LINE BALANCING TECHNIQUE IMPLEMENTATION IN A

SMALL AND MEDIUM INDUSTRY

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ABSTRACT

The objective of this project is about the implementation of line balancing technique in a Small and Medium Industry. The implementation of line balancing in Automotive Industry has brought significant improvement to the plant's productivity. However, line balancing technique is not commonly used in Small and Medium

Industry. The objective of this project is to simulate the line balancing technique and implement it in a Small and Medium Industry. The simulation was done using software called Arena where it gave overall picture of the future condition and analyze the result of production after improvement using line balancing technique. This project describes how to use line balance to save production time. Takt time and cycle time were computed with formula. The times were recorded and shorten by reducing downtime and wastes. As a result, the waiting time and total time taken were reduced. The time saved means the productivity can be increased with more time available. The waiting time has decreased around 50.81%, 50.98%, 50.76%, 50.55%, 50.88%, 50.68% and 50.77% for each extrusion machine. For each rewinding machine, the waiting time has decreased around 37.33%, 36.55%, 36.12%, 35.45%, 34.86%, 34.18% and 35.76%.

ABSTRAK

Objektif projek ini adalah mengenai pelaksanaan teknik penyeimbangan baris pengeluaran di Industri Kecil dan Sederhana. Pelaksanaan penyeimbangan baris pengeluaran dalam Industry Automotif membawa peningkatan ketara kepada pengeluaran kilang. Namun, teknik penyeimbangan baris pengeluaran masih tidak biasa digunakan di Industri Kecil dan Sederhana. Simulasi telah dijalankan dengan menggunakan perisian yang bernama Arena di mana ia memberikan gambaran mengenai keadaan masa hadapan dan juga keputusan simulasi selepas peningkatan pengeluaran menggunakan teknik penyeimbangan baris pengeluaran. Projek ini menerangkan cara menggunakan penyeimbangan baris pengeluaran untuk menjimatkan masa pengeluaran. Takt Time dan cycle time telah dikira dengan formula. Masa yang diperuntukkan telah dicatatkan dan boleh dikurangkan sekiranya downtime and pembaziran boleh dikurangkan. Secara keputusan, masa menunggu dan jumlah masa yang diperuntukkan untuk pengeluran berjaya dikurangkan. Masa menunggu untuk setiap mesin extrusion sudah dikurangkan sebanyak 50.81%, 50.98%, 50.76%, 50.55%, 50.88%, 50.68% dan 50.77&%. Untuk setiap mesin rewinding, masa menunggu berjaya dikurangkan sebanyak 37.33%, 36.55%, 36.12%, 35.45%, 34.86%, 34.18% dan 35.76%.

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LIST OF ABBREVIATIONS

LB	Line Balancing
ALB	Assembly Line Balancing
SMI	Small and Medium Industry

LIST OF FORMULA

2.1 $$\text{Takt Time} = \frac{\text{Available time per day}}{\text{Customer demand per day}}$$

2.2 $$\text{Cycle Time} = \frac{\text{Production time per day}}{\text{Required output per day (unit)}}$$

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter is about the introduction of line balancing idea. Line balancing is still not common in Small and Medium Industries in Malaysia. The purpose of the project is to simulate and implement this technique in one of the companies categorized under Small and Medium Industries.

1.2 BACKGROUND OF STUDY

Line balancing (LB) is a tool to improve the throughput of a work cell or line which at the same time reducing manpower and cost needed. It is often used to develop product based layout. LB job description is to assign tasks to a series of connected workstations where the number of workstations and the total amount of idle time are minimized for a given output level. The line is balanced if the amount of work assigned to each workstation is identical.
Generally, LB technique is used by many companies to improve the productivity, decreases the man power, decreases idle time and buffer or even to produce more than two products at the same time. One of the examples of the result of LB is one worker can control two or more machines at the same time. LB technique was used to achieve the minimization of the number of workstations, the minimization of cycle time, the maximization of workload smoothness and the maximization of work relatedness.

Improper LB might refer to the distribution of workloads and numbers of worker are not equal along a production line. One of the factors that bring to this phenomenon is machine breakdown. Machine breakdown often causes bottleneck where the products that were moving suddenly stop and accumulate at a station. The station will have maximum time to finish the production and causes unbalance of the production line.

LB is a bit different from assembly line balancing (ALB). ALB involved the action of assemble different parts together. It involves many production lines while normal LB may only involve one production line. The LB problem is to assign a set of tasks to workstations with some measure of performance to be optimized under the following restrictions. (de Souza, 1998)

a) Each task is assigned to one and only one workstation.

b) The sum of the task times of any workstation should not exceed the cycle time.

c) The precedence relationship among the tasks cannot be violating.

The aim of the study is to improve the productivity and efficiency of a Small and Medium Industry (SMI) company by using LB technique. Computer aided simulation is used to view how to improve the productivity or time saving in the meaning analyze the outcome of the improvement.

A survey done by Becker and Scholl (2004) shown that there were only two commercially packages which are optimization algorithm and another user-friendly interface for data management available by that time. The outcome of human trial-and-error experience included long lead time, large work-in-progress (WIP), large inventories and many more.

Therefore, computer simulation seems to be an effective way to tackle with the problem of production line balancing. Related work using computer simulation can be found in de Souza et al. (1998).

1.3 PROBLEM STATEMENT

According to the Malaysia National SME Development Council. 2005. *SME Annual Report*, SMI here refers to the manufacturing sector that has annual turnover which is less than RM 25 million and individually employing not more than 150 full time employees.

Most of the SMI in Malaysia do not use the LB technique in their production system to improve the productivity. LB technique was mostly used in assembly line especially automotive industry.

1.4 OBJECTIVES

The objectives of this project are listed as followed:

a) Simulate the actual system without LB technique in SMI company.

b) Simulate the LB technique to the actual system.

c) Compare before and after the implementation of LB technique and recommends suggestion to the current production flow of a specific company.

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1.5 SCOPE OF STUDY

This project only limited to the three major scopes. Among the scopes are:

a) Only using LB technique

b) Implementation of LB technique in a SMI only.

c) Simulation of software but the decision of apply it in industry is based on company perspective.

LB technique was used commonly in assembly line of the automotive industry which is called ALB. Most of the SMI do not use line balancing technique in the production line. This project is aim to simulate and compare the condition of before and after the implementation of line balancing in a production section of a SMI.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is about the exploration and the gathering of all the information regarding to the line balancing. In this chapter there are three categories. The first part is introducing SMI industry. The second part is the criteria of line balancing to calculate the performance and productivity such as takt time, cycle time, downtime and workstation. Another part is software simulation. SMI was selected as the scope of study given. Therefore the area to focus can be narrowed down to the SMI production line.

2.2 SMALL AND MEDIUM INDUSTRIES

Table 2.1: Categories of Small and Medium Industries

Sector / size	Micro-enterprise	Small enterprise	Medium enterprise
Manufacturing, Manufacturing Related Services and Agro-based industries	Sales turnover : Less than RM250,000 Full time employees: Less than 5	Sales turnover : RM250,000 to RM10million Full time employees: 5 to 50	Sales turnover : RM10 million to RM25 million Full time employees: 51 to 150
Services, Primary Agriculture and Information & Communication Technology (ICT)	Sales turnover : Less than RM200,000 Full time employees: Less than 5	Sales turnover : RM200,000 to RM1 million Full time employees: 5 to 19	Sales turnover : RM1million to RM5 million Full time employees: 20 to 50

The table shows the Small and Medium Industry definition by Malaysia National SME Development Council. 2005. *SME Annual Report.* In this project, the focus is on the stretch film processing in a manufacturing industry based in Batu Pahat, Johor.

2.3 CRITERIA IN LINE BALANCING

There are some criteria which should be considered in a line balancing process.

2.3.1 Takt Time

According to Heizer and Render (2010), takt time is pre-requisite procedure in doing line balancing task. Takt time is the pace of production that aligns production with customer demand. It shows how fast the need to manufacture product in order to fill the customer orders. (Vome lean Briefs, 2006). Producing faster than takt time results in overproduction which is a type of waste whereas producing slower than takt time results in bottlenecks where the customer orders may not be filled in time.

$$\text{Takt Time} = \frac{\text{Available time per day}}{\text{Customer demand per day}} \tag{2.1}$$

Takt time is most simply as the average rate at which customers buy products and hence the rate at which products should be manufactured. It is expressed in time units. Takt Time can be said as the available work time divided by customer demand per day. It can maximize the productivity due to easily manage the process and output of each process can match with customer demand. The importance of using takt time included (Heizer and Render, 2010):

a) Achieve a steady sand continuous flow of production.

b) Eliminate the waste of overproduction by producing actual customer demand.

c) Improves accuracy of planning.

d) Encourage the development of standardize work instructions, promoting quality and efficiency.

e) Set real time targets for production that shows operators exactly where their work output should be at any given point of time.

f) Establish what-if scenario for customer demand based on flexible manning.

However, takt time has its own limitation. Takt time is useful for simple cells but has little relevance for job shops or other low volume, high variety operations. If the designers only think of takt time may conclude that certain products cannot use cellular manufacturing and their companies will lose the benefits of using it. It also can lead to unsuitable process designs.

Normally, takt time was recorded by video because it can used to visually record the whole activity. It is also an accurate method to record. Modern approach to establishing method (Heizer and Render, 2010):

a) Capture a representative sample of the process.

b) Review the video with the operators present.

c) Break down the 'elements' of work and record a time for each one.

d) Identify which of the elements are Value-added and non-value added.

2.3.2 Cycle Time

According to Gaither and Fraizer (2001), cycle time shows how often the production line can produce the product with current resources and staffing. It is an accurate indicator to represent of how the line is currently set up to run. The calculation of cycle time takes into consideration of the entire production quantities. If multiple lines are producing the same product, then the composite cycle time is less than the actual lapse time of any individual line.

In other words, cycle time is the expected average total production time per unit produced. On an assembly line or in a work cell with multiple operators, each operator will have his own time associated with completing the work he is doing. Normally, we are looking at the longest of the individual cycle time. To reduce the cycle time of a line, we only have to focus on the operation which is sets the pace.

Takt time and cycle time are definitely not the same. Takt time represents the maximum time allowed to meet the customer demand whereas cycle time is the actual time necessary for an operator to perform an activity or complete one cycle of his process. Both takt time and cycle time are determined by customer demand.

$$\text{Cycle Time} = \frac{\text{Production time per day}}{\text{Required output per day (unit)}} \tag{2.2}$$

By eliminating the non value activities through continuous improvement and waste reduction, the cycle time can be reduced.

$$\text{Cycle time} = \text{value added activities} + \text{non value added activities}$$

2.3.3 Downtime

Downtime can be defined as the time that is non value added. (Chase, *et al.* 2000). It is often related with the 7 wastes as below:

a) Defects

Defect is direct costs of a company. The Toyota philosophy thinks that defects should be regarded as opportunities to improve rather than something to be traded off against what is ultimately poor arrangement.

b) Overproduction

One of the serious wastes discourages a smooth flow of goods and services, which may lead to excessive lead and storage time. It will cause the defects cannot be detected earlier and then the products may deteriorate. It will also lead to excess work-in-progress stocks.

c) Waiting

It happens when the goods are not moving or being worked on. It affects both goods and workers where the waiting time should be used for some value added activities such as training and maintenance.

d) Transportation

Any movement in factory can be considered as waste. Double handling and excessive movements are likely to cause damage and deterioration with the distance of communication between processes proportional to time taken it takes to feed back reports of poor quality and take corrective action.

e) Unnecessary inventory

Problems are hidden by inventory. Inventory will increase the lead time, preventing rapid identification of problems and increasing space. Significant storage costs are wasted which definitely lower the competitiveness of the organization of value stream.

f) Unnecessary motion

Involve the ergonomics of production where operation might have to stretch, bend and pick up when these actions actually could be avoided. It not only tires the workers but also lead to poor productivity.

g) Inappropriate processing

Over- complexity of a process discourages ownership and encourages the employees to over produce to recover the large investment in the complex machines. It encourages poor quality and take corrective action.

2.3.4 Workstation

According to Gaither and Fraizer (2001), a workstation is a physical area where a worker with tools, a worker with one or more machines, or an unattended machine performs particular sets of work together. Number of workstations working is the amount of work to be done at a work center expressed in number of workstations.

Minimum number of workstation is the least number of workstations that can provide the required production. Actual number of workstation is the total number of workstations required on the entire production line, calculated as the next integer value of the number of workstations working.

2.4 SIMULATION

Simulation can be defined as the reproduction of a real system with its related processes in a model in 2007. *Introduction to* Arena. South Portland: Rockwell Productions. The purpose of simulation is to reach transferable findings for the case in real world. In other words, simulation means preparing, implementing and evaluating a specific experiment with a model simulation.

The following are the steps to complete a simulation:

a) Formulation of problems
b) Test of the simulation
c) Formulation of targets
d) Data collection and data analysis
e) Modeling
f) Execute simulation runs
g) Result analysis and interpretation
h) Documentation

All the criterias in line balancing are essential for further improvement of the production and process. By study on the time such as takt time, cycle time and downtime, the problems and wastes can be identified and eliminated.