OPTIMISATION CONTROL PROCESS IN REMANUFACTURING SYSTEM

Submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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I hereby, declared this report entitled "Optimisation Control Process In Remanufacturing System" is the result of my own research except as cited in references.

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Date   : 2 SEPTEMBER 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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(DR. NUR AIDAWATY BINTI RAFAN)

ABSTRAK

Pembuatan semula adalah salah satu inisiatif untuk mengekalkan sisa yang terbuang atau produk terguna menjadi lebih berguna. Kajian ini memfokuskan pada jalur pemasangan dalam sistem pembuatan semula dalam industri automotif yang bertujuan untuk menetapkan strategi untuk meningkatkan efisiensi dan mengoptimumkan proses kontrol menggunakan kaedah Taguchi. Kajian ini dilakukan untuk mengenal pasti masalah semasa, seperti proses barisan pemasangan yang tidak sistematik, masa pemprosesan yang tidak dapat diramalkan, dan kualiti produk yang tidak menentu. Dengan menggunakan simulasi Arena, tiga model susun atur yang diusulkan dirancang yang menghasilkan parameter Taguchi. kaedah Taguchi dilakukan analisis yang merujuk keadaan lebih kecil lebih baik dengan menggunakan parameter model susun atur yang diusulkan yang menyumbang keadaan output optimum di Level 3 dengan nilai nisbah S/N adalah -37,02 dB, validasi 5,63%, dan rata-rata untuk masa pemprosesan dan bilangan stesen yang diperoleh ialah 73.00 dan 84.33. Prestasi model susun atur yang dicadangkan dianalisis menggunakan simulasi di Arena selama 20 jam dengan kedatangan setiap 7 jam. Dalam hasil yang diperoleh ini, susun atur simulasi (3) adalah susun atur yang optimum yang meningkatkan jumlah produksi yang merupakan jumlah bahagian yang dihasilkan dari model susun atur ini adalah 273 bahagian, jumlah bagian dalam adalah 819 bahagian, dan kerja dalam proses (WIP) adalah 510.74 bahagian. Berdasarkan kaedah Taguchi dan hasil simulasi Arena, susun atur 3 yang dicadangkan adalah susun atur keadaan yang optimum. Sebagai penambahbaikan kajian ini adalah mencadangkan susun atur ini dapat diterapkan pada yang industri lain, untuk mengusulkan idea baru dengan menggunakan atribut yang sama, menerapkan aplikasi analisis lain, dan kualiti produk perlu dipertimbangkan kerana ketidakpastian dari segi bahan.

ABSTRACT

Remanufacturing is one of the initiatives to sustain the waste or used products or components. This study focuses on the assembly line in remanufacturing systems in the automotive industry that aims to establish strategies to improve efficiency and optimize the control process using the Taguchi method. This study was conducted to identify the current problem, such as the unsystematic assembly line process, unpredictable processing time, and uncertainties quality of the product. By using the Arena simulation, three proposed layout model was designed that generated the Taguchi parameter. Taguchi method was performed the analysis referred the condition of smaller is better by using the parameter of proposed layout model that contributes optimal condition output in Level 3 with the value of S/N ratio is -37.02 dB, validation of 5.63%, and mean for processing time and the number of station obtained of 73.00 and 84.33. The performance of the proposed layout model was analyzed using the simulation in Arena for running 20 hours with the arrival every 7 hours. In this result obtained, the simulation layout (3) is the optimal layout that increases the number of production which is the number of parts out generated from this layout model is 273 parts, the number of the part in is 819 parts, and the work in progress (WIP) is 510.74 parts. Based on the Taguchi method and Arena simulation result, the proposed layout 3 is the optimal condition layout. As an improvement of this study is to propose this layout can be applied to another industry, to propose the new idea by using the same attributes, applying to another analysis application, and the quality of product need to be considered due to uncertainties in term of material

DEDICATION

This study is wholeheartedly dedicated to my beloved parents, who have been my source of inspiration and gave me strength when I thought of giving up, who continually provide their moral, spiritual, emotional and financial support.

To my lovely supervisor, Dr Nur Aidawaty Binti Rafan, Senior Lecturer of Universiti Teknikal Malaysia Melaka, for giving me the opportunity to do research and providing invaluable guidance throughout this research. Her sincerity and motivation have deeply inspired me.

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LIST OF ABBREVIATIONS

End of Life	-	EOL
Gross Domestic Product	-	GDP
National Automotive Policy	-	NAP
Ministry of International Trade and Industry MALAYSIA	-	MITI
Original Equipment Manufacturers	-	OEM
End-of-Life Vehicles	-	ELV
Independent Remanufacturers	-	IR
Analytic Hierarchy Process	-	AHP
Fuzzy Interpretive Structural Modeling	-	FISM
Taguchi method	-	TM
Orthogonal Array	-	OA
Signal Noise	-	S/N
Design of Experiments	-	DOE
Work In Progress	-	WIP

LIST OF SYMBOLS

Percentage	-	%
Degree	-	°
Decibels	-	dB
Minutes	-	mins

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The manufacturing industry is one of the largest in the world. These industries are important for the welfare system in the human population and another reason is for technological and economics of the country. From the data in the United States, the manufacturing industries create wealth with the manufacturing account for about 15% Gross Domestic Product (GDP) and also affect the country has natural resources such as s agricultural lands, mineral deposits, and oil reserves (Mikell P. Groover, 2010).

From the manufacturing industry is growing rapidly and use a lot amount of natural resources. Therefore, these continue with the issue of the waste management that required to be controlled in higher-level and more efficient move due to environmental regulations. Initiatives were applying is remanufacturing that the waste or end of life product needs to sustain in the development industries and reduce the number of use the natural resources. The largest number of waste or end of life product is continuity to the critical scenario and become one of the environmental impacts and affect the world ecosystem. The result from the waste management of remanufacturing lithium-ion battery from electric vehicles which is the reduction of energy consumption and greenhouse gas emissions is 8.55% and 6.62% respectively (Siqin Xiong, 2019).

The remanufacturing is the best initiatives but to fulfil the needs that meet the customer requirements is the challenge for the supplier to think before proposing their product to the customers. Remanufacturing product may be attributed to their properties, the good product will go through a certain process to compete their properties almost similar to the original or natural product has been made. In Malaysia, the Implementation remanufacturing industry is still growing and needs more exposure to take a lead in global environmental sustainability in

these industries. From a view of point customers, the remanufactured product can be considered to be the same as the new product (N.M. Yusop, 2015)

The process that involved in the remanufacturing system is different in every company because the flow of the process is not standardized and the research about the process needed in the remanufacturing system is still continuing to make the system more systematic and efficient. The planning of the system is important to the company because it can maximize their profit and serves the product at the higher quality same as a new product. Most of the challenge in the remanufacturing system is the processing times due to the uncertain quality of the product that will remanufacture and these issues will affect the demand that required by customers will be delayed (Peter Lundmark, 2014).

In order to solve this situation, this project is set to introduce the study on investigation of the optimisation control process in the remanufacturing system. The process involved in the system is still unsystematic and this study aims to counter the problem which is to remove the uncertain process. The method used for this study is using the Taguchi Method that will optimize the process in the remanufacturing system. By using the Taguchi Method, the flow of process will be analysed one by one and make the comparison with another layout.

1.2 PROBLEM STATEMENT

Remanufacturing development need for the automotive industry in Malaysia because to enjoy various initiatives of green technology and supporting the campaign of safe our environment. To ensure that the product is appropriate for remanufacturing, the uncertain quality condition of the used or waste product may be considered so each producer has the technology of the product. In order to improve the remanufacturability of automobile products, concern for remanufacturing must be integrated into certain areas of vehicle design, including joint procurement, choice of components, the layout of systems, handling and transportation, etc. (Yüksel, 2010).

Otherwise, remanufacturing is the strategy for material recovery so that it will involve several processes in the operation. The highly variable of processing times in remanufacturing operation is the problem that occurs because the condition of the waste product is unpredictable. High inventory levels, high process throughput times are the major problem in the remanufacturing process which can be tackled by the traditional concept of operations management (Seitz, 2007).

In remanufacturing, the environment of the remanufacturing sector in Malaysia is still fresh and the process involves also still on research and in future will be standardized by the government to sustain the remanufacturing sector. In 2006, one of the initiatives for sustain the remanufacturing industry in Malaysia, the National Automotive Policy (NAP) is has been established by the government which are Ministry of International Trade and Industry MALAYSIA (MITI) (Ministry of International Trade and Industry MALAYSIA, 2009). The process involves in the remanufacturing is different in every company, the basic concept of remanufacturing operation remains the same which is Inspection and Grading, Disassembly, Reprocessing, and Reassembly. By using the Taguchi method, it will optimize the operation involves in remanufacturing.

3. OBJECTIVES

The purpose of this study is to optimize the remanufacturing operation by using the Taguchi method. Detailed objectives of this study are as follows:

1) To identify the problem of the current remanufacturing system
2) To propose the model by using the Taguchi method
3) To analyse the performance of the remanufacturing system after applying the Taguchi method.

1.4 SCOPE

This project focused on the study of topics relating to the remanufacturing system literature review the including journals, case studies and articles (remanufacturing companies, manufacturing, Taguchi Method, etc.). It basically affects the whole remanufacturing systems process in the automotive industry. This project would concentrate on the study of remanufacturing in automotive and Taguchi Method literature. This project aims to establish strategies to improve efficiency and optimize in the control process the remanufacturing system and to improve performance by using the Taguchi Method, as well as to improve the quality of service to customers and work procedures. After investigating by reviewing and make a comparison, it is possible to analyze issues that frequently exist in the remanufacturing system across different processes.

1.5 SIGNIFICANT OF STUDY

The aim of this project is to optimize and improve the effectiveness of the use of all the process in the remanufacturing system and to improve the efficiency of the services sector as an alternative method of expanding the country's economy in competition with other countries that are increasing in the remanufacturing system and services sector. When performing a reviewing, it is possible to investigate issues that also reduce processing times in the remanufacturing system in automotive industries, meaning that this investigation is not limited to an evaluation in the selection of control process to be analysed during the data acquisition phase. There are some benefits that can be obtained when this study is completed, the remanufacturing can make a comparison about their existing flow of the process that will be optimized and reduce the number of processing times and make comparison with the other methods.

1.6 ORGANIZATION OF REPORT

The overall organization of the study takes the form of three chapters, including this introductory chapter. Chapter 1 discusses the background of the study and the problems that are identified through the research on journals, articles and current news. It is then accompanied by targets that are set to be accomplished across a lens that narrows down the research field. The significant of the study to the machining industry is also disclosed.

Chapter 2 begins by reviewing the remanufacturing development in the world and also the confusion of the meaning remanufacturing. It was then continued reviewing the remanufacturing process in the automotive industry that included all the basic principles and the perspective about remanufacturing development. After that, the review focusing on the assembly line that the important factor of this study and review the basic process in the assembly line with the challenges and barrier. Lastly, the methods for experimenting with the procedure of the assembly line layout by using the Taguchi method application.

Chapter 3 describes the methods and procedures to achieve the objectives mentioned in this study. The flow starts from the assembly line layout that will be designed through the Matrix Laboratory (MATLAB) and generated the three layout design with the different arrangement of the assembly line sequence This is followed by using the Taguchi method, the three assembly line layout of the remanufacturing system in the automotive industry will be validated and produce the final result of optimization.

CHAPTER 2

LITERATURE REVIEW

2.1   REMANUFACTURING SYSTEM

In this chapter, the control process in the remanufacturing system is reviewed based on the previous and present control process that still applicable in the remanufacturing industry. The information gain of this study may be in form of journals, case studies, books, articles, and articles (remanufacturing companies, manufacturing production, Taguchi Method, etc.). Furthermore, this literature summarised the investigating including the previous and present control process in the remanufacturing system and the optimisation medium to improve the quality of the remanufacturing system.

2.1.1   Introduction of Remanufacturing System

Remanufacturing is an important element of the new world technology for the global economy of sustainable development to growth. The management and technology of remanufacturing assemblies are more relevant. The role of engineering in ensuring the effectiveness of the production line and the quality of remanufactured goods (Liu et al., 2019). Remanufacturing has been described as one of the most effective strategies for providing a successful End of Life (EoL) recovery in today's resource-efficient and global ecosystem. A circular economy has been defined as an industrial system that is restorative or regenerative by intentions and design by The Ellen MacArthur Foundation (The Ellen MacArthur, 2013).

Remanufacturing is a method where used products are torn down to become same as a new condition product and the product recovery from End-of-Life (EOL) that restores used goods to their original state with minimal loss of material and energy for sustainable production (Priyono et al., 2015). Figure 2.1 shows the product is from used components and End-of-Life (EOL) that recover to become more useful and meet the requirements same as new condition products without any lack of performance and contribution to sustain the environmental

friendly in manufacturing industries to maintain the ecosystem without the harmful impact that becomes dangerous for the future generation (The Ellen MacArthur, 2013).

Remanufacturing is one of the initiatives to sustain the waste or End-of-Life (EOL) products or components. Furthermore, every product in the world particularly components made from metal which has a lack of performance after a long period and the scenario will contribute to the waste or End-of-Life (EOL) products. Remanufacturing is the process to rebuild the performance of waste product same as new condition products after following several processes that improving the performance. Table 2.1 shows the related term of the remanufacturing
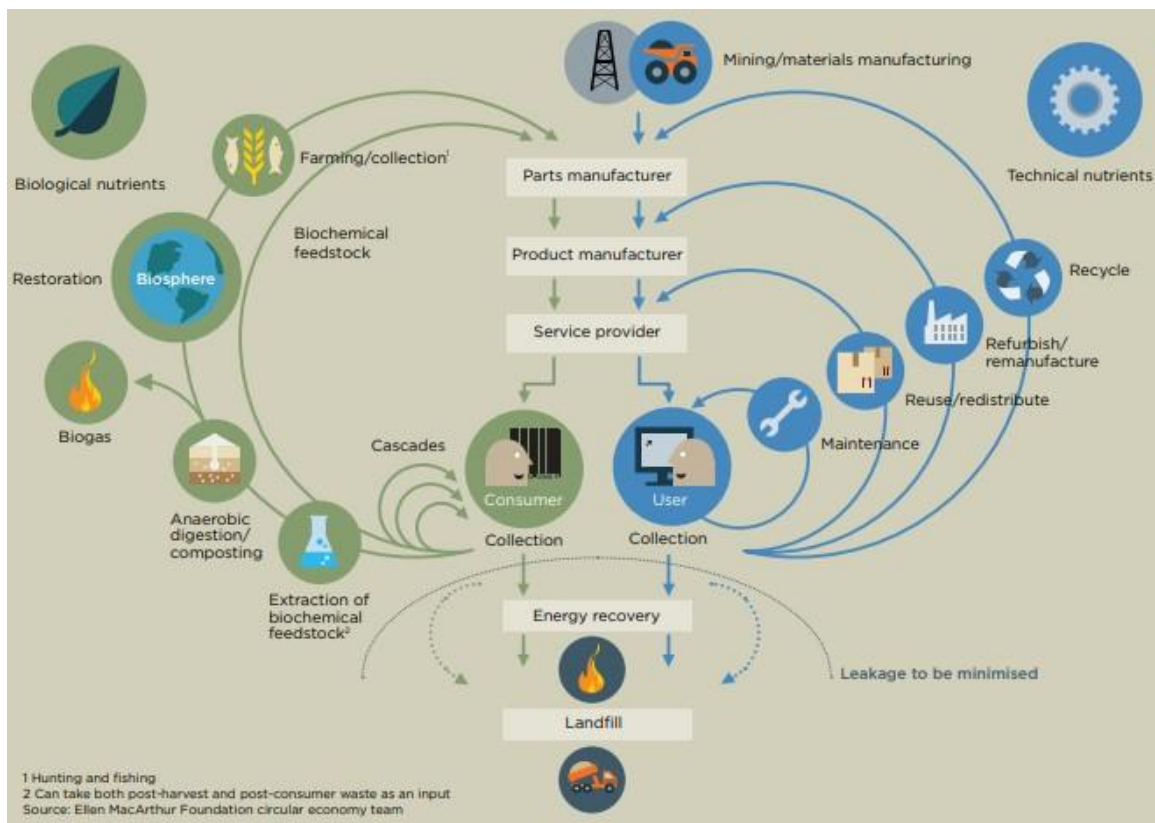

Figure 2.1 Circular Economy by Ellen MacArthur Foundation. Source: (The Ellen MacArthur, 2013)