



**KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN
MALAYSIA**

**Optimizing Number Of Servers For
Haemo-Dialysis Fluid (HDF) Production Line
At Ain Medicare Sdn. Bhd.
To Increase Efficiency**

Thesis submitted in accordance with the requirements of the
Kolej Universiti Teknikal Kebangsaan Malaysia for the Bachelor of Manufacturing
Engineering (Manufacturing Process) (Honours)

By

Nur Izzati Binti Marzuki

Faculty of Manufacturing Engineering

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JUDUL: OPTIMIZING NUMBER OF SERVERS FOR HAEMO-DIALYSIS FLUID (HDF)
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Saya NUR IZZATI BINTI MARZUKI (No. K.P: 830508-03-5152, No. Matriks: B050210032)
(HURUF BESAR)

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No.2662, Pt.1053, Tmn. Perumahan SEDC,
Jalan Padang Tembak, Pengkalan Chepa,
16100 Kota Bharu, Kelantan.

Cop Rasmi:
PROF. MADYA DR. ADI SAPTARI
Pensyarah
Fakulti Kejuruteraan Pembuatan
Kolej Universiti Teknikal Kebangsaan Malaysia
Karung Berkunci 1200, Ayer Keroh
75450 Melaka

Tarikh: 25/05/06

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I hereby, declare this thesis entitled “Optimizing Number Of Servers For Haemo-Dialysis Fluid (HDF) Production Line At Ain Medicare Sdn. Bhd. To Increase Efficiency” is the results of my own research except as cited in the reference.

Signature : 

Author's Name : Nur Izzati Binti Marzuki

Date : 25 May 2006

APPROVAL

This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the Bachelor of Manufacturing Engineering (Manufacturing Process) (Honours). The members of the supervisory committee are as follows:



Main supervisor

Faculty of Manufacturing Engineering

PROF. MADYA DR. ADI SAPUTARI
Pensyarah
Fakulti Kejuruteraan Pembuatan
Kolej Universiti Teknikal Kebangsaan Malaysia
Karung Berkunci 1200, Ayer Keroh
75450 Melaka

ABSTRACT

This thesis which the title is “Optimizing Number Of Servers For Haemo-Dialysis Fluid (HDF) Production Line At Ain Medicare Sdn. Bhd. To Increase Efficiency” discuss about the initial efforts to optimize and simulate the model as a visual management and analysis tool at the shop floor. The production shop floor was modelled using WITNESS software to identify bottleneck, and evaluate machine performance, cycle time that are essential for efficient production control. This thesis developed three alternatives solutions in order to reduce the number of queues in a production line of Haemodialysis Fluid (HDF). The first alternative simulate about adding one machine and one operator in the production line. Next, the second alternative is about reducing the cycle time of Filling Machine, Conveyor 1, 2, 3 and also Wrapping Machine. Lastly, the third alternative is about combining the Leak Test Process and Labeling Process to become one process. These alternatives will evaluate based on the achievement of the production target which is to get 1.5% from the current demand. Furthermore, this thesis also will consider about the cost efficiency for each alternatives. Further research of this area need to extend in order to obtain the rules of the simulation process and also may propose more than three alternatives to compare the different configuration for each layout.

DEDICATION

For My Beloved Abah and Mama.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

λ	-	customer arrival rate
μ	-	service rate per server
T	-	time (in minute)
N	-	number of units
P_n	-	the probability of n units in the system
(M)	-	Malaysia
Bhd.	-	Berhad
B.C	-	Before Century
CIM	-	Computer-Integrated Manufacturing
CNC	-	Computer Numerical Control
Co.	-	Company
DES	-	Discrete-Event Simulation
HDF	-	Haemo-Dialysis Fluid

CHAPTER 1

INTRODUCTION

1.1 Background.

“Optimizing number of servers for Haemo-Dialysis Fluid (HDF) production line at Ain Medicare Sdn. Bhd. to increase efficiency” has been research in an attempt to solve the problems in queuing systems especially in manufacturing industry that occurred in the daily life. Indeed, phenomena of queuing are every where, and it need to solve in order to increase the quality of people life. By optimizing the production line in any manufacturing, the productivity of the company can be increased which also can be translated as higher satisfaction of their customers. Moreover, this problem is not only domain in manufacturing industry but also in service industry like banking, post office, restaurant, etc.

The word *queue* comes from the Latin *cauda*, meaning tail. Most researchers in the field prefer the spelling 'queueing' over 'queuing', although the latter is somewhat more common in other contexts. From the time of birth (usually involving an approximately 9-month period from the moment of conception) until death (an entire life-time - whether brief, extensive or in between) and at many moments along the way human beings often find themselves waiting for things, events, conditions, etc. A major topic that deals with this phenomenon of waiting is called Queuing Theory. Using the word "Queue", which is more common in British than American English and means "a line up" or "to form a line", a closely reasoned body of a theory that has been developed in order to describe this common human activity - theory

applicable to normal economic activity. Realistic applications can be made to the phenomena of customers awaiting the delivery of goods/services, as well as to goods-in-process coming to be finished goods.

Actually, a queuing system consists of one or more servers that provide service of some sort to arriving customers or products. These customers or products that arrive to find all servers busy generally join one or more queues (lines) in front of the servers, hence the name queuing systems. There are several everyday examples that can be described as queuing systems, such as bank-teller service, computer systems, manufacturing systems, maintenance systems, communications systems and so on. The elements of the queuing system consist such as the input population of customers or products, arrival, queue, service and output.

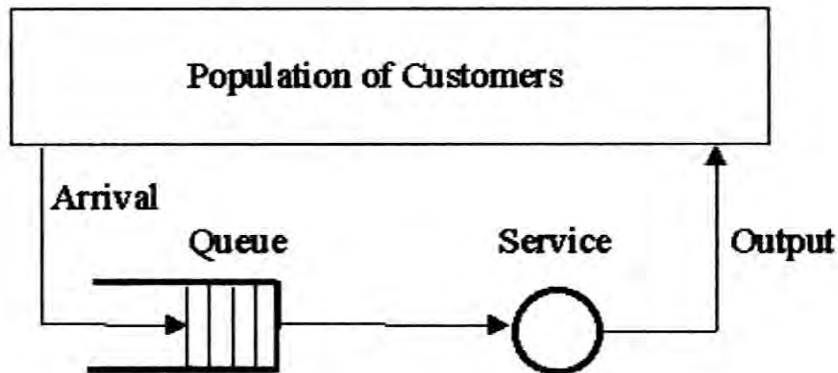


Figure 1.1: The Elements of the Queuing Systems

Population of Customers or products can be considered either limited (closed systems) or unlimited (open systems). Unlimited population represents a theoretical model of systems with a large number of possible customers (a bank on a busy street, a motorway petrol station). Example of a limited population may be a number of processes to be run (operated) by a computer or a certain number of machines to be repaired by a service man. It

is necessary to take the term "customer" very generally. Customers may be people, machines of various natures, input of products, computer processes, telephone calls, etc.

Arrival defines the way customers or products enter the system. Mostly the arrivals are random with random intervals between two adjacent arrivals. Typically the arrival is described by a random distribution of intervals also called *Arrival Pattern*. Arrival process may originate from one or several sources referred to as the calling population. The calling population can be limited or 'unlimited'. An example of a limited calling population may be that of a fixed number of machines that fail randomly. The arrival process consists of describing how customers or products arrive to the system.

Queue represents a certain number of customers or products waiting for service (of course the queue may be empty). Typically the customer and products being served are considered not to be in the queue. Sometimes the customers form a queue literally (people waiting in a line for a bank teller). Sometimes the queue is an abstraction (planes waiting for a runway to land). And also, sometimes the products waiting in a conveyor to proceed to the next process in the production line of manufacturing industry.

Service represents some activity that takes time and that the customers or products are waiting for. Again take it very generally. It may be a real service carried on persons or machines, but it may be a CPU time slice, connection created for a telephone call, being shot down for an enemy plane, etc. Typically a service takes random time. Theoretical models are based on random distribution of service duration also called *Service Pattern*. Another important parameter is the number of servers. Systems with one server only are called *Single Channel System*, meanwhile the systems with more servers are called *Multi Channel Systems*.

Output represents the way customers or products leave the system. Besides, output also is mostly ignored by theoretical models, but sometimes the customers and products leaving the server enter the queue again ("round robin" time-sharing systems).

Furthermore, the system usually involved in two ways interaction which are consist the queers and the servers. Therefore, for this thesis, some systems that are related to the queuing problems to increase the efficiency especially in the manufacturing management have been observed. The queuing systems actually are basically of the process management for the companies.

Moreover, the increasing of the productivity and better overall efficiency of the production line are the most important goals for almost all the manufacturing company. The survival of any industry in today's competitive market place depends on response time, production costs and flexibility in manufacturing (Chase et al. 2001). Because of the complexity and dynamic behaviour of such systems, simulation modelling is becoming one of the most popular methods of evaluating their floor layout design and operating strategies (Hlupic and Paul, 1993), (Hollocks, 1992), (Pidd, 1992), (O'Keefe and Haddock, 1991).

Actually, the manufacturing modelling and simulation is a concept of creating the real world problems in simulation software. The purpose of creating these real problems in the software is to reduce and minimize the production cost and also at the same time to increase the output productivity of the company's products.

Besides that, in this chapter also will be provided an overview of this thesis starting with the problem statement, which explain and discuss about the problems that was faced by the selected manufacturing company during the production of a products.

Moreover, an overview of the objectives and the scope of this thesis also will be explained briefly. Basically, the objective of this thesis is to find an alternative way to increase the productivity of the company. Actually, this thesis will be done in one of the pharmaceutical factories in Malaysia.

Finally, the importance of this thesis to the manufacturing industry will be discussed and the outline of the thesis also will be reviewed in general.

1.2 COMPANY PROFILE

AIN MEDICARE SDN BHD (AMSB) was officially inaugurated by the Right Honourable Fourth Prime Minister of Malaysia, Tun Dr Mahathir Mohamed on the 17th April 1997. AMSB is a fully integrated pharmaceutical complex, situated in Kota Bharu, Kelantan, which was completed in 1995. Initially RM35 million complex, which was built by local expertise consists of production floor, laboratories, warehouses and administration office. The production floor is equipped with clean rooms ranging from class 1000 to 100 000. Both microbiology and chemistry laboratories are well equipped with the latest equipment. With the state of art of production facilities, AMSB is capable to produce a range of intravenous solution (Large Volume Parenterals [LVP]), small volumes injections (Small Volume Parenterals [SVP]), Haemodialysis concentrates and peritoneal dialysis solutions. More than 300 peoples are employed by AMSB, including pharmacists, chemists, microbiologists, engineers and accountants.

AMSB is constantly upgrading its product, quality, facilities and also diversifying its products range. In order to fulfill these visions, recently AMSB has invested additional RM 30 million to install the state of art machineries, Blow-Fill-Seal Bottlepack Machine for Intravenous solutions production and inject able. The machineries would enable AMSB to increase its production capacity to more than 20 million bottles per year. They are always open to work closely with other companies and research centers in area of research and development and also contract manufacturing. Genetically engineered drugs/product will soon be manufactured by them.

With the certification to the current Good Manufacturing Practice (cGMP) by the National Pharmaceutical Control Bureau (NPCB), Ministry of Health (MOH) in May 1995 and being the first locally owned company with the available facilities, backed up by experienced management team, AMSB is poised to be the major producer to meet the country's increasing needs. Recently, their manufacturing facilities have been certified to Pharmaceutical Inspection Cooperation scheme (PIC/s) by the National Pharmaceutical Control Bureau (NPCB) of Ministry of Health (MOH) and is also an ISO 9001:2000 certified company accredited by Det Norske Veritas (DNV).

Ain Medicare Corporate Vision

- To further innovate superior quality healthcare products to the highest standard possible to serve patient worldwide.

Ain Medicare Corporate Mission

- Ain Medicare is committed to providing products that consistently meet the customer's satisfaction and comply with regulatory requirements. Besides, Ain Medicare is committed to continuously improving its operations to excel beyond the quality standard. Ain Medicare believes in providing good services to meet with the customers' satisfaction.

Certification

- The Ain Medicare pharmaceutical complex has been certified to current Good Manufacturing Practice by the National Pharmaceutical Control Bureau, Ministry of Health, Malaysia, since 1995 also accredited with ISO 9002 by Det Norske Veritas.

Ain Medicare Motto

- Life Solutions for Health and Healing

Quality Policy

- Meeting customer's satisfaction through quality, efficacious, safe and reliable products supported with excellent services.

Quality Objectives

- Zero defect
- Zero Complaint
- Conform to contractual and regulatory standards.

Quality Commitment

- Quality, efficacy and safety must be the utmost importance.
- To excel in the implementation of total quality management system.
- To inculcate a strong teamwork spirit.

1.3 Problem Statements

One of the major inefficiency companies is having too many servers or fewer servers to fulfill their customer request. Too many servers mean idle capacity, meanwhile less servers mean not satisfying the customer. Having the right number of servers that could respond to the customer requirements would be beneficial to the company. Therefore, queuing and simulation method could help the company to find out the optimum number of servers to implement the customer needs. This will help increasing the productivity of the company.

In Haemodialysis Fluid (HDF) Production Line, there is a flow process involving:

- a) Filling
- b) Leak Test
- c) Labeling
- d) Cartonizing
- e) Palletizing
- f) Wrapping

During the production, there is always a queue in front of the machines especially at palletizing process.

This queue is a signal of unbalance of incoming material or parts with the speed or production time of the machines and operators. The thesis is an attempt to reduce the number of queue by letting different configuration of machine and change the speed of several machines such as Filling Machine, Conveyor 1, 2, 3 and also Wrapping Machine.

1.4 Objectives

The main objective of this thesis was to simulate the manufacturing process for manufacturing Haemodialysis Concentrates Solution and evaluate effectiveness of the process in terms of machine utilization and systems performance. Some objectives that need to be achieved at the end of the thesis are as follows:

- (a) To understand and recognize the queue phenomena in the one of production line in a selected manufacturing company.
- (b) To measure manufacturing performance such as production quantity, cycle time and bottle neck.
- (c) To apply computer simulation software in helping to solve queuing problem of the selected production line in the manufacturing company.
- (d) To explore some alternatives model of production line to solve the queue problem.
- (e) To recommend the best alternatives based on current problem situation.

1.5 The Scope

This thesis will analyze an industry specific problem of production of Haemodialysis Fluid (HDF) in order to increase the productivity and try to solve it through the several alternatives of production scenario. This thesis is conducted in Ain Medicare Sdn. Bhd. located in Pengkalan Chepa Industrial Area, Kota Bharu, Kelantan. This company is one of the pharmaceutical manufacturer which produce medical solution for hospitals and clinics as it major customers.

There are 6 types of products that have been produced in this company. They are:

- 1) Metronol
- 2) Haemodialysis Concentrates Solution
- 3) Peritoneal Dialysis Solution
- 4) Irrigation Solution
- 5) Intravenous Infusion Solutions
- 6) Small Volume Injections

This thesis will be focused at Haemo-Dialysis Fluid (HDF) Production Line which produced Haemodialysis Concentrates Solution. The production line was chosen because the cycle time to produce the products is the longest process in this company factory. Actually, the complete Haemodialysis Concentrates Solution process is starting from filling process, inspection by using leak test machine, labeling, cartonizing, palletizing and finally wrapping packaging. It looks like very simple process but in reality it is a very complicated process, which it involves knowledge, technology and skills.

Besides that, at the same time, the target that had been set by the company which is to increase up the product output per month to 1.5% from the current demand which was 1260 pallets per month cannot be achieved. Therefore, in order to deal with that problem, a new of production line will be proposed.