AN EVALUATION ON CAPACITY OF CASTING INDUSTRY BY USING SIMULATION

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An Evaluation on Capacity of Casting Industry by Using Simulation

Report submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor's Degree of Manufacturing Engineering (Manufacturing Management)

By

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This report submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management). The member of the supervisory committee is as follow:

……

Supervisor

Prof Madya Dr Adi Saptari

Faculty of Manufacturing Engineering

DECLARATION

I hereby, declared this report entitled "An Evaluation on Capacity of Casting Industry by Using Simulation" is the results of my own research except as cited in the references.

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ABSTRACT

This study is about an evaluation on capacity of casting industry by using simulation. This study focuses on the manufacturing system of ABC Company which is mainly produces aluminum casting product. Data collection was performed through personal observation, personnel interview, and time study of the processes. The gathered data was analyzed and identified to find the best fitted distribution by using Goodness of Fit test before simulate in the simulation software. The model of the production system was built to imitate the current manufacturing process of ABC Company. The model was simulated using PROMODEL to forecast the manufacturing performance of coming next 3 months. The animation result and graphs was shown in the simulation software. Based on the outcome, the actual behavior of the production system can be known and the bottleneck production was identified. Major roots cause bottleneck production was included in the discussion part of this study. In order to improve the current manufacturing performance, two alternatives were proposed to ABC Company to solve the bottleneck problem. For alternative A, a milling machine was added into manufacturing system; for alternative B, a GDC machine was shut down. After comparison between alternative A and B, alternative A was selected.

ABSTRAK

Pengajian ini adalah mengenai satu penilaian terhadap keupayaan industri tuangan dengan menggunakan simulasi. Kajian ini menumpukan kepada sistem pembuatan dalam Syarikat ABC, dimana hasil pengeluaran utamanya adalah produk aluminum kumuh. Pengumpulan data telah dijalankan melalui pemerhatian peribadi, temu ramah dengan kakitangan, dan kajian masa terhadap proses-proses. Data yang dihimpunkan telah dianalisis dan dikenalpasti untuk mencari pengedaran yang terpasang dan terbaik dengan menggunakan Ujian Padanan Kebaikan sebelum disimulasikan dalam perisian simulasi. Model sistem pengeluaran telah dibina untuk meniru sistem pembuatan semasa dalam Syarikat ABC. Model in telah disimulasikan menggunakan PROMODEL untuk meramal prestasi sistem pembuatan pada 3 bulan yang akan datang. Hasil animasi dan graf telah dipersembahkan dalam perisian simulasi. Berdasarkan hasil simulasi, tingkah laku sebenar sistem pengeluaran dan kesesakan pengeluaran telah dikenalpasti. Punca-punca utama menyebabkan kesesakan pengeluaran telah dimasukkan dalam bahagian perbincangan kajian ini. Untuk memperbaiki prestasi sistem pembuatan semasa dalam syarikat ABC, dua alternatif telah dikemukakan kepada syarikat ABC untuk menyelesaikan masalah kesesakan pengeluaran. Untuk A alternatif, satu mesin kisar telah ditambah ke dalam sistem pembuatan; untuk B alternatif, sebuah mesin GDC telah dipadamkan daripada beroperasi. Setelah perbandingan dijalankan antara A alternatif dan B alternatif, A alternatif telah dipilih.

DEDICATION

To everyone I loves and everyone who loves me

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

AD	-	Anderson-Darling
AS	-	Automated Storage
ATM	-	Automated Teller Machine
DC	-	Dual Command
FCFS	-	First Come First Serve
FECN	-	Forward Explicit Congestion Notification
GDC	-	Gravity Die Casting
GoF	-	Goodness of Fit
PC	-	Personal Computer
PSM	-	Projek Sarjana Muda
RS	-	Retrieval Storage
RTI	-	Run Time Interface
SC	-	Single Command
UTeM	-	Universiti Teknikal Malaysia Melaka
WLC	-	Work Load Control
WLN	-	Work Load Norm

CHAPTER 1
INTRODUCTION

1.1 Background

A queue is a waiting line, for example, customers waiting at a supermarket checkout counter. For queueing theory, it is known as mathematical theory of waiting lines. More generally, queueing theory is concerned with the mathematical modeling and analysis of systems that provide service to random demands. Unlike many other modeling methods, it is not process specific and it can be used to model any dynamic system in which discrete events alter the state of the system. Typically, a queueing model represents the system's physical configuration to specify the number and arrangement of the servers, which provide service to the customers, and the probabilistic or statistical nature of the demands, and specify the variability in the arrival process and in the service process.

Queueing theory can be applied to any manufacturing or service system where a queue occurs over time, such as airport, a walk-in medical clinic, fast food restaurants, and so on. In an airport, a queue forms when departing airplanes wait to place and pick up their orders. In the manufacturing context, customer may be part and servers may be machines, material-handling carriers, or pick-and-place robots. When a server becomes available, a customer is selected for service by some queue discipline. Similarly, in a machine shop, jobs are waiting to be machined on an automated lathe. The foundation of modern queueing theory is based on studies made in the early part of the 20^{th} century by

Danish telephone engineer A. K. Erlang. Prior to World War II, very few attempts were made to apply queueing theory to business problems.

Simulation modeling method has become an essential tool to simulate a model. Its had widely used in various kind of industry, such as waiting line in ATM, congestion at the plaza toll, bottleneck production in manufacturing system, logistic and many more. Nowadays, people are much relies on this simulation technology because of its capability to predict the outcome before the actual plan is put into real practice. Besides that, simulation can account for system variances. The conventional analytical methods, such as mathematical models, do not effectively address variances as calculations are derived from constant values. For simulation, it looks at variances in a system which incorporates independence, interaction among components, and time.

Simulation modeling is the best way to visualize, analyse, and predict process performance. (Harrington and Tumay, 2000) It is very true that simulation modeling methods can promote a total solution which allows modeling entire systems. *The modeling of a process or system in such a way that the model mimics the response of the actual system to events that take place over time.*(Schriber, 1987) By study the behavior of the model, it can provide insight into the impact that process changes will have on input to and output from the system as well as system capabilities. Furthermore, simulation can be cost-effective. As the organization try to respond quickly to the changes in their market, a validated simulation model can be an excellent too for evaluating rapid responses. For example, a sudden change in market demand for a product can be modeled using a validated system model to determine whether existing system can cater to their needs. Additionally, simulation is an effective communication tool and helps to quantify performance measures for a system. A simulation model is capable to communicate the new or reengineered process in a dynamic ad animated fashion. Thus, this provides a powerful means of communicating the function of various components to those who will use the new system, and helps them understand how it works.

Computer simulation was first used in the defense industry in 1950s. In the early 1960s, the use of simulation spread out to other industries, including manufacturing and finance. In the late 1980s and early 1990s, graphics capabilities of personal computers enabled software developers to create graphical model major development tools and use animation with simulation. The first half of the 1990s brought another very exciting development to simulation-object-oriented modeling analysis.

One of the success stories is from IBM PC Company, one of the largest personal computer manufacturers in the world. In early 1993, they had faced some huge challenges that were eroding its market share, such as frequent price cuts, rapid customer order response times, and a steady arrival of new product and features by aggressive competitor. The IBM Company had suffered losses due to poor forecasting and critical shortages of popularity products. To rescue such a critical situation, they implemented the simulation modeling method to evaluate different manufacturing execution strategies, and evaluate the effect of different planning and forecasting methods. The outcome was a success, where the IBM Company successfully improves its customer service levels, at the same time decrease finished goods inventory. The estimated saving in distribution costs for IBM PC company would totally approximately $40 million per year. *The simulation study showed how extraordinary improvements can be achieved through very ordinary means.* (Moore, 1997) In fact, it is unquestionable that the development of simulation modeling tools has brought astonishing enhancement and created many triumphant history.

For this research, ABC Company was selected to perform the study. This company general produce casting product. The material used to produce casting product is aluminium. The casting methods that used to produce the products are pressure die casting and gravity die casting.

1.2 Problem statement

In manufacturing industry, the company which applies line production and continuous processing production will results a high volume of buffer in finished inventory. Due to the high market needs, these companies prefer to implement tradition push system as their manufacturing strategy and to be competitive in market. However, they had experienced the bottleneck production due to the push system.

Improper manufacturing strategy and process choice may cause much longer lead time, low productivity and poor on time delivery. This would indirectly affect the company's competitiveness in the market and their reputation. Furthermore, the company may suffer huge loss in their business if the process planning is not implemented properly.

Moreover, industrial and service enterprise face increase pressure to minimizing the time it takes to service customer and fulfill demand. Today, customers tend to set high expectation on the product and service quality with custom features at affordable prices. This situation has put tremendous pressure on business manager to maximize profits while minimizing the risks.

Due to the seriousness of the problem, some of the company has implemented simulation modeling methods as the new tool to support their business. By using simulation modeling methods, the evaluations have been performed to different manufacturing execution strategies. Moreover, process simulation has enabled the manufacturing firms to examine the effect of palling and forecast methods. And yet, there are many real applications were simulated over the past 20 years and the simulation modeling methods has brought a major success in their business.

In ABC Company, demand variation and process variation has been the most serious problem to them. Due to the demand variation, such as product

volume, they have to assign different task to different machine and at the same time able to meet the delivery. But the main problem is the lack of tool to tell them about capacity of machine. So, this eventually ended up with tight scheduling and improper assignment task to machine. Meanwhile, the process variation, such as scrap, unexpected longer cycle time and so on, has cause the increase level of buffer in the production. Thus, the company suffers from losses.

1.3 Objectives

The objectives of this project are:

a) To simulate the manufacturing process under a given set of circumstances.
b) To recognize the bottleneck and constraint in the production process.
c) To identify the major root that cause to bottleneck process.
d) To suggest alternative solutions and improvement on the process performance.

1.4 Scope of study

This project mainly focuses on manufacturing system performance evaluation in ABC Company. The method to evaluate the system performance is simulation modeling methods. The performance analysis will focus to the production of the ABC Company's manufacturing plant. The set of circumstances, such as utilization, waiting times, number of servers, and so on, will be taken into measurement. The capability analysis is also apart form the study, which is purposely to analysis the ABC Company manufacturing process capability of meeting specific performance requirements. Necessary changes, such as added resources and improved methods, will be recommended to formulate much capable manufacturing system. Besides that, the constraint analysis is one of the vital tasks of the study. It is intentionally to identify the

bottleneck in the process and propose the workable solutions to reduce and eliminate the constraints.

In order to accomplish these tasks, PROMODEL simulation modeling software becomes the tool to assist in performance measurement production system. By collecting the data from ABC Company, their current production system can be simulated. The output analysis of modeling simulation method will report the symptomatic behavior of problems. Due to the simulation software is not capable to identify the causes of problems, therefore, this project will discuss the major roots that caused bottleneck production. Finally, improvement and solutions will be suggested in order to make the system more efficient and to reduce waiting time.

However, this project will exclude the performance analysis on supply chain management and the logistic. The facility planning of the manufacturing system will not be included in this project.

1.5 Organization of The Study

This study will be categorized into six chapters, which are Introduction, Literature Review, Methodology, Results, Discussion, and Conclusion.

a. Chapter 1 : Introduction

   This chapter contains the background of the problem statement, the objectives and the scope of the study. In this chapter, it summarizes the progress of the study and describes the plan to accomplish the study.

b. Chapter 2: Literature Review

   In this chapter, the information and theory which is related to the research is studied and summarized. The source of the information is from journals, books, internet, articles and etc.

c. Chapter 3 : Methodology

It describes overview of the research methods and how to conduct the research methods. The steps to perform simulation modeling methods for will be included in this part.

d. Chapter 4 : Results

In this chapter, the result of simulation will be presented in animation display and graph. The results will be gathered from simulation modeling software.

e. Chapter 5: Discussion

The outcome of the simulation will be discussed more in detail. The discussion includes the reason that caused to bottleneck production. Alternative solutions will be proposed to improve the manufacturing performance.

f. Chapter 6 : Conclusion and Recommendations

It summarizes the main findings and how the scope is covered fully and brief recommendation for further studies. Hence, alternative ways or suggestions will be recommended to improve the study in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Queueing Theory

Queueing theory studies how queues or waiting lines develop and behave as a function of their primary characteristics. (Stevensen, 2007*)* Queueing theory is the mathematical study of waiting lines or queues. The queueing theory is used primarily in assisting the design and operation of queuing system.

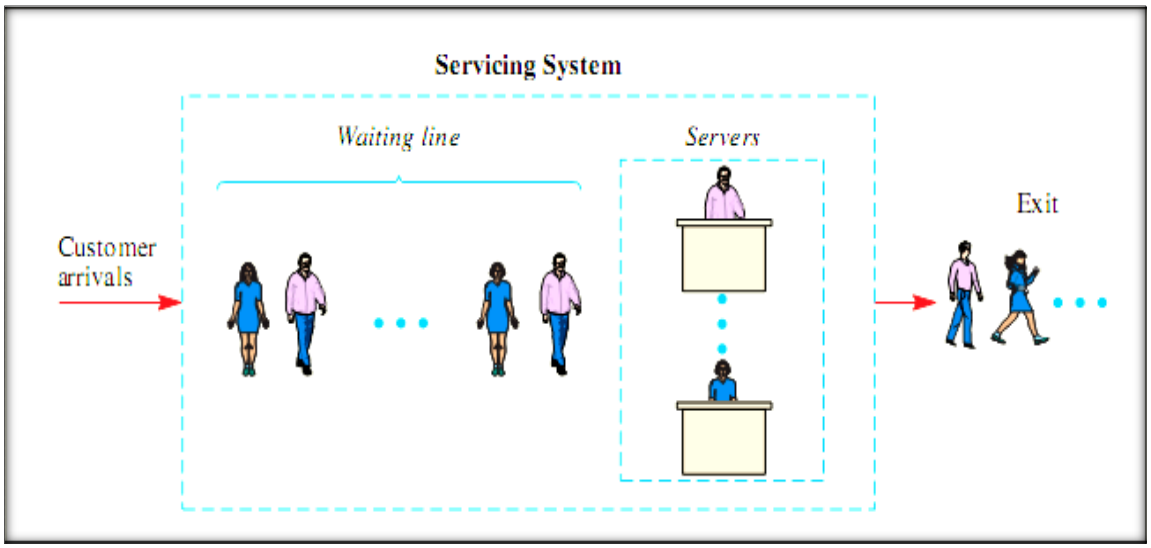

Figure 2.1: Components of Queueing system.

Source: Aquilano, Chase, & Jacobs (1998)