IMPLEMENTATION OF COMPUTER SIMULATION IN RUBBER ASSEMBLY LINE: A CASE STUDY (RUBBER RESEARCH INSTITUTE OF MALAYSIA)

MOHD FAHMI BIN MOHAMAD AMRAN

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Faculty of Computer Science and Information System
Universiti Teknologi Malaysia

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Abstract

Simulation is one of the modeling techniques in solving industrial problem that can imitate the real system through model development. In Rubber Research Institute of Malaysia (RRIM), assembly line of Deproteinised Natural Rubber (DPNR) that has been operating since 1994 had never been modeled through simulation method in improving and solving the production problem. Therefore, the implementation of computer simulation in the DPNR assembly line at RRIM is appropriate to solve two main problems namely increasing production capacity, and ineffective production line. In order to achieve the objective, facilities layout, automating the process of assembly line and increase the conveyor speeds were proposed as a method to improve the current system. In this project, the simulation modeling was applied discrete event simulation and the flow manufacturing simulation as a methodology. The simulation model was developed and tested using *ProModel 6.0 Network Version* software. The data analysis was carried out using *Stat::Fit* of *ProModel* software. Data was collected and evaluated to determine the necessary parameters that are used in the simulation model. This project is wished to be implemented as solutions to the problem faced by the current system.

Abstrak

Simulasi merupakan teknik pemodelan dalam menyelesaikan masalah industri yang dapat meniru sistem sebenar menerusi pembinaan sebuah model. Di Institut Penyelidikan Getah Malaysia (RRIM), baris pengeluaran bagi *Deproteinised Natural Rubber* (DPNR) yang telah mula beroperasi sejak tahun 1994 tidak pernah dimodelkan melalui kaedah simulasi yang dapat menyelesaikan masalah pengeluaran. Oleh itu, pengimplementasian komputer simulasi untuk baris pengeluaran bagi DPNR di RRIM adalah kaedah yang sesuai untuk menyelesaikan dua masalah utama iaitu peningkatan jumlah pengeluaran dan baris pengeluaran yang tidak efektif. Untuk mencapai objektif, *layout fasiliti*, pengautomasian proses baris pengeluaran dan meningkatkan kadar kelajuan konveyor telah dicadangkan sebagai kaedah dalam meningkatkan keupayaan sistem semasa. Dalam projek ini, pemodelan simulasi menggunakan *simulasi peristiwa diskrit* dan *simulasi pembuatan aliran* sebagai metodologi. Model simulasi dibangunkan dan diuji menggunakan perisian *ProModel 6.0 Network Version*. Analisa data pula menggunakan *Stat::Fit* yang terdapat dalam perisian *ProModel*. Data telah dikumpul dan dinilai untuk menentukan parameter yang digunakan dalam pemodelan simulasi. Adalah diharapkan semoga projek ini dapat digunakan untuk menyelesaikan masalah yang dihadapi sistem semasa.

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LIST OF ABBREVIATION

°C	Celcius
DPNR	Deproteinised Natural Rubber
GOF	*Goodness of Fit*
HNS	Hydroxylamine Neutral Sulphate
kg	kilogram
K-S	*Kolmogrov-Smirnov*
mpm	meter per minute
MRB	Malaysian Rubber Board
NR	natural rubber
R & D	research and development
UTM	*Universiti Teknologi Malaysia*

CHAPTER 1

INTRODUCTION

1.1 Introduction

Simulation is one of the most powerful analysis tools available to those responsible for the design and operation of complex processes or systems. It is heavily based upon computer science, mathematics, probability theory and statistics. The use of simulation as a problem solving tool continues to expand.

Deproteinised Natural Rubber (DPNR) is a purified form of natural rubber (NR) in which most of the ash and protein components have been removed. It is specially rubber intended for use in special engineering applications. It contains about 96% rubber hydrocarbons compared to about 93% for normal natural rubber grades. The removal of these non-rubber components confers special attributes to the rubber which enhance its value in certain specialized applications.

Deproteinisation Natural Rubber (DPNR), whether in dry rubber or latex form, or products generates a lot of interests in the past and at present. The numerous publications available attest to the great interest in this topic.

Some consumers of dry natural rubber are interested too because of the special attributes that come along with the deproteinisation of natural rubber. Many attempts have been made in the past to produce commercial quantities of Deproteinisation Natural Rubber (DPNR) at a reasonable price and quality to meet the needs of such consumers.

The Malaysian Rubber Board (MRB) has been successful in this respect and has developed a new and improved method for its production. The DPNR thus produced is actually a purified form of natural rubber with very low nitrogen and ash contents. When compounded using the soluble efficient vulcanization system, DPNR has low creep and stress relaxation, low water absorption, low compression set and a more consistent modulus when subjected to conditions of variable humidity. DPNR is therefore suitable for a niche market where the requirements for such properties are very stringent.

One application for DPNR is in the manufacture of hydromounts for the automobile industry. The main advantages of hydromounts are that the automobile engine is so gently supported that there is negligible vibration transfer to the main body compartment even when the road surface is poor.

Another application is in large shock absorbers for Deltawerken in the Netherlands. These large shock absorbers have to withstand prolonged contact with seawater and yet must not absorb too much seawater to cause corrosion in the embedded steel plates. In addition, the creep of the rubber should be minimal because of the very long expected service life. For both these reasons, DPNR is preferred over normal NP in this application.

The MRB has taken serious note of the requirements of the industry for DPNR and has purposely built a special plant solely for its production. The plant has been in operation for 9 years already and has supplied commercial quantities to various customers as well as for promotional purposes.

This project presents a study on simulation of assembly line at Rubber Research Institute of Malaysia in Sungai Buloh, Selangor. Generally this study analyses the data and of rubber assembly line and try to simulate it to make the alternative model that would give benefits to manufacturer. Simulation was applied to rubber assembly line to investigate system parameters and to test various hypotheses.

1.2 Background of Problem

As the twenty first century begins, the global marketplace continues to grow stronger. To stay competitiveness, factories need to make long as well as short term capacity decision with proper planning. This project is about simulation study in rubber assembly line. The preliminary study at the factory revealed that they have a problem in the current system of assembly line.

The implementation of assembly line in manufacturing system can optimize and increases the productivity. In this study, the current assembly line could not manufacture and distribute the DPNR as schedule by the factory. Furthermore, the demand from customers is increasing and the factory has to increase their monthly production rate. The manufacturing lead time is one of the problems that industry expertise has to accomplish.

The material handling system that factory applied now is not fully optimized. They still use a man power to organize and transfer the raw material and product from one workstation to another workstation. This could cause a problem to operators who are highly exposed to chemical effects. Raw materials are mix with chemical content during early stage of manufacturing the DPNR.

1.3 Statement of the Problem

Below are some statements of the problem:

i. How to improve the production capacity and assembly line productivity using based simulation model?
ii. How to developed valid simulation model that suits with the scenario?
iii. How the performance of assembly line managed with the current system?

1.4 Project Objectives

Below are some objectives of the project:

i. To design and develop a simulation model of assembly line based on real system using *ProModel* software.
ii. To propose what are the possible manufacturing improvement design which is able to significantly increase the manufacturing performances and production capacity using valid simulation model.

1.5 Scope of Project

Below are some scopes of the project:

i. This project focuses on Deproteinised Natural Rubber (DPNR) assembly line in Rubber Research Institute of Malaysia.
ii. The project cover operation process from *steam coagulation* workstation to *wash* workstation of manufacture the DPNR which is consists of 9 workstations.
iii. Collect and analyze the input and output data in order to develop the simulation assembly line.
iv. To develop a simulation model using *ProModel 6.0, Network Version* meanwhile *Stat::Fit* and *Microsoft Excel* software were used for statistical analysis.
v. This project recommendation only based on manufacturing variable aspect and assume that the real system have no constraint about anything outside the analytical manufacturing aspect (*e.g financial limitation, land, workforce and technology*).

1.6 Importance of Project

From this project it can helps Rubber Research Institute of Malaysia as a manufacturer and manufacturing industry in Malaysia. Rubber Research Institute of Malaysia can increase their production rate and improve the efficiency of the line production. Beside that, the total time and manufacturing lead time can even faster by simulate the current system. When the system have been automated, numbers of workers can reduced to cut the production costs and also to avoid accident that can occur during manufacturing process.

Manufacturing industry in Malaysia can get a benefit with this project indirectly. Because not many company or researchers in Malaysia involve in the rubber industry, this project can give a knowledge and information with the simulation of the rubber.

Hopefully with the efforts in doing this project it can helps other researchers in guiding and solving the problems related with rubber industry in Malaysia especially in modeling and simulation of assembly line.

1.7 Chapter Summary

In this introductory chapter, the outline of the whole project have been presented and tried to bring to the fore why this project is necessary at this time. The prevailing problems that necessitate the study have been discussed and the project problems highlighted. The objective, scope and the importance of this project have also been pointed out.

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