



UNIVERSITI TEKNIKAL MALAYSIA MELAKA(UTeM)

**TITLE: EFFECT OF ASSEMBLY LINE AND NORMAL
WORKING ENVIRONMENT TO CYCLE TIME**

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DECLARATION

I hereby, declared this report entitled “PSM Title” is the results of my own research
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Signature :.....
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ABSTRAK

Sekarang ini, sektor pembuatan di Malaysia mempunyai banyak persaingan. Ini menunjukkan bahawa sektor pembuatan di Malaysia berkembang dengan pesat dan pengeluar sentiasa mencari cara untuk meningkatkan produktiviti mereka, kualiti dan lain-lain. Laporan projek ini membincangkan tentang kesan persekitaran barisan pemasangan (assembly line) di bawah persekitaran kerja biasa kepada kitaran masa. Dua bekas berbeza untuk komponen plug (bersudut dan rata), dua aliran lain reka bentuk jig (tegak dan segi empat tepat), dua kerja berlainan keadaan (duduk dan berdiri) dan jantina berlainan pengendali (lelaki dan wanita) akan dikaji dengan tujuan untuk memerhatikan kesan kesemua pembolehubah ini kepada produktiviti. Reka bentuk eksperimen 2^4 dengan dua peringkat di mana setiap faktor digunakan untuk menjalankan eksperimen ini. Objektif kajian ini ialah untuk mengenal pasti pembolehubah-pembolehubah yang boleh mempengaruhi barisan pemasangan (assembly line) di bawah persekitaran kerja biasa kepada kitaran masa dan menentukan pembolehubah yang nyata sekali mempengaruhi prestasi barisan pemasangan (assembly line) di bawah persekitaran kerja biasa. Hanya satu set reka bentuk barisan pemasangan (assembly line) digunakan untuk eksperimen ini, di mana ianya adalah untuk menyiapkan eksperimen dalam satu kitaran masa tetapi ia melibatkan operator lelaki dan operator wanita dengan postur kerja yang berbeza ketika proses pemasangan plug dilakukan. Dua jenis jig digunakan yang mana bentuk segi empat tepat dan tegak. Selain daripada itu, dua set penempatan bekas digunakan untuk eksperimen (bersudut dan rata). Data terkumpul berdasarkan kepada eksperimen yang dijalankan sahaja. Selain daripada itu, kaedah digunakan untuk menganalisa data eksperimen ini ialah dengan menggunakan teknik Rekabentuk Eksperimen. Salah satu daripada teknik analisis di Rekabentuk eksperimen ialah Analisa varian.

ABSTRACT

Nowadays, manufacturing sectors in Malaysia have high competition. This indicator shows a manufacturing sectors in Malaysia had growth faster and the manufacturers are constantly looking for ways to improve whether in their productivity, quality and others. This report is discussed about the effect of assembly line and normal working environment to cycle time of plug. Two different bin placement (angular and flat), two different set of jig design (vertical and rectangular), two different working postures (sitting and standing) and different genders of operator (male and female) will studied to observe their effect to productivity. Design of Experiment 2^4 with two levels of each factor is used in order to conduct the experiment for obtaining the most productive gender and bin placement. The objective of these studies is to identify variables influence performance of assembly line design in normal working environment and to determine variables that significantly influence the performance of assembly line in normal working environment. Only one set of assembly line design is use for the experiment to complete assembled one plug but it involves male and female operator with standing and sitting working posture. Both type of jig is used which is vertical and rectangular shape. Besides that, two sets of bin placement were set up for the experiment (angular and flat). Data collected will be based on the experiment only. Others than that, the method apply to analyze the data in this experiment is Design of Experiment. One of the analysis techniques in Design of Experiment is the Analysis of Variance (ANOVA).

DEDICATION

This report is dedicated to my parent that has given me the encouragement and motivation to succeed in the future. They taught us some of our most valuable lessons, sometimes painfully, but always constructively and with fairness. Without their encouragement and support, this success would not have been possible. Besides that, high appreciated to my friend who involved indirectly to complete this report and not forget also to someone really special in my life because always supported me from behind.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

KLIA	-	Kuala Lumpur International Airport
MIDA	-	Malaysian Industrial Development Authority
FDI	-	Foreign Direct Investment
UTeM	-	Universiti Teknikal Malaysia Melaka
ANOVA	-	Analysis of Variance
DoE	-	Design of Experiment
WIP	-	Work In Progress
PSM	-	Projek Sarjana Muda
BS1363	-	Electric Plug Model
T – TEST	-	A statistical examination of two population means.

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter contains the background of manufacturing industry in Malaysia. Problem statement is also written in this chapter. The problem statement is the part where it states the problem regarding to this report. Objective of the project are also stated in this report. Scope of the experiment is also discussed in this chapter in order to identify the specific limit of these studies. Besides that, organization chart is the part where the short summarize of each chapter in this reports are discuss.

1.1 Background

The manufacturer is derived from two Latin words, *manus* (hand) and *factus* (make). The combination these words means ‘made by hand’. The English word was several centuries old, and “made by hand” accurately described as manual methods used when the word was first coined. According to Groover (2007), manufacturing is about the application of physical and chemical process to alter the geometry, properties or appearance of a given starting material to produce a part or products. Manufacturing process also includes assembly of multiple parts to make products.

In Malaysia, manufacturing is one of the most important sectors. Besides agriculture, labor intensive is considered high yield investment opportunity in Malaysian manufacturing sector. The development of countries economic is driven by sector export orientated manufacturing and as a result, it makes Malaysia the top choice for foreigners to invest in the industry. There are a few reasons basically that encouraged

continuous growth of manufacturing sector in Malaysia. Strategic location at South East Asia, enhance with the government effort to offers a dynamic and productive business environment which is suitable for investors to establish office, factories or corporations to manufacture high quality products for international market. Furthermore, the proper development of infrastructure and trained workforce are also been reasons that brought in countless foreign investors to the country. The five latest international airports complete with air-cargo facilities such as Kuala Lumpur International Airport (KLIA) and seven international seaports like Port Klang make it convenient for investors to expand and flourish their business in regional and global market.

Pursuant to data issued by the Malaysian Industrial Development Authority (MIDA, 2012), the accounted of manufacturing sector for just over half of all Foreign Direct Investment (FDI) inflows last year (2011), almost double the 27% drawn in by the services sector. With FDI in 2011 increasing by 12.3% to around \$11billion, manufacturing's share of that total came to around \$5.5 billion (Community, 2011). Total investments in the sector also surged in 2011, with 846 manufacturing projects carrying a total value of \$18.57 billion approved last year, a 19% increase over the \$15.6 billion recorded in 2010 (Community, 2011). Of these investments, locals' contributions numbered \$7.3 billion, or 39% of the total, while the balance came from FDI. A full third of new projects approved were in the electrical and electronic industry, followed by basic metal products, and chemicals and chemical products (Community, 2011).

Malaysian Investment Development Authority (MIDA) is the body that accountable to give information on the business opportunity in the country. Other than that, MIDA also responsible to supervise the promotion and development of manufacturing sectors in the country. A company who newly established should seek MIDA for advice in facilitating and executing their projects. To a new company, once they try to produce a product in large quantity so that they can fulfill the demand of the customer and this is called productivity. Indirectly they can sustain their business in their invested country because productivity influencing profit and performance of the company.

Productivity is an important element in manufacturing industry in order to fulfill customer demand with maximum output and minimum loss without affecting production yield. Every industry is concern about their productivity because it can be their benchmarking to prospect client. Nowadays, many industries try to improve their productivity by implementation of a few method or technique. Usually productivity refers to physical relation where output is divided into input. Output is about how much product quantity can be produced by the organization and input refers to land, labor, capital, management and etc. In other word, the more output produced the higher is the productivity. Design of assembly line and jig are two factors influence productivity.

Design of assembly line is defined as a manufacturing process where the part are added to a product in a sequential manner to create a finished product by using a special tool (such as jig and fixture) to make the process runs smoothly. A good design of assembly line can contribute higher productivity of production. This is because it gives a large impact in term of short cycle time. In other word, a good design of assembly line can make a process time to produce finished product shorter especially by using special tool such as jig. Jig is a tool that design to ease the process (such as assembly process). There are number of methods can be used to analyze the data collection. This project will describe about the effect of assembly line design and normal working environment to cycle time.

1.2 Problem Statement

Nowadays, manufacturing industry has been come out with a few techniques to achieve the maximum performance on their assembly line design. Workers performance is actually related to the design and indirectly influences company productivity. Adi, Seri Rahayu et al. (2007) explored about the effect of different workstation design such as height of the table used for plug assembly process and different position of working posture. Besides that, the effect of using production tool (jig) to cycle time are also investigated and the optimum setting of workstation design is also include in the first journal. Saptari, Lai et al. (2011) studied about the

effect of workstation design, assembly design, jig design and working posture. The different of this second journal compared to the first one is in second journal, the researcher studied about the two sets of assembly line design (one and two operators) and the effect this two assembly line design to productivity.

Design of the workstation is one of the factors that influence productivity. A good workstation design should be safe to the workers. This research will explore about a plug assembly process which considering container position, working posture, jig design and gender. In plug assembly process, container position that use to put the assembly part component should be consider carefully. Whether the container in flat or angular position. Generally, in assembly process sitting and standing posture for the workers plays an important role to measure the workers' performance. Seated posture gives a better controlled for operator arm movements and it provides a stronger sense and balance (Adi, Seri Rahayu et al. (2007). While standing posture, might put an excessive load to the body due to the stressful that cause by a prolonged standing and these may lead to body accumulation in the legs (Adi, Seri Rahayu et al. (2007). On the other hand, gender of the workers also one of the factor that can influence productivity. Jig is used to help the operator in plug assembly process. The purpose of using jig is to hold the plugs earth pin with cover in proper position. Other than that, it also helps the operators to maximize their productivity. In plug assembly process, two types of jig will be designed and produced. The first one has vertical shape orientation in one line and the other has rectangular shape. Besides that, the experiment of this study will be conducted under the normal working environment and the effect of cycle time will be analyzed. Under normal working environment means, the operator will do the plug assembly process without pressure because they assembled the plug without putted the production target to achieve.

1.3 Objective

- a) To identify variables influence performance of assembly line design in normal working environment.

- b) To determine variables that significantly influences the performance of assembly line in normal working environment.

1.4 Scope

- a) This study only explore about assembly line design and jig

Only one sets of assembly line design is use for the experiment to complete assembled one plug but it involves male and female operator with standing and sitting working posture. Both type of jig is used which is vertical and rectangular shape.

- b) The data collected based on the experiment.

Data is collected while the experiment runs for three days. Operator's works at normal working hours from 8.00 am to 5.00 pm with three times breaks. 15 minutes morning breaks, 1 hour lunch break and 15 minutes more for afternoon breaks. Besides that, the experiment is also conduct under the normal working environment (without pressure).

- c) The method to be implemented is design of experiment.

The method apply to analyze the data in this experiment is Design of Experiment. One of the analysis techniques in Design of Experiment is the Analysis of Variance (ANOVA).

1.5 Organization Report

Organization report is about the explanation for each chapter contains in this study. Started from chapter 1, it describe about the development of manufacturing industry in Malaysia. Chapter 1 also stated the problem statement, objective and scope for this project. Next, chapter 2 is present about the literature review related to the study. Literature review means a history about the element, method and technique that used

by previous researcher that related to this project. Methodologies of the study will be briefly explained in chapter 3. It's about the technique and method that identified to be use in this project. Commonly, a suitable method and technique chosen so that it can give a result that related with the project objective. Then, chapter 4 will present result and discussion. Result produce by the method use will be discussed in this chapter. This chapter also decides the main factor that gives impact to the assembly line design and normal working environment to cycle time. Finally, chapter 5 will discuss the conclusion of this project been made based on the overall project result. This chapter also discussed about how far the objective about this study is achieve.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter contains research history or literature review which related to the objective and scope of the project. This literature review chapter covering about the design of assembly line, jig and fixture, working posture, workstation design, productivity, product design and workspace design. All of this information was obtained from the journals, paper and some books that related to the project. Each sources or information was selected based on the relation with the scope of the study.

2.1 Productivity

In manufacturing industry, productivity is an important element use to achieve their target with maximum output and minimum loss without affected production yield. In conjunction to improve productivity, a proper production planning is one of the factors should be considered. As a production engineer, to plan the production output, working condition in the production need to be considered. Productivity is defined as the ratio of what is produced to what is required to produce it. Productivity also can be considered as a measure of the machine, factory, system and person (Perumal, Mohamed et al. 2013).

$$\text{Productivity} = \frac{\text{Input}}{\text{Output}}$$

Output refers to anything comes from a services process or production. Input can be refers to the sources used to produce the particular output. Based on the definition above, it means that productivity is related to the effective use of one or more resource used to generate a required output. For example, the labor productivity can be measured as units produced per labor hour worked. Profitability, technology and quality are usually related with productivity. Nowadays, there is a big challenge on improving productivity in competitive business environment.

To be more specific, productivity can be unnaturally inflated over the short term, product size can be unnaturally extended. It is not only effect in reducing the clarity of the code and its maintainability, but it also effect the performance of the product. To reduce the development time, limited testing and documentation must be done effectively. According to von Mayrhauser and Hirsh (1990), the entire employee should know how they self-improve and indirectly can contribute to the productivity improvement. Quality has an element of cost consideration in it. Once the organization tries to minimize cost in their productivity, costing element can be a constraint. Nowadays manufacturers face a lot of problem of labor shortage. Absenteeism of staff and workers is one of the problems that company can't achieve maximum productivity. Due to the problem, manufacturer tries to find a countermeasure and as the solution, many companies choose to use automation system. By implementing automation system, manufacturer can reduce manpower usage in their process and indirectly improve their productivity. To implement the automated system, design of assembly line in the main factors should be considered. It will give higher impact in productivity especially if the suitable type of assembly line were implemented. There is a few factors give influence to organization's productivity. It can be divided into five categories, which are:-

1) Human factors

The most significant element determined in this factor is human nature and human behavior. Human factors involve both of their ability as well as their willingness:

- a) Ability to work: The more efficient and caliber employee and manager, the higher productivity can be achieved for the organization. Ability to work can be developed by education, training, experience, aptitude, etc. of the employees.
 - b) Willingness to work: Motivation and morale of people plays an important role in productivity. The organization should strive to develop the employee motivation and morale by launch a few method that can affected these two elements such as incentive schemes, labor participation in management, communication systems, informal group relations, promotion policy, union management relations, quality of leadership, flexible working hours, sanitation, ventilation, subsidized canteen, and company transport.
- 2) Technological Factors: Technological factors contributed to significant influence on the level of productivity. Technological factors include implementation of automated system or uses of high technology machine and equipment to help the organization improve their productivity.
- 3) Managerial factors: Productivity is also depends on competency and attitudes of managers. In manufacturing industries, productivity is low even though latest technology is in use and with trained manpower. This is because of the inefficient and indifferent management. An exceptional result can be obtained from the dedicated and competent manager. Performance of employees depends on their ability and willingness to work. Management line acts as the motivator to create both. Application of advanced technology requires knowledgeable and experience workers those are able to work productively under professionally qualified managers.
- 4) Natural factors: such as physical, geographical and climate conditions is determined as factors that give some impact on productivity, especially in unreasonable climates (extreme weather) inclines to be comparatively low. Natural resources like air, fuel and minerals also influence productivity. According to Granjean (1982), environmental satisfaction and air quality affects the job of the workers.

- 5) Economic factors: The market size, banking and credit facilities, transport and communication systems play important roles influencing productivity.

2.1.1 Measure Factor of Productivity

As discuss before, productivity is the important element should be measure by the organization in order to know their employee performance. The standard measure of productivity is by using a formula where input is divided with output. Others than using this formula, There are a several methods that can be used to measures productivity. The choice of the productivity measurement methods is depend on the purpose of productivity measurement and the availability of data.

1) Output

Output can be defined as something produced by some organization through a manufacturing process until the product complete. It can be measure an hour or days. Output is divided in two forms whether physical quantity or financial value.

a) Physical quantity

Product or service is homogenous at the operational level. Output can be measure in physical units such as number of customer served or number of sticker printed. Commonly, such measures can gives reflect to the physical effectiveness and efficiency of a process but it is not affected by price fluctuation (Singapore, 2011).

b) Financial value

Output is seldom uniform at the organization level. It can be measured in financial value such as sales, production value and value added element. (Singapore, 2011)

2) Input

Input can be defined as a material or something use to produce output through the manufacturing process. It can be divided into three categories:

a) Labors

Labor is refers to the all categories of employees in one organization. It includes the managing director, secretary, cleaner, operator and etc. It can be measured in three ways:

i. Number of hours worked

Actual amount of input used is reflecting by these measures. It excludes hours paid but not worked such as public holiday or annual leave.

ii. Number of workers engaged

For these measures, the data on hours work may not be readily available. Part time labor should be converted into full time equivalently. If the number of workers may be fluctuating over a time, the average figure for a period is used.

b) Capital

A term of capital commonly refers to the physical assets such as factory building, land, machinery and equipment that used by the organization to running their production and it can be measures in physical quantities such as number of machine hours or in financial value (Singapore, 2011).

c) Intermediate input

Intermediate input can be defined in a few categories such as energy, business service and materials. Sometimes, such inputs can be measures in kilowatt per hour or kilograms or in financial units.

2) Rework

The goal of manufacturing process is to achieve zero defect or free defect. Zero defects are philosophy should be implementing for each manufacturing sector so that they can reduce their scrap or rework product. Rework encountered at

various steps in the process and some manufacturing process contains multiple inspections with rework. Vital issue for the poor quality product and low production rate is rework (Islam, Khan et al. (2013)). Reworks are non-productive activity where the customers are not willing to pay for. Non-productive activities means the customer did not consider as adding value to the product. Sometimes, it is very useful to estimate the percentage of rework or scrap product will be produced so that the countermeasure for the cause can be identified and indirectly improve the process. According to Graves (1997), if rework or scrap problem are severe, they substantially increase cost and sometimes contributes to material shortages and scheduling problems. Furthermore, units or product rework can affect to customer confidence if the product reach to the customer. Others than that rework product can increase the inventory cost and space due to management did not have enough time to do rework activity because of highest demand for a good product, because of this situation rework product is categorized as a on hold product. By provide a countermeasure in minimization of reworks to make a product as per customer demand with expected quality, the company can invest less money and more costs savings (Islam, Khan et al. 2013).

2.2 Design of Assembly Line

An assembly line is a manufacturing process where the part are added to a product in sequential manner to create finished product by using special tool (such as jig and fixture) to make the process runs smoothly. The origins of the assembly line can be traced back where the used bucket elevators to the shipbuilders of the fourteenth century who created moving lines of parts during medieval times. The assembly line concept was developed and revolves throughout. It is exponential development at the end of 19th century and beginning of the 20th can be attributed to various people over decades, as another advanced technological development took place. To start designed the assembly line, it is important to determine the sequences of operations to manufacture of components or parts as well as the final product. The process flow should be made as simple and short as possible. The previous researcher explained

the assembly line is wide area to be explored. The important of assembly design is to increase the efficiency of the line by maximize the ratio between throughput and costs. A simple process design criterion is to balance the assembly line so that each operation will takes approximately the same amount of time. A balanced line often means better resource utilization and consequently lower production cost (Chow 1990). In other words, the design of assembly line is important in manufacturing industry. The effective technique used in assembly line design will contribute bigger influence in productivity.

2.2.1 Classification of Assembly System

Type of production used is one of the important characteristic of industrial manufacturing. On the other hand, there is the flow line production system and another half is the job shop production system (Lindahl, Hellman et al. 2011). Between these two types of production, there are number of hybrid system that contains properties of both. According to the Scholl (1999), in flow line production system the arrangement of machine and system is based on the technological sequence of production operations. Job shop production is identified when the machine is performing similar production such as milling and lathe machines. There are several production systems that can be suitable for assembly of products. According to (Wild 1975), in flow line production system, two basic type is identified, the mechanical and non-mechanical line. Whose further identifies the other two alternatives system where the individual assembly system and collective assembly system. Below is the different assembly system according to (Wild 1975):

- 1) Mechanical line: Paced lines with fixed or removable items.
- 2) Non mechanical line: Without mechanical pacing and usually with buffer stocks between stations.
- 3) Individual assembly: Complete manufacturing by an operator in a no flow basis.
- 4) Collective assembly: Operators work together on an item.