UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZING OPERATIONS IN MANUFACTURING INDUSTRY BY USING LINEAR PROGRAMMING.

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours.

by

NADIRAH ADILA CHE ARBAEI

FACULTY OF MANUFACTURING ENGINEERING

2008

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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JUDUL:

Optimizing Operations in Manufacturing Industry By using Linear Programming

SESI PENGAJIAN: **Semester 2 (2008/2009)**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honours. The member of supervisor committee is as follow:

.....

Muzalna Mohd Jusoh

MUZALNA BINTI MOHD JUSOH
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

ABSTRACT

This report presents the study of optimizing operation in manufacturing industry by using linear programming. This study is conducted in one of the company that involved in metal and fabrication sector in manufacturing industry which is Impressive Edge (KL) Sdn Bhd. This report is focusing to the operation optimization by using Hungarian Method under Assignment Problem model. Through out this study, the data required which are the number of labor that work in production area in the morning shifts, process that involved in the production and the number of machinery involved in every process are collected within the duration specified. Based on data collected, the assignment model been formulated and the model been analysis by using Hungarian Method. At the end of this study, the optimal solution, which is the worker's job assignment to machine on one-to-one basis are obtained. The optimal solution from the analysis been compared to the true system and the result is being discussed.

ABSTRACT

This report presents the study of optimizing operation in manufacturing industry by using linear programming. This study is conducted in one of the company that involved in metal and fabrication sector in manufacturing industry which is Impressive Edge (KL) Sdn Bhd. This report is focusing to the operation optimization by using Hungarian Method under Assignment Problem model. Through out this study, the data required which are the number of labor that work in production area in the morning shifts, process that involved in the production and the number of machinery involved in every process are collected within the duration specified. Based on data collected, the assignment model been formulated and the model been analysis by using Hungarian Method. At the end of this study, the optimal solution, which is the worker's job assignment to machine on one-to-one basis are obtained. The optimal solution from the analysis been compared to the true system and the result is being discussed.

ABSTRAK

Kajian in membincangkan tentang cara untuk meningkatkan operasi syarikat yang terdapat di dalam industri pembuatan dengan menggunakan pengaturcaraan linear. Kajian ini di laksanakan pada satu syarikat yang terlibat dalam sektor besi dan pembuatan di dalam industri pembuatan iaitu Impressive Edge (KL) Sdn Bhd. Laporan ini memfokuskan pada cara mengoptimumkan operasi menggunakan Kaedah Hungarian yang terdapat di dalam model permasalahan tugasan. Melalui kajian ini, data yang diperlukan adalah bilangan pekerja yang terlibat dengan operasi pembuatan pada sesi pagi, bilangan mesin yang terlibat dalam proses pembuatan. Data ini dikumpul di dalam tempoh masa yang telah di tetapkan. Menggunakan cara kerja yang dipilih, model di bangunkan dan data di analisis dengan menggunakan "Hungarian Method". Berdasarkan analisis model, masalah pembahagian tugas secara optimum di mana setiap seorang operator di jadualkan untuk menjalankan satu mesin dapat diselesaikan. Keputusan analisis yang optimum dibandingkan dan dibincangkan dengan sistem sebenar syarikat.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to Allah the Almighty for His will, I have the chance to finish up my Projek Sarjana Muda (PSM) report from the very first word till the end point within the specified period.

First of all, I would like to take this opportunity to express my thankfulness and appreciation to my PSM supervisor, Cik Muzalna binti Mohd Jusoh for her supervision, comments and guidance in order to make sure I can gain as much experience and knowledge to complete my PSM report. I also want to say thank you to my fellow course mate from BMFU for the input sharing and al those comments for my PSM report.

I would also like to express a special thank to my family members for their priceless support, encouragement, constant love, valuable advices, and their understanding of me. Lastly, to those who involved directly and indirectly with my PSM report completion – I just can say thank you. The kindness, corporation and support would always be remembered. Thanks for being so supportive and helping all the way through this process.

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LIST OF ABBREVIATIONS

CNC	-	Computer Numerical Control
HAM	-	Hungarian Assignment Method
IEKL	-	Impressive Edge Sdn Bhd
LP	-	Linear Programming
ME	-	Mass Excavation
MIDA	-	Malaysia Industrial Development Authority
UTeM	-	Universiti Teknikal Malaysia Melaka
QA	-	Quality Assurance
(□)	-	Square
(x)	-	Cross
(√)	-	Marking

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

In this chapter, consists of the background of the study where it explains about the title of this study which is Optimizing Operation in Manufacturing Industry by using Linear Programming. Every aspect which is the optimization, the manufacturing industry and the linear programming is been relate to each other. After that the background of company selected is briefly explain. Followed by the problem statement, objectives and scope of the study and last but not least is outline of the study.

1.1 Background of the study

For this study, the issue want to be put forward is about the operation optimization in manufacturing industry by using one of the mathematical programming called linear programming. The optimization is widely implemented in every sector and very well known as a tool for reducing the cost and at the same time increase the profit. Its also can be characterized as an effort to maximize productivity. This optimization is very important in manufacturing industry. It helps to improve and achieve the goal of any operation involve in manufacturing industry. Under manufacturing system, usually have a production system that content of five parts which are inputs, conversion process, outputs, feedback and operating environment (Cheema, 2005). This production system can be simplified in the Figure 1.1.

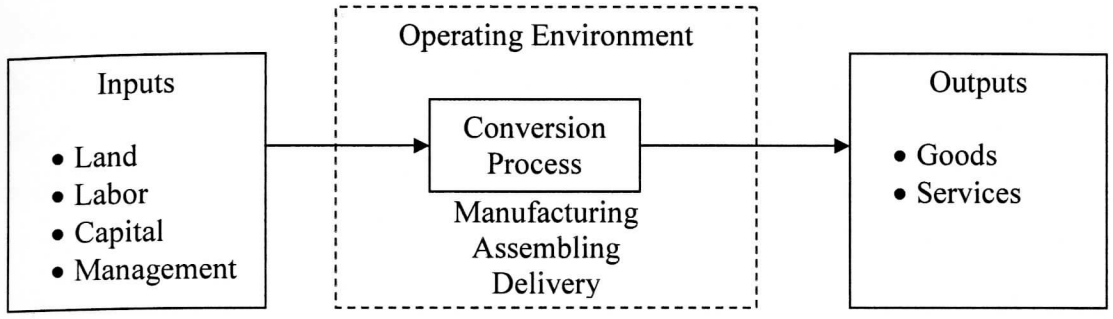

Figure 1.1: Production System (Cheema, 2005)

From the Figure 1.1, can be understood that the resources such as land, labor, capital and management is among the input that been use in manufacturing industry. The output usually in the form of goods or service. For the environment operating, is when the resources are converted into desirable results. Environment provides better quality of manpower and other resources for ease of understanding. Another feature of the production system is the productivity of the conversion process. Using optimization, the productivity in the production system can be improved. Usually the usage of inputs will be fully utilized. With the same amount of input, the production can still increase the amount of specific and desirable standards output. The production system also can decrease the amount of input used to produce the normal amount of output. This will give an advantage because automatically the cost of production also has been reduced. Last but not least, the optimization also can be done by increasing output and decreasing input to change the productivity ratio. Optimization also can reduce lead time in production system. Less lead time means more production in the normal working time. The organization also will be able to fulfill customer order on time.

Manufacturing is the use of tools and labor to make things for use or sale. Manufacturing takes place under all types of economic systems. In a free market economy, manufacturing is usually directed toward the mass production of products for sale to consumers at a profit. (Kalpakjian, and Schmid, 2005). In a collectivist economy, manufacturing is more frequently directed by the state to supply a centrally planned economy. In free market economies, manufacturing occurs under some degree of government regulation. Modern manufacturing includes all intermediate processes required for the production and integration of a product's components. Manufacturing

industry is widely define and been divided into various type of industry. Under the Malaysia Industrial Development Authority (MIDA) list of industry, there are a number of manufacturing industries which are classified as manufacturing sector. The major manufacturing industries are electronic industry, automobile industry, textile industry, wood based industry, steel industry and petrochemical industry. Even though there are various types of manufacturing industry, this optimization is always suitable to be implement but maybe using the other mathematical programming depends to their requirements.

Linear programming from the mathematical programming is an important field of optimization. Historically, ideas from linear programming have inspired many of the central concepts of optimization theory. Linear programming is heavily used in manufacturing industry, either to maximize the income or minimize the costs of a production. As long as there is an area for optimization, linear programming can be use for it. Linear programming is designed to aid organization allocating scarce resources among competing activities and is extensively used in business and economics, but may also be used to solve certain engineering problems.

1.2 Company background

For this study, the optimization is focusing to the manufacturing industry so the company that has been selected is one of company that involved in metal and fabrication sector, known as Impressive Edge (KL) Sdn Bhd. Impressive Edge Sdn Bhd (IE KL) is principally involved in the manufacture of high precision engineering mainly for the Semiconductor Industry and also Trim and Form Industry. IE (KL) has been specialized for ultra precision and precision pin and punches using two main material of carbide and steel and also ceramic if demanded by customer. Ultra precision pins and punches are mainly used in stamping, IC moulding or plastic injection moulding processes. The pins can achieve the smallest diameter of 50 micron with accuracy of ± 1 micron and the punches thickness of 180 micron with accuracy of ± 2 micron. The precision pins and

punches are designed and affixed on mould and die sets to stamp, trim and shape and bend lead frames according to predefined specifications.

IE (KL) is divided into 4 departments which are Computer Numerical Control (CNC) Department, Polishing Department, Grinding Department and Quality Assurance (QA) Department. All of these departments are involved in producing part. IE (KL) operates with 2 system shift. There are about 30 operators currently working for IE (KL) in both shifts. All the workers usually been trained for a multi-task operators, which means every operators are expose to every departments and processes.

1.2.1 Computer Numerical Control (CNC) Department

In CNC department, there are 3 CNC machines that run almost 24 hours and maximum 3 operators are allocated to run the machine per shift. These machines are able to produce thousand pieces of parts in one shift depends to its design. In this department, not all workers are able to work and handle the machinery. This is because the machine is among the high technology machinery and required a high skill worker to handle it. Only the trained operators will be allocated in this department.

1.2.2 Polishing Department

Polishing department have 6 polishing machine that been use for one of the process involved in production. The polishing machine is a simple type of machinery and did not require a high skill worker. However, they still need to be train to be expose to the basic concept and requirement in polishing process. Even though all the operators had been trained for this process, only 4-6 people is assign to this department per shift. This machinery also usually runs in both shifts, which is almost 24 hours depends to the production and product requirement.

1.2.3 Grinding Department

There are 5 grinding machine in grinding department that been use for grinding process. This department also operated in both shifts which are 24 hours with the quantity of worker 4-5 person per shift. The machinery in this department also not listed as the high technology machinery so semi-skilled operators are also able to handle this grinding machine.

1.2.4 Quality Assurance (QA) Department

In QA department, there are a few type of equipments that been use. Even though all the equipments look simple, the skills in handling it are required to guarantee the life span of the equipments. This department only operates in one shift and only 2-3 workers are usually assign to this departments.

1.3 Problem Statement

Doing business nowadays is a lot more adventure compared to previous years. People doing business are everywhere. They are competing among each other to gain contract or business in their sector. In order for them to stay in the industry, they have to find some way to give them the guarantee of their business stability. In mathematical field, there is one area which called linear programming that can be used as an optimization tool and optimizing operation is needed in the manufacturing industry. IEKL is facing a problem of arranging their operators to the suitable machinery in order for them to fulfill customer order on time. IEKL working roaster is been setup by the administration. The administration usually arranging them based on their physically and experience ability. There is no proper study has been made to identify the operator's true ability. The classical problem of optimal assignment of n persons to m objects been taking consider, whereby given a benefit a_{ij} that person i associates with object j, the thing that want to

find an assignment of persons to objects, on a one-to-one basis, that maximizes the total benefit. This method is basically focusing to the operator's job task assigning and the average of the quantity product, which is pilot pin that can be generating by the production. Indirectly, this model in this linear programming can helps the company to analyze the best way to give them the ability of decreasing the cost and increasing the profit. With this helps, the company able to compete and at the same time can guarantee their stability in industry.

1.4 Objectives of the Study

The objectives of this study are:

a) To formulate a linear programming model for the company.

b) To solve the problem using linear programming model by using Hungarian method.

c) To compare the new model solution (assign *n* persons to *m* different type of jobs) with the true system (company).

1.5 Scope of the Study

This scope is purposely to help in directing this study on track. The scope for this study is focus on the application of linear programming for operations optimization in company selected which is Impressive Edge (Kuala Lumpur) Sdn Bhd. The method that will be use for the optimization is a Hungarian method from the Assignment Problem model. The data that needed are number of labor that work in production area in the morning shifts, process that involved in the production and the number of machinery involved in every process. The duration for data collection is 1 week in February 2009.

1.6 Outline of Study

This study is divided into six (6) chapters. Chapter 1 consists of problem statements, company background, objectives, scope of study, and, study outline.

Chapter 2 is the literature review. Based on the reference gathered, this chapter focuses on the definition and explanation to the key words which are the optimization and linear programming. The model uses under linear programming which is the assignment problem also briefly explain in this chapter. The basic formulation also included.

Chapter 3 is methodology. This chapter discussed the research methodologies that were used to gather data required to support the development and analysis of the study. This includes the process planning for the study, flowchart of the study, Gantt chart, data collection methods and the data analysis.

Chapter 4 is the result and analysis. In this chapter, the data that been collected is been analyzed using the chosen method, which is the Hungarian method. Every step of Hungarian method been used in order to obtained the result which is the optimal solution.

Chapter 5 is discussion. This chapter is elaborating the optimal solution that obtained through the analysis in chapter 4. The result obtained being compared to true system which is the company itself and the differences is being discussed.

Chapter 6 is the conclusion and recommendation. This chapter is concluding the whole study about the model that been developed and the company. The suggestion for the future study and improvement also been stated.

CHAPTER 2
LITERATURE REVIEW

Literature review is a method to gain more knowledge and explanation for the study title which is about the optimization and linear programming. This chapter is describing about the optimization, the relationship between the optimization with the manufacturing industry and the linear programming. Then it followed by the linear programming explanations stating from its history, include the application of the linear programming that been applied in other industry and their formulation. The branch of linear programming that been chosen for this study which is the Assignment Problem method also been explained in this chapter.

2.1 Optimization

The definition of optimization is the procedures used to make a system or design as effective or functional as possible, especially the mathematical techniques involved (Papalambros and Wilde, 2000a). So the term of optimization in mathematical programming, refers to the study of problems in which one seeks to minimize or maximize a real function by systematically choosing the values of real or integer variables from within an allowed set. Such a formulation is called an optimization problem or a mathematical programming problem.

A mathematical optimization model consists of an objective function and a set of constraints expressed in the form of a system of equations or inequalities. Optimization models are used extensively in almost all areas of decision-making such as engineering design, and financial portfolio selection. If the mathematical model is a valid

representation of the performance of the system, as shown by applying the appropriate analytical techniques, then the solution obtained from the model should also be the solution to the system problem. The effectiveness of the results of the application of any optimization technique is largely a function of the degree to which the model represents the system studied.

Optimization problems are ubiquitous in the mathematical modeling of real world systems and cover a very broad range of applications (Arsham, 1994). These applications arise in all branches of Economics, Finance, Chemistry, Materials Science, Astronomy, Physics, Structural and Molecular Biology, Engineering, Computer Science, and Medicine.

Optimization modeling requires appropriate time. The general procedure that can be used in the process cycle of modeling is to describe the problem. Then prescribe the solution and the problem is control by assessing the optimal solution continuously, while changing the parameters and structure of the problem.

As soon as the problem is detected, the problem must be review and understood in order to adequately describe the problem in writing. Develop a mathematical model to represent reality in order to use an optimization solution. The problem formulation must be validated before it is offered a solution. A good mathematical formulation for optimization must be both inclusive which is includes belongs to the problem and exclusive which is what does not belong to the problem.

Then find an optimal solution. This is an identification of a solution and its implementation stage. The only good plan will be implementing and become an implemented plan.

Once the solution been recognized, the appropriate module of software is been determine and apply, utilize software to obtain the optimal strategy. Next, the solution will be presented to the decision-maker in the same style and language used by the

decision-maker. This means providing managerial interpretations of the strategic solution, not just handing the decision-maker a computer printout.

Post-solution analysis been applied after the implementation. These activities include updating the optimal solution in order to control the problem. In this ever-changing world, it is crucial to periodically update the optimal solution to any given optimization problem. A model that was valid may lose validity due to changing conditions, thus becoming an inaccurate representation of reality and adversely affecting the ability of the decision-maker to make good decisions. The optimization model created should be able to cope with changes.

It is necessary to place heavy emphasis on the importance of thinking about the feedback and control aspects of an optimization problem. It would be a mistake to discuss the context of the optimization modeling process and ignore the fact that one can never expect to find a never-changing, immutable solution to a decision problem. The very nature of the optimal strategy's environment is changing, and therefore feedback and control are an important part of the optimization-modeling process. For a simple explanation, Figure 2.1 can be referred.