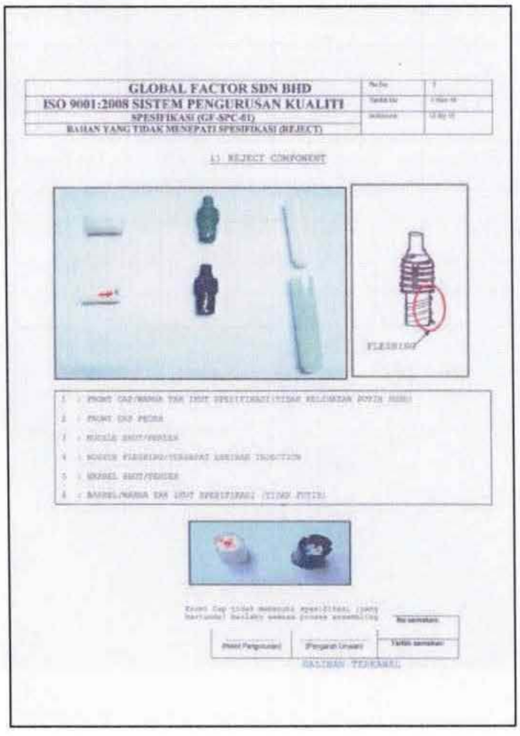
Marker Pen Permanent

Marker Pen Whiteboard

Refill Marker Pen

DISEDIAKAN OLEH	DISAHKAN OLEH	No semakan:
(Wakil Pengurusan)	(Pengarah Urusan)	Tarikh semakan:

SALINAN TERKAWAL



GLOBAL FACTOR SDN BHD
ISO 9001:2008 SISTEM PENGURUSAN KUALITI
SPESIFIKASI (GF-SPC-01)
BAHAN YANG TIDAK MENEPATI SPESIFIKASI (REJECT)

i) REJECT COMPONENT

FLESHING

DISEDIAKAN OLEH	DISAHKAN OLEH	No semakan:
(Wakil Pengurusan)	(Pengarah Urusan)	Tarikh semakan:

SALINAN TERKAWAL

GLOBAL FACTOR SDN BHD
ISO 9001:2008 SISTEM PENGURUSAN KUALITI
SPESIFIKASI (GF-SPC-01)
BAHAN YANG TIDAK MENEPATI SPESIFIKASI (REJECT)

ii) REJECT PRINTING FILM

DISEDIAKAN OLEH	DISAHKAN OLEH	No semakan:
(Wakil Pengurusan)	(Pengarah Urusan)	Tarikh semakan:

SALINAN TERKAWAL

APPENDIX C3

CHECK SHEET FROM GLOBAL FACTOR SDN BHD

No. Ruj	GF-FINJ-12
SALINAN ASAL	

GLOBAL FACTOR SDN.BHD.
PENGIRAAN KAUNTER SHOT(HARIAN)
HEAT TRANSFER FILM WHITEBOARD/PERMANENT
SEKSYEN PENTADBIRAN, KEWANGAN & PENGELUARAN
UNIT INJECTION & PRINTING

JENIS WRAP FILM	WHITEBOARD/~~PERMANENT~~	MASA MULA MAC	10 am
TARIKH	15 08 2011	MASA TAMAT MAC	5 30 pm
OPERATOR		REST MAC	–
SYARIKAT (JIKA DARI LUAR)	BOD	DOWNTIME MAC	-
KUANTITI SASARAN	6250 pcs	UPTIME MACHINE	6 - jam - 30 m

OPERASI	OK	SEBAB KECACATAN				RECYCLE
		JUMLAH REJECT	INCOMPLETE PRINTING	POOR PRINTING ALIGNMENT	OTHERS WRONG DIRECTION, INCORRECT FILM	
INJECT 1		12				
INJECT 2	1220		7			
INJECT 3	1220			3		
INJECT 4	1220	10	1	3		
INJECT 5	1220		13	9		
INJECT 6	1220					
INJECT 7	68	15	9			
FINISH						
JUMLAH	6168	37	30	15		

TOTAL OUTPUT	-	TOTAL REJECT	=	PART OK		PLAN-PART OK	EFFICIENCY %
6250		82		6168		6250	98.68

KOMEN/ULASAN:	DISEMAK OLEH:
GLOBAL FACTOR SDN. BHD. UNIT LEADER UNIT INJECTION/PRINTING	GLOBAL FACTOR Q.C INSPECTOR UNIT QC

APPENDIX D1

CALCULATIONS OF COST AND PRODUCTIVITY

(i) Comparing the Cost

The cost of the defects before and after implementation of the new method is calculated and compared. The original method:

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ month = 720\ pcs$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 720\ pcs\ x\ 12\ months$$

$$= 8{,}640\ pcs\ per\ year$$

$$Average\ cost\ of\ miss\ printing\ shots\ defects\ per\ pieces = RM0.10\ per\ pieces$$

$$Total\ of\ loses\ every\ year\ (on\ miss\ printing\ shots)$$

$$= 8{,}640pcs\ per\ year\ x\ RM0.10\ per\ pieces$$

$$= RM864.00\ per\ year$$

The new method (after the implementation):

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ month = 96\ pcs$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 96\ pcs\ x\ 12\ months$$

$$= 1{,}152\ pcs\ per\ year$$

$$Average\ cost\ of\ miss\ printing\ shots\ defects\ per\ pieces = RM0.10\ per\ pieces$$

$$Average\ cost\ of\ cellophane\ tape = RM3.00\ per\ pieces$$

$$Total\ of\ loses\ every\ year\ (on\ miss\ printing\ shots)$$

$$= (1{,}152\ pcs\ per\ year\ x\ RM0.10\ per\ pieces) + RM3.00$$

$$= RM118.20\ pcs\ per\ year$$

The change in costs between the original method with the new method:

$$RM864.00 - RM118.20 = RM745.80$$

The Global Factor Sdn Bhd could save RM745.80 per year for implementing the new method.

(ii) Labour Productivity

The calculation of the labor productivity of the original method is calculated and compared to the new method.

$$Working\ staff\ on\ Heat\ Transfer\ Machine = 1\ worker$$
$$Working\ hours\ per\ day = 8\ hours$$
$$Working\ day\ per\ week = 5\ days$$
$$Total\ working\ hour\ per\ year = 2080\ hours$$
$$Total\ labor\ hour\ per\ year = 2{,}080\ hours\ x\ 1\ worker$$
$$= 2{,}080\ labor\ hours$$
$$Average\ production\ of\ printing\ film\ per\ month = 70{,}000\ pcs$$
$$Average\ production\ of\ printing\ film\ per\ year$$
$$= 70{,}000\ pcs\ per\ month\ x\ 12\ months$$
$$= 840{,}000\ pcs\ per\ month$$

The original method:

$$Average\ of\ miss\ printing\ film\ defect\ per\ month = 720\ pcs$$
$$Average\ of\ miss\ printing\ film\ defect\ per\ year = 720\ pcs\ x\ 12\ month$$
$$= 8{,}640\ pcs$$
$$Average\ of\ production\ every\ year = 840{,}000\ pcs - 8640\ pcs$$
$$= 831{,}360\ pcs\ per\ year$$
$$Labor\ productivity = \frac{831{,}360\ pcs\ per\ year}{2080\ labor\ hours}$$
$$= 399.70\ pcs\ per\ labor\ hours$$

The new method (after the implementation):

$$Average\ of\ miss\ printing\ film\ defect\ per\ month = 96\ pcs$$
$$Average\ of\ miss\ printing\ film\ defect\ per\ year = 96\ pcs\ x\ 12\ month$$
$$= 1{,}152\ pcs$$
$$Average\ of\ production\ every\ year = 840{,}000\ pcs - 1{,}152\ pcs$$

$$= 838{,}848\ pcs\ per\ year$$

$$Labor\ productivity = \frac{838{,}848\ pcs\ per\ year}{2080\ labor\ hours}$$

$$= 403.29\ pcs\ per\ labor\ hours$$

Change in labor productivity:

$$\frac{403.29 - 399.70}{399.70} x\ 100\% = 0.90\%$$

The Global Factor Sdn Bhd could produce 838,848 pcs per year using the new method compared to 831,360 pcs of printing barrel per year using the original method. The labor productivity increased about 0.90% by using the new method.

(iii) Defect Reduction

The original method:

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ month = 720\ pcs$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 720\ pcs\ x\ 12\ months$$

$$= 8{,}640\ pcs\ per\ year$$

$$Average\ frequency\ of\ the\ defects\ of\ printing\ film = 1{,}408\ pcs\ per\ month$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 1408\ pcs\ x\ 12\ months$$

$$= 16{,}896\ pcs\ per\ year$$

$$Average\ percentage\ of\ miss\ printing\ shots\ per\ year = \frac{8{,}640}{16{,}896}\ x\ 100\%$$

$$= 51.14\%$$

The new method (after the implementation):

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ month = 96\ pcs$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 96\ pcs\ x\ 12\ months$$

$$= 1{,}152\ pcs\ per\ year$$

$$Average\ frequency\ of\ the\ defects\ of\ printing\ film = 715\ pcs\ per\ month$$

$$Average\ frequency\ of\ miss\ printing\ shots\ defects\ per\ year$$

$$= 1{,}152\ pcs\ x\ 12\ months$$

$$= 8{,}580\ pcs\ per\ year$$

$$Average\ percentage\ of\ miss\ printing\ shots\ per\ year = \frac{1{,}152}{8{,}580}\ x\ 100\%$$

$$= 13.42\%$$