MANUFACTURING PROCESS RE-ENGINEERING DESIGN IMPLEMENTATION USING COMPUTER SIMULATION MODEL

(Case study in Body Shop and Metal Finish section of Truck Assembly line)

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ABSTRACT

Simulation is one of tools that have been used widely in several manufacturing areas and organizations as well as in automotive industries. Using a valid simulation model may possible give several benefit and advantages in creating better manufacturing design in order to improve the system performances. This project is concerning in implementing a computer based simulation model to design Manufacturing Process Re-engineering scenarios for performances improvement. The basic problem addressed by this project is that the current manufacturing system performances have to be improved to deal with the business environment. Project's objective is to develop/design four improvement alternatives design using Valid Computer Simulation model. Three approaches which are: Line Balancing, Facilities re-layout and process enhancement, and manufacturing process automating were applied as the foundation in creating improvement scenarios of the real system. Simulation modeling formally followed the enhanced Discrete Event Simulation methodologies. Simulation models were developed using Process Oriented Simulation Software which is ARENA version 7.1 while Statfit and Microsoft Excel software package were used for statistical analysis. Project's case study was taken from the Job Shop Manufacturing line / Intermittent Process Industries in Body welding and metal finish operations of Isuzu N-series Truck assembly line of PT. Pantja Motor, Indonesia. The project deliverable might be differ into the initial simulation model of current system and four Manufacturing Process Re-engineering scenarios that will be based on three approaches as mentioned above. Constraints and challenges in conducting the project seemed might be reduced wisely, so that the whole project outcome and deliverables are still achieved appropriately.

ABSTRAK

Simulasi merupakan sebuah metodologi yang telah digunakan secara meluas dalam pelbagai industri pembuatan dan organisasi termasuk industri automotif. Dengan menggunakan model simulasi yang bersesuaian, ia dapat memberikan faedah dan kelebihan di dalam merancang rekabentuk sistem pembuatan bagi meningkatkan keupayaan sistem. Projek ini memfokuskan kepada pelaksanaan model simulasi berkomputer dalam proses merekabentuk Kejuruteraan Semula Proses Pembuatan bagi meningkatkan keupayaan sistem. Masalah utama bagi projek ini adalah keupayaan sistem pembuatan semasa harus dipertingkatkan untuk bersaing dalam persekitaran perniagaan kini. Objektif projek adalah untuk membangunkan model simulasi sistem semasa dan merekabentuk empat cadangan penambahbaikan menggunakan model simulasi berkomputer yang sah. Tiga pendekatan iaitu Pengimbangan Barisan, Lay-out Semula Fasiliti, dan automasi proses pembuatan digunakan sebagai asas dalam perancangan penambahbaikan bagi sistem semasa. Pemodelan simulasi yang dilakukan adalah berdasarkan metodologi Simulasi Peristiwa Diskrit. Model simulasi dibangunkan dengan menggunakan perisian aplikasi simulasi berorientasikan proses iaitu ARENA versi 7.1 manakala Statfit dan Microsoft Excel sebagai analisa statistik. Kajian kes adalah berdasarkan daripada Bahagian *Body Welding* dan Kemasan Logam, sistem baris pembuatan kenderaan trak Isuzu N-Series, PT. Pantja Motor, Indonesia. Hasil yang diperolehi daripada projek ini adalah berpandukan kepada simulasi model sistem semasa dan empat cadangan penambahbaikan. Segala kekangan dan cabaran dalam melaksanakan projek ini dapat ditangani dengan baik seterusnya objektif dan skop dapat dicapai seperti mana yang dikehendaki.

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BIQ	Built-in-quality
BOM	Bill of Material
CKD	Completely Knock Down
CT	Cycle Time
FSKSM	Fakulti Sains Komputer dan Sistem Maklumat
FV	Face Validity
GOF	Goodness-of-Fit
JAD	Joint Application Design
LT	Load Time
MPV	Multi Purpose Vehicle
NT	Normal time
PF	Performance Rating
PMI	PT. Pantja Motor Indonesia
PPI	Persatuan Pelajar Indonesia
PT	Process Time
ST	Set-up Time
STT	Standard Time
SUV	Sport Utility Vehicle
UIN	Universitas Islam Negeri
UT	Un-load Time
UTM	Universiti Teknologi Malaysia
WBS	Work's Breakdown Structure
WIP	Work-in-process
WS	Workstation

CHAPTER ONE

PROJECT OVERVIEW

1.1 Introduction

Along with the rapid growth of technology in last four decades, industrial / manufacturing enterprises confronted in the situation that improvement of the manufacturing performance is the matter which very insist to be certainly achieved. At the other hand, experimental design in existing system will give negative impact for the enterprise. This matter make many companies, finally choose not changed anything to their manufacturing system rather than take a high risk of trial and error processes in experimental design.

Simulation, as a contemporary computer/Information Technology (IT) based technology was raise to minimize that particular risk as mentioned above. In advance to develop a valid simulation model, company can conduct experimental design to get the improvement design of their manufacturing system without disturbing the working system. Computer Simulation model accommodates implementation of various Manufacturing Process Re-engineering Designs into computer based model and simulate it as well as justifying the performances.

So that, conducting experimental design based on Computer Simulation Model might be the favorable solution which is collaborate the necessity of improving manufacturing performance and minimize the risk of doing direct modification to the real working system.

Manufacturing and material handling systems provide one of the most important applications of simulation. Simulation has been used successfully as an aid in the design of new production and manufacturing facilities, warehouses, and distribution centers as well as in automotive industries. It has also been used to evaluate suggested improvements to existing systems (Banks *et al.*, 2001). Engineers and analysts using simulation have found it valuable for evaluating the impact of capital investments in equipment and physical facility, and of proposed changes to material handling and layout. They have also found it useful to evaluate staffing and operating rules, and proposed rules and algorithms to be incorporated into warehouse management control software and production control systems. Managers have found simulation useful in providing a "test drive" before making capital investments, without disrupting the existing system with untried changes.

At the other side, as one of the most important sector in manufacturing filed, automotive industries also have been applying Simulation for decision support approach for more than 20 years since the rapid improvement of computer technologies. Many automotive expertises believe that simulation still will be the important decision support approach in Automotive Industries.

1.2 Automotive Industry Environmental Background

As realized, automotive manufacturing system is a complex task involving several steps of machining and assembly (Hee Han, 2002). Typically, large components of an automobile such as the body, engine, etc are assembled over multiple systems. As shown in Figure 1.1, three main stages of assembly line in the automotive industry are: the body shop, the paint shop, and the trim and chassis shop. Cars flow through the assembly line from stage to stage in sequence.

Figure 1.1 General step of cars assembly line

An automotive company will typically sequence cars based on several objectives, most dealing with line balancing and material management. In the first and last stages (the body shop and the trim and chassis shop), different cars might require the installation of different components. Such imbalance of the workload at the automotive assembly line can be due to:

1. Different options of the same car model (e.g. one car might have an automatic transmission and sunroof, while another car might have a manual transmission, but no sunroof),
2. Different types of the same model (e.g. sedan vs. wagon), or
3. Different models assembled in the same line.

This project will cover how simulation can be applied into Manufacturing Process Reengineering Design in Automotive industries sub system (which is will explained more detail in the following section) in order to improve their performances using certain manufacturing performance improvement approaches. Manufacturing Process Reengineering will be conducted using simulation based experimental design. Each design will represent the solution alternative that proposed based on particular manufacturing improvement technique.

Furthermore, one of the improvement approaches that will be used is manufacturing line balancing. Firstly, this method will determine the workload of each section in manufacturing line and illustrate the manufacturing line efficiency. Next, in order to improve line efficiency, workstation's workload imbalances will be minimizing using related algorithms which are described more detail in the following chapter.

Later on, as realized, material handling is one of the most important factors regarding to Manufacturing Performance Improvement. Optimal material handling system must drive the manufacturing flow become lean and balance. There are several techniques to increase the material handling performance, whereby one of them is determining the accurate and appropriate facilities layout that can accommodate the criteria of optimum material handling operation.

The other method that will be applied in this project to improve the manufacturing performances is automating the processes. As Groover (2001) stated that Automated Manufacturing had become a popular approach to improve the performances of manufacturing system, especially for the system that produce large number of product with high level of similarities. The common characteristic in automated manufacturing is that the system consists of automated components, such as industrial robot, automated guided vehicles, sensors, and controllers.

1.3 Background of Problem

The project will be based on the case study at Isuzu N-Series Truck Assembly Plant, PT. Pantja Motor, Tbk Indonesia (PMI). PMI is an official Isuzu licensed manufacturer in Indonesia. The company is currently produce two type of Isuzu cars, which are the passenger car and commercial car. Commercial cars divide into bus and truck bases while passenger car have two main models whereby Multi Purposes Vehicle (MPV) and Sport Utility vehicle (SUV). The truck and bus assembly line is located in Jl. Kaliabang, Pondok Ungu, Bekasi – Jakarta and the head office is located about 50 kilometers from this assembly line in Jl. Gaya Motor Selatan Jakarta Utara, just next to their one another assembly plant which is for passenger car. Figure 1.2 illustrated the view of Isuzu Indonesia's assembly plant and commercial truck models.

Figure 1.2 Isuzu Indonesia's N-series assembly plant and commercial truck model

PMI's grand total production capacity of whole type is 15000 units per year, whereby the N-Series production is limited only about 6900 unit annually. Since the significant raise of product demand in the past 3 years, so the PMI is facing the problem in improving their production capacity, especially of N-series truck model which is most demanding product.

As mentioned earlier, like the other automotive type, the processes of N-series truck assembly basically consists of three general stages, which are Body shop/welding, Paint shop, and chassis and cabin shop. The appropriate performance improvement design has to be defined into the production section. Figure 1.3 indicates the general process of Isuzu N-Series assembly.

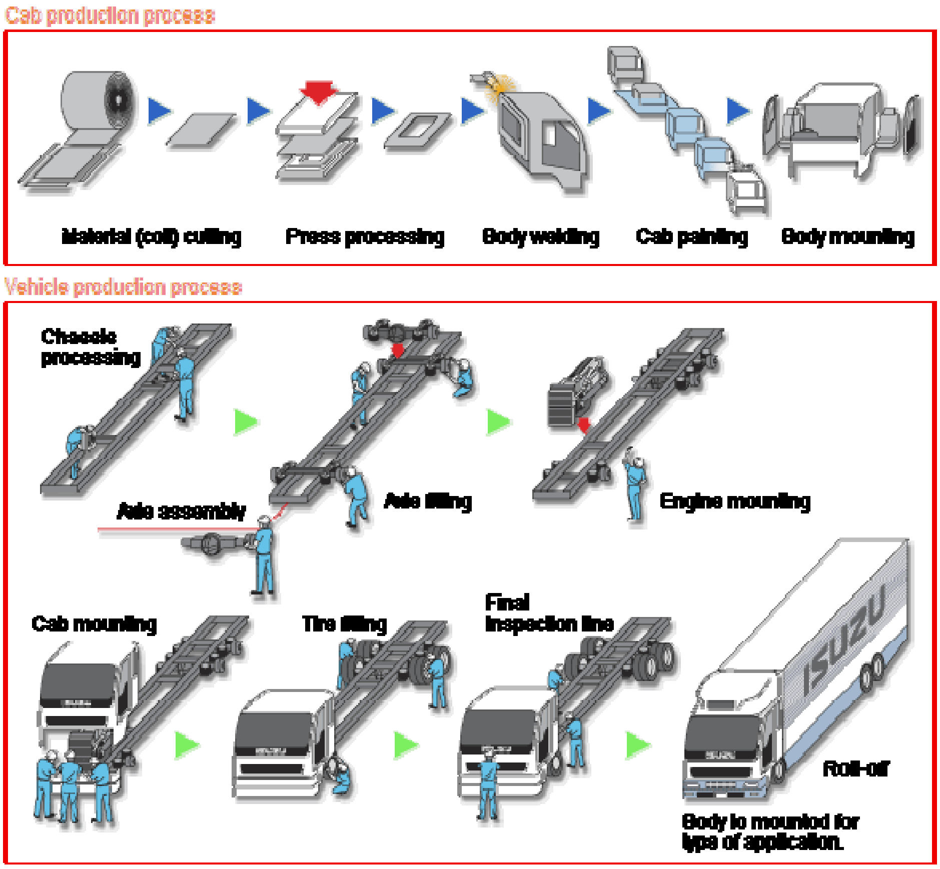

Figure 1.3 Isuzu N-Series Truck General Assembly Process

Based on the preliminary observation and survey, it is can be concluded clearly that the processes in N-series assembly line have several opportunities to be improved because of following findings: lack of process automating, un-lean manufacturing processes, poor facility layout orientation, Work In Process (WIP) problems, and also poor line efficiency. With the appropriate manufacturing re-engineering design, using such as line balancing, facility re-layout, and automating the manufacturing process, the significant manufacturing performances may possible achieved promptly.

1.4 Statement of the Problem

Based on the preliminary study and information gathering process through documentary analysis, this project will try to overcome the problems related to the real system. The basic problem of the current manufacturing system is that the production capacity does not meet the future business environment, so the current manufacturing system has to be improved significantly. This general problem also drives several major questions that have to be answered appropriately in order to solve the problem:

1. Does the current manufacturing system is the optimal configuration in terms related to manufacturing system performance?
2. What manufacturing designs may possible significantly improve the current manufacturing / industrial system?
3. How to conduct experimental design to develop scenarios for Manufacturing Performances Improvement without disturbing the real working system?
4. How far the new design can improve the manufacturing performance?

1.5 Project Objective

Based on the case study on PMI's Body Shop N-series Assembly Line, the project will cover several objectives:

1. To analyze the current Manufacturing or Industrial Performance
2. To study what are the possible manufacturing improvement design which is able to significantly increase its manufacturing performances.
3. To develop/design several improvement alternatives design using Valid Computer Simulation model.
4. To propose the Manufacturing Process Re-engineering design for performance improvement related to the real system using three approaches: Line Balancing, Facilities re-layout and process enhancement, and automating the processes.

5. To identify the significances of improvement that achieved by implementing those three approach using computer based simulation based.
6. To implement the most valuable manufacturing re-engineering design in the computer simulation model instead of disturbing the real system.

1.6 Project Scope

In case of project coverage area, the following assumption, environmental boundaries, and constraint can be mentioned in determining the project scope:

1. Primary data is collected straightly to the Manufacturing Real system by observation, interviews, sampling methods and time study.
2. Data types that used in this project are the manufacturing variables such as: process time, transfer time, set-up time, standard output, cycle time, number of work-in-process, working time, and other common manufacturing variables.
3. Secondary data are used in case of unavailability of the primary data.
4. Case study is taken from the Job Shop Manufacturing line / Intermittent Process Industries in Body shop and metal finish of Isuzu N-series Truck assembly line of PT. Pantja Motor, Tbk Indonesia (PMI).
5. Simulation modeling formally will follow Discrete Event Simulation methodology.
6. Simulation model is developed using a Process Oriented Simulation Software which is ARENA version 7.1.
7. Statfit and Microsoft Excel software package will be used for statistical analysis.
8. This project recommendations are only based on manufacturing variable aspect and assume that the real system have no constraint about anything outside the technical manufacturing aspect (e.g financial limitation, land, workforce, and technology).
9. For justifying the significance of performance improvement, the Manufacturing Process Re-engineering design will be simulated and compared to the real system.

10. Complexity of the real system, time, and the capability in making computer simulation model will be the most consideration in determining how deep alternative designs will be proposed.

1.7. Importance of Project

Based on what have been illustrated before, generally this project will recommend several scenarios of manufacturing improvement design for the certain case studies. The improvement significances will be determined by a valid simulation model so that the users or clients will more easily justifying the right policies. More detail, the project potential benefits to the organization can be defined as follows:

1. Users can use the initial valid simulation model for analyzing their manufacturing process at particular stages more conveniently and efficient than studying directly through the real system.
2. With the computer based simulation model, the company may conduct the experimental design iteratively to find their best solution regarding to improve manufacturing system accurately and safely rather than do the experiment in their working system whereby definitely disrupting and deal with high risk probability.
3. Simulation model can be capable enough to predict what are the consequences and following effects that might be raised from a certain strategies implementation.
4. The result of the project will contribute the management a valuable input and consideration for supporting their decision making processes.

At the other hands, manufacturing simulation studies and research are still active and many more simulation studies are being done by time to time. So that, this project perhaps may little bit enriching the simulation studies discourse especially in applied simulation in automotives industries.

1.8. Organization of Thesis

This Master Project report is consist of eleven Chapters which are describe about seventeen Project's steps as attached in Appendix A.

1.9. Chapter Summary

Simulation is one of tools that have been used widely in several manufacturing area and organizations. Using a valid simulation model may possible give several benefit and advantages in creating the better manufacturing design in order to improve the performances. This project is concerning in implementing a computer based simulation model to design scenarios for performances improvement.

Manufacturing process reengineering design will be based on three approaches and principles: minimizing imbalance workloads in assembly line, improving material handling capabilities through facilities re-layout, and automating the manufacturing processes. Meanwhile, Body Shop and Metal Finish department of PMI's Isuzu N-Series assembly plant will be the base of the project's case study.

The project outcome is expected to give the significant contribution to the user or client in improving their manufacturing performances in order facing the business challenges and dealing with the problem environment.

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