

**IMPROVING PRODUCTIVITY OF ASSEMBLY LINE IN A MANUFACTURING COMPANY
(PRINTED CIRCUIT BOARD ASSEMBLY)**

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ABSTRACT

This study describe on how to improve the productivity on the production line of Printed Circuit Board Assembly (PCBA) manufacturing plant in Tangkak with the application of line balancing technique. The process of this manufacturing plant is combination of automated machine assembly and manual assembly which are using human to assemble the PCBA. Line balancing techniques are important to equalize work load among the workstations, balance the workstation and keeping the production line produce in high productivity. To achieve this objective, three heuristic line balancing methods (Largest-candidate rule, Kilbridge and Wester's method and Ranked Positional Weight method) and software (ARENA) were used to analyze the data from the production line of the company. After analyzes, Kilbridge and Wester's method and Ranked Positional Weight method provides the same result and also the best results. The performance (productivity, production output and line balancing loss) of the proposed line is compared with the current line to justify the improvement of productivity. This has achieved its objective because the productivity has shown an improvement of as much as 152% just by reducing 53.9% of the line balancing loss and improved 101.5% of the production output.

ABSTRAK

Kajian ini mengenai meningkatkan produktiviti pengeluaran kilang papan litar elektrik. Kajian ini dilakukan di kilang Top Empire yang terletak di Tangkak Muar dengan menggunakan kaedah pengimbangan baris dan melalui simulasi perisian. Di dalam menghasilkan satu papan litar elektrik ia melibatkan pemasangan sepenuhnya oleh mesin dan terdapat beberapa bahagian yang tidak dapat dipasang melalui mesin dan ia dipasang secara manual yang dilakukan oleh pekerja kilang tersebut. Kaedah pengimbangan baris penting didalam menyamakan beban kerja di setiap stesen kerja, memberi keseimbangan di semua stesen kerja dan menghasilkan produktiviti kerja yang tinggi. Untuk mendapat semua objektif tersebut tiga kaedah dalam pengimbangan baris digunakan iaitu 'Largest-candidate rule', 'Kilbridge and Wester's' dan 'Ranked Positional Weight' serta simulasi perisian menggunakan perisian ARENA. Ketiga – tiga kaedah pengimbangan barisan dan simulasi perisian digunakan pada data yang diperolehi dari pengeluaran kilang tersebut. Selepas menganalisis semua data menggunakan semua kaedah, didapati keputusan dari kaedah 'Kilbridge and Wester' dan 'Ranked Positional Weight' adalah yang terbaik dari segi produktiviti dan hasil pengeluaran. Hasil dan keputusan dari analisis dibandingkan dengan prestasi pada masa sekarang dan ia mencapai objektif yang dikehendaki kerana ia menunjukkan peningkatan dari segi produktiviti iaitu 152% dengan mengurangkan 53.9% kehilangan keseimbangan barisan dan pening katan dalam hasil pengeluaran iaitu 101.5%.

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LIST OF SYMBOLS

| | | |
|-----------|---|--------------------------------------|
| d | - | Balance delay or Line Balancing Loss |
| hr | - | Hour |
| min | - | Minute |
| n | - | Number of Workstations |
| n_e | - | Number of work elements |
| s | - | Second |
| T_e | - | Cycle Time |
| T_{e_j} | - | Work element time |
| T_{si} | - | Workstation time |
| T_{wc} | - | Total work contents |

LIST OF ABBREVIATIONS

| | | |
|------|---|--------------------------------|
| FL | - | Final Line |
| IC | - | Integrated Circuit |
| ICT | - | Internal Circuit Test |
| MI | - | Manual Insertion |
| PCB | - | Printed Circuit Board |
| PCBA | - | Printed Circuit Board Assembly |
| RPW | - | Ranked Positional Weight |
| SMT | - | Surface Mount Technology |
| WS | - | Workstation |

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CHAPTER I

INTRODUCTION

1.0 Background

Production lines are an important class of manufacturing systems when large quantities of identical or similar product are to be made. They are suited to situations where the total work to be performed on the product or part consists of many separate steps. Example includes assembled product and mass-produced machined parts on which multiple machining operations are required. In a production line, the total work is divided into small tasks and workers or machines are assigned to perform this task with the great efficiency.

Productivity improvement has become one of the important issues to cope with the high demand of global market and to survive in this competitive world. Otherwise, increasing in productivity generates a potential increase in production. If viewed in quantitative terms, productivity is the ratio of the output produced to the input use. At the national level, productivity is a major element of economic growth and progress.

Productivity improvement can be achieved by various techniques and methods, which consists of technology-based techniques, employee-based techniques, task-based techniques, product-based techniques, and material-based techniques. Line balancing-is one of the task-based techniques that can increase productivity, machine utilization, material utilization and labor utilization in a manufacturing industry.

The study of improving the productivity and efficiency of manufacturing in line balancing will carry out in a Printed Circuit Board (PCB) manufacturing plant. PCB assembly process consist a combination of automatic system and manual system. The assembly process of PCB is very complicated, so that line-balancing techniques are important to balance the workstation, equalize workload among the workstation and keeping the production line in continuous production to achieve the high productivity and high quality.

1.1 Problem Identification

A Printed Circuit Board (PCB) assembly process consists of various processes and work elements. Many factors which causing the low productivity of the plant of production. From the observation and interview, some of the problems that occur in the production line, which cause low-productivity are:

- i. Poor line balancing - Processing time of each of the process in production line and work element is very different. An automated chip placer machine may

take much less time than an internal circuit test (ICT-a partial automated process). Therefore, a high line balancing causes increasing of cycle time at each station that resulted labor utilization at the line, low-level of productivity and machine utilization. Imbalance of the production line caused some work elements would not keep in continuous production.

ii. Machine malfunction- The machine in the production line is running 24 hours a day and only shuts down during the holiday. Many problems will occur everyday and therefore the machine needs to be repair. The problems of the machine will affect the continuity of the production process and the flow of chip mounting on PCB will disrupted.

iii. High defects- One of the factors which causing low productivity at the workstation is high rejects. Low productivity makes the company cannot achieve their vision and mission as a developing company. These situation reduced income and their customer will find another sub-contractor to fulfill their requirement.

iv. Others- Other minority causes such as flow of material utilization in production line is slow, the workers not perform well, material handling is insufficient etc.

In order to achieve the productivity improvement, many ways and techniques can be use to settle the problems. In this study, the productivity improvement concentrates on the line balancing techniques that will repair the poor line balancing. Here, we have three method of the solution by hand to solving the line balancing problems.

- i. Largest-Candidate Rule
- ii. Kilbridge and Wester's Method
- iii. Ranked Positional Weights Method

They are heuristic approaches - based on logic and common sense rather than on mathematical proof. They do not guarantee an optimal solution, but result in good solutions which approach the true optimum.

1.2 Objective of the study

The objective of this study is improving productivity and efficiency of assembly line in a manufacturing. The objectives that include in the main objective are:

- i. To understand identify the problems and causes that affected the productivity of a manufacturing.
- ii. To study the methods of line balancing techniques in order to achieve productivity improvement of a production line in a manufacturing.
- iii. To compare the performance of the production line before and after apply the line-balancing method.

1.3 Scope of the study

The scopes for this study are:

- i. To get the information that related with theory and assembly product of line balancing
- ii. The study will be done on the production line for certain model of product in PCB manufacturing.
- iii. The data that collected is use in the line balancing method.
- iv. Apply the three method of the manual solution to solve the line balancing problems.
 - Largest-Candidate Rule
 - Kilbridge and Wester's Method
 - Ranked Positional Weights Method
- v. Using the Line Balancing function in software ARENA to analyze the production line

CHAPTER II

LITERATURE REVIEW

Literature review will be focused on a few topics that are relevant to this project. This topic will be used in this study of productivity improvement by line balancing techniques in Printed Circuit Board (PCB) assembly manufacturing plant.

2.0 Productivity

According to Sumanth (1990), Productivity is concerned with the efficient utilization of resources (inputs) in producing goods and services (outputs). Similarly, capital productivity and material productivity are examples of partial productivity. There are three basic types of productivity. First, *partial productivity* is the ratio of output to one class of input. For example, labor productivity (the ratio of output to labor input) is a partial productivity measure. Second, *total-factor productivity* is the ratio of net output to the sum of associated labor and capital (factor) inputs. "Net Output" is the total output minus intermediate goods and services purchased. The denominator of this ratio is made up of only the labor and capital inputs factors. Third, *total productivity* is the ratio of output to the sum of all inputs factors. Thus, a total productivity measure reflects the joint impact of all the inputs in producing the output.

2.1 Printed Circuit Board (PCB) Assembly Process Flow

According to the study of Muhammad Zamri Mat Saman and Chung (1997), PCB assembly process flows consist of two main categories in production line. They are SMT (Surface Mount Technology) and OCI (Odd Component Insertion) . The most important process in the manufacture of PCB assembly is SMT operation. In SMT operation, all the stations are linked by conveyors that act as transport used to transfer the PCB from one station to another station.

2.1.1 Surface Mount Technology (SMT)

SMT is a process of mounting chips, small part (chip) and integrated circuit (IC) on the PCB through automation system machine. SMT process is the complicated process because all the part were mounted is very small. There are several operation under this main process which include bonding (mounting glue) or screen printing (solder paste), chip mounting, IC mounting, oven (convection reflow) and convection reflow inspection.

2.1.2 Odd Component Insertion (OCI)

This process is a manual process where odd shaped components are inserted. The process is manual because of the machine cannot do this operation to mount the component. There are several operations for this main process which are manual insertion, wave soldering, board removal, post wave soldering inspection, internal circuit test (ICT), stamping, labeling and packaging. At the last stage, inspections were carried out in order to check the location and orientation of each component and also the function of PCB. The process flow of PCB assembly is shown in **Figure 2.0**

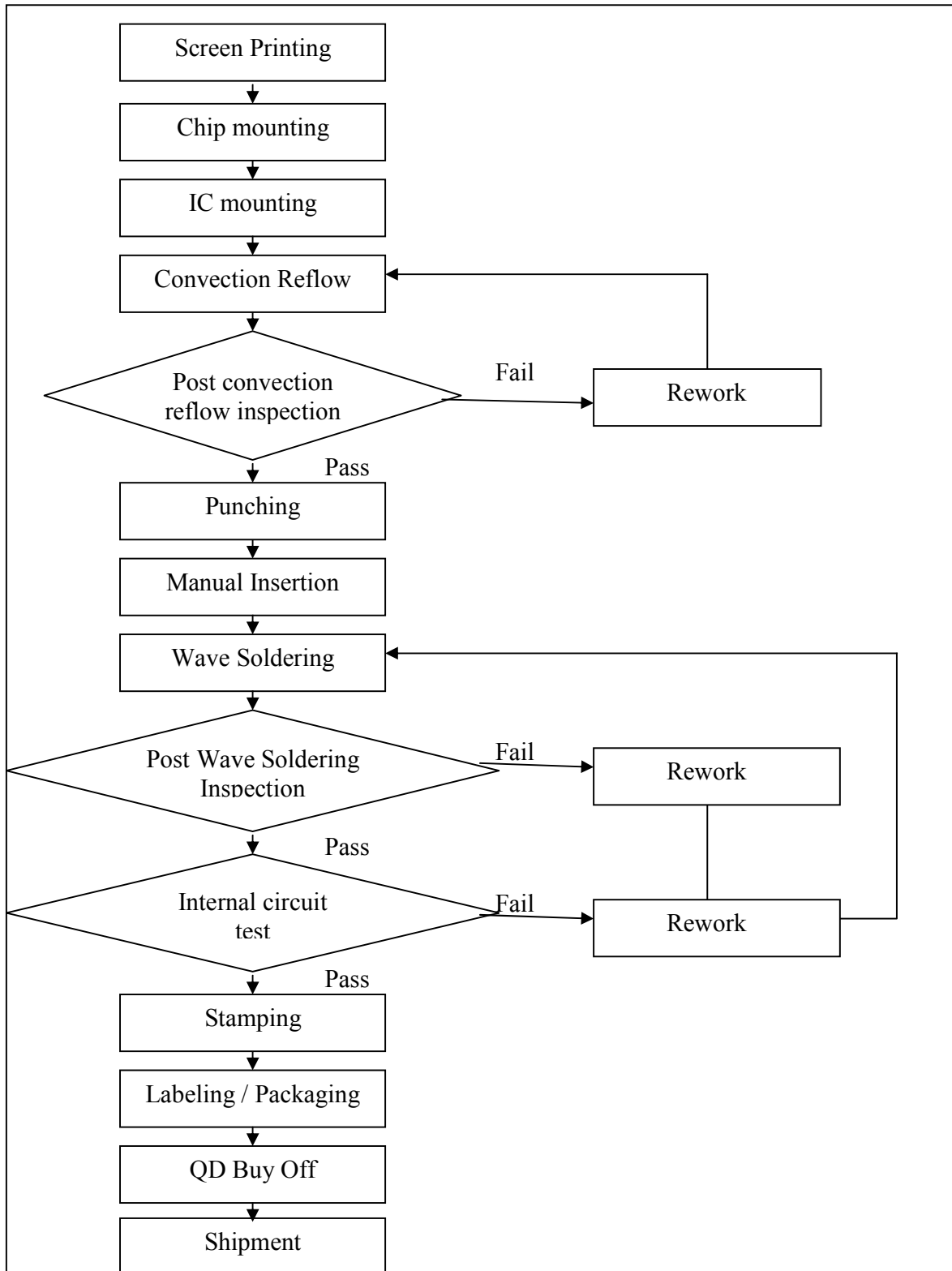


Figure 2.0 Process Flow of PCB Assembly