



**Faculty of Mechanical and Manufacturing Engineering  
Technology**

**IMPROVEMENT OF PRODUCTION LINE FLEXIBILITY  
THROUGH RAPID CHANGEOVER VIA TIME REDUCTION OF  
INTERNAL ACTIVITIES**

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**Bachelor of Manufacturing Engineering  
Technology (Product Design)**

**2019**

**IMPROVEMENT OF PRODUCTION LINE FLEXIBILITY THROUGH  
RAPID CHANGEOVER VIA TIME REDUCTION OF INTERNAL  
ACTIVITIES**

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**A thesis submitted  
in fulfillment of the requirements for the Bachelor's Degree in Manufacturing  
Engineering Technology (Product Design) with Honours**

**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2019**

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

Tajuk: IMPROVEMENT OF PRODUCTION LINE FLEXIBILITY THROUGH RAPID CHANGEOVER VIA TIME REDUCTION OF INTERNAL ACTIVITIES

Sesi Pengajian: 2019/2020

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## **DEDICATION**

To my beloved father, mother and siblings.

## ABSTRACT

Nowadays, the manufacturing sectors are in the process to increase their performance to increase productivity because there are so many challenges from competitors in the same sectors, especially in the food industries. The purpose of this study is to understand the Single Minute Exchange of Dies (SMED) factor occurs in the production line according to the first objective of this study. SMED method is a set of techniques that make it possible to perform the setup of equipment and changeover operations for less than ten minutes. It can be applied by changing the internal activities to become external activities. The method is applied by reducing the internal activities that cause the changeover time getting longer. The second objective is to practice the SMED in the production line of manufacturing industries in order to improve the production line flexibility through the rapid changeover. Besides the paper also summarizes all the major issues that affected productivity in the SMED method. There a few methods that are done in order to complete this study. The first method is to identify the problem and objective of the study. After that, the data collection is done by observation and also the data from the company itself. An interview is also done by interviewing the operator to know the exact process that occurs in the production line. The data collection then will be analyzed by using Fishbone Diagram and Why Why Analysis. In this study, the Fishbone Diagram tool is used to find the root cause of the problem while Why Why Analysis is used to find the solution of the root cause. The result only can be done after the data is being analyzed in order to find the solution for problems that occur in the food industries. Thus, there are a few proposed improvements is proposed for this study. The first suggested improvement is to create a Standard Operating Procedure (SOP) for the changeover. The second proposed improvement is to redesign new mixture tanks that were flexible to move and last but not least is to proposed a changeover training schedule. However, there is some limitation for this research as the data collected is not completed because there is no production and sometimes the workers do not record the data. This study is useful for manufacturing managers and a company willing to increase flexibility and at the same time can reduce the changeover time within their available resources without compromise the machine efficient and without using high cost. This study also describes what is believed to be the first thing to study that explicitly examines the problem faced in achieving higher flexibility and at the same time can increase production. In conclusion, this study had provided a better understanding of the implementation of the SMED method by reducing the internal activities that cause the changeover time getting higher. In addition, the last objective to propose the SMED method for enhancing productivity is achieved.

## ABSTRAK

Kini, sektor pembuatan sedang dalam proses untuk meningkatkan prestasi mereka melalui peningkatan produktiviti oleh kerana terdapat pelbagai cabaran dari pesaing dalam sektor yang sama, terutamanya dalam industri makanan. Tujuan kajian ini adalah untuk mengkaji faktor Single Minutes Exchange of Dies (SMED) yang berlaku di barisan pengeluaran seiring dengan objektif pertama kajian ini. Kaedah SMED adalah suatu set teknik untuk melakukan persediaan peralatan dan operasi pertukaran yang tidak melebihi sekurang-kurangnya sepuluh 10 minit. Ia boleh diaplikasikan dengan cara menukarkan aktiviti dalaman yang menyebabkan masa pertukaran berubah menjadi lebih lama kepada aktiviti luaran. Objektif kedua adalah untuk mempraktikkan SMED dalam barisan pengeluaran industri pembuatan sekali gus dapat meningkatkan fleksibiliti melalui pertukaran yang pantas. Selain itu, kajian ini juga turut meringkaskan semua isu utama yang mempengaruhi produktiviti dalam kaedah SMED. Terdapat beberapa kaedah yang dilakukan untuk menyelesaikan kajian ini. Kaedah yang pertama adalah dengan mengenal pasti masalah dan objektif kajian. Selepas itu, pengumpulan data dilakukan melalui pemerhatian dan juga pengumpulan data yang diperolehi dari syarikat itu sendiri. Suatu temu bual juga telah dilakukan dengan menemubual operator untuk mengetahui lebih lanjut proses yang berlaku di setiap barisan pengeluaran. Data yang telah dikumpul kemudiannya akan dianalisis dengan menggunakan Fishbone Diagram dan Why Why Analysis. Dalam kajian ini, Fishbone Diagram digunakan untuk mencari punca utama masalah sementara Why Why Analysis digunakan untuk mencari penyelesaian terhadap masalah yang dihadapi. Keputusannya hanya boleh didapati selepas data tersebut dianalisis untuk mencari penyelesaian terhadap masalah yang berlaku dalam industri makanan. Oleh yang demikian, terdapat beberapa cadangan penambahbaikan yang dicadangkan untuk kajian ini. Penambahbaikan pertama yang dicadangkan adalah dengan mewujudkan Standard Operating Procedure (SOP) for Changeover untuk pertukaran. Penambahbaikan kedua yang dicadangkan ialah dengan mereka suatu reka bentuk baharu terhadap tangki campuran menjadi lebih fleksibel untuk bergerak dan yang terakhir ialah mencadangkan jadual latihan perubahan. Walau bagaimanapun, terdapat beberapa kesukaran untuk kajian ini kerana data yang dikumpul tidak lengkap kerana tiada pengeluaran produk ketika itu mahupun pekerja tidak bertanggungjawab merekodkan data. Kajian ini berguna untuk pengurus bahagian pembuatan dan syarikat yang mahu meningkatkan fleksibiliti dan pada masa yang sama dapat mengurangkan masa perubahan dengan sumber yang tersedia ada tanpa menjejaskan mesin mahupun menggunakan kos yang tinggi. Kajian ini turut menerangkan apa yang dipercayai boleh dikaji dengan lebih teliti masalah yang dihadapi untuk mencapai tahap fleksibiliti yang lebih tinggi justeru dapat meningkatkan pengeluaran. Sebagai kesimpulan, kajian ini telah memberikan pemahaman yang lebih baik mengenai pelaksanaan kaedah SMED dengan mengurangkan aktiviti dalaman yang menyebabkan masa perubahan menjadi lebih tinggi. Di samping itu, objektif terakhir untuk mencadangkan kaedah SMED untuk meningkatkan produktiviti telah tercapai dengan jayanya.



## ACKNOWLEDGMENTS

First and foremost, I would like to take this opportunity to express my sincere acknowledgment to my supervisor Ts. Dr. Amir Hamzah bin Abdul Razib from the Faculty of Mechanical and Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka (UTeM) for his essential supervision, support and encouragement towards the completion of this thesis.

I would also like to express my greatest gratitude to Encik Razali bin Mohd Yunus from Zaliza Food Industries Sdn. Bhd, as an industrial supervisor for his advice and cooperation throughout the completion of this research. Other thanks also go to Mrs. Aisyah also from Zaliza Food Industries Sdn. Bhd. for her time and information throughout this study. Special thanks to UTeM short term grant funding for financial support throughout this project.

Special thanks to all my peers, my beloved mother, father and siblings for their moral support in completing this degree. Lastly, thank you to everyone who had been to the crucial parts of the realization of this project.

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## **LIST OF ABBREVIATIONS**

<b>SMED</b>	Single Minutes Exchange Dies
<b>QC</b>	Quality Control



# CHAPTER 1

## INTRODUCTION

### 1.1 Research Background

Nowadays, when the demands for goods and services changing repeatedly and some companies are always facing difficult challenge among other companies, thus a new manufacturing system is needed to make the production can proceed rapidly and the most important thing is it must profitable in order to respond to all the market changes. Afterward, the goal of every company in the manufacturing sector is to gain high productivity without the need to used high manufacturing cost and minimal setup time. Due to these two main factors, the flexibility in the production line must be balanced or flexible as it will help to increase the productivity for the manufacturing companies.

According to Lafou et al., (2016) defined that flexibility is the sensitivity of a manufacturing system to changes as the more flexible a system, the less sensitive to change depending on its surroundings. Thus, it is important to note that, each of the manufacturing activities needs to be flexible so that it will help the production line become faster and can be run smoothly. Frequently, either big or small manufacturing companies will choose to apply manufacturing strategies in their organization. This is because the awareness of strategies that can help the companies to be organized well is high due to the development of modern technology.

Other than that, these manufacturing strategies also will help them to handle their production system and improve their previous way to become more systematically. Manufacturing Flexibility (MF) can be classified as one of the strategies that will help to

improve the flexibility in the production line. MF can be referring to as the capacity of a manufacturing system that can adapt to the environmental changing corresponding to the changing of product and process requirements. Based on previous studies, it was reported that the majority of the studies explained the reactive use of manufacturing flexibility in which emphasis was placed for the flexibility's use to deal with surrounding uncertainty (Mishra, 2018).

Furthermore, the MF can be implemented by applying the lean manufacturing tool which is Single Minutes Exchange Die (SMED). This tool could help to convert the internal activities to external activities as it enables to reduce the setup time of the production. In order to achieve flexibility, the rapid changeover must be performed and it can be generated from the reduction of internal activities through SMED.

It is crucial to know that the reduction of internal activities is really useful to help to reduce the setup time and indirectly lowering the manufacturing cost. Thus, this study is focusing on implement a suitable lean manufacturing tool as well as to improve the flexibility in the production line through rapid changeover by reducing the internal activities.

## **1.2 Problem Statement**

Flexibility is the measure of performance of a firm in handling the production line. Being flexible means that the system is carried out a good performance in order to reduce the time. The main problem that always happens in manufacturing companies is unnecessary activities or some internal activities which can drag the time to produce the product becomes longer. Normally, small manufacturing companies do have a difficult task to manage flexibility while doing the changeover in the production line.

Other than that, the elements that are related to customers' demands are the quality and the efficiency of the production itself. The reduction of internal activities in the company is one of the ways to produce better quality and high efficiency of the product. Sometimes, poor services also tend to get lower customer satisfaction. It is due to the slow production which it may cause from the slow changeover in the production line or unwanted activities. As the higher the flexibility in the manufacturing companies, the higher the productivity. However, to achieve higher flexibility, food industries need to overcome many challenges. To face the challenges, the best way to overcome the challenges is by practicing and applying lean manufacturing tools.

### **1.3 Research Questions**

Based on the problem statement, there are three research questions that are recognized.

RQ1: What are the activities for internal and external?

RQ2: How internal activities can help to reduce the changeover time?

RQ3: How internal activities can increase the flexible line?

### **1.4 Research Objectives**

The general objective of this project is purposed to improve the production line flexibility through rapid changeover via time reduction of internal activities. The specific objectives of this project are:

- i. To study the SMED factor occur in the production line.
- ii. To practice the SMED method in the production line in manufacturing industries.
- iii. To propose the SMED method for enhancing productivity.

## **1.5 Research Scope**

Particularly, this thesis study will focus on the changeover of the internal activities in Zaliza Food Industries Sdn. Bhd. The crucial task of this study is to produce a significant improvement which is mostly related to flexibility and time reduction. The main focus on the reduction of internal SMED activities in order to achieve rapid changeover. In addition, the k-chart that was shown in Appendix A will explain more about the research scope.

## **1.6 Expected Result**

The expected result for this study is to present the best recommendation solution from a lean manufacturing tool that improves the flexibility of line production in Zaliza Food Industries Sdn. Bhd. Moreover, this study will also help to determine the internal activities that can be reduced or eliminated from the production line in the company. Next, this study will help to enhance the knowledge about the significance of Manufacturing Flexibility (MF) in the food industry.

Besides that, the expected result that will be gain from this study is able to see the good changes after doing some improvement on the changeover problem in the production line. The improvement is achieved by the implementation of MF in the manufacturing company. The MF will be applied according to the stated classification of flexibility in the MF.

In addition, the expected result for this study is to apply the Single Minutes Exchange of Die (SMED) to the company. Last but not least, the expected result is that this study can help in suggesting a proper solution which is able to increase the flexibility in the production line of the company.

## **1.7 Thesis Frame**

In this chapter one, the main focus of this chapter is the introduction of the overall study. The research background of this study is described in this chapter. Besides that, the problem statement of this study is also mentioned in this chapter. The research questions and objectives of the study are stated in this chapter too. And yet, the research scope and expected results of this study are not forgotten to be explained in this chapter. Other than that, the thesis frame and the summary of this study are also stated in this chapter.

Subsequently, for chapter two, the literature review of this study is elaborated. In this chapter, all the knowledge and previous research related to Manufacturing Flexibility (MF) are explained in detail. The method that used to write this literature review is by reading the past journals. In addition, all the term which is related to the title of this study is described under its own subtopics in this chapter. The proper description regarding the title will be given for each subtopic.

Then, the methodology of this study that had been implemented is explained well in chapter three. Chapter three will also give a further explanation of the tools that had been used in this study. Furthermore, the Detailed Process of Research Methodology of this study will also be given in chapter three.

Next, chapter four will be focused on the tool that already introduced in the previous chapter on how it can be applied. In this chapter, the tool is also explained how it able to help achieve the research objectives.

Eventually, in chapter five, all the detail of this thesis study will be clarified based on the research that had been done. In addition, the suggestion to improve the study will also be presented in this chapter along with an explanation. Lastly, this thesis study will be

no complete if there is no conclusion in chapter five. Thus, a conclusion will be presented in order to conclude the overall detail of this thesis study.

## **1.8 Summary**

In conclusion, it is important if the companies in the manufacturing sector are able to apply the lean manufacturing tool to prioritize the productivity and the efficiency in the production line. In regard to this matter, the thing that is crucial to be given a major emphasis is to make sure the flexibility of production can be improved in order to achieve high sustainable. In industries, the flexibility of the manufacturing may be acquired if the companies can fully apply the tool which can help them to improve flexibility. It comes as no surprise that when the company is managed to handle the flexibility profitably, no wonder that their manufacturing cost can be reduced along with the time to manufacturer become more quickly.

Therefore, to sum it up, there is a variety classification of flexibility under the manufacturing flexibility. For instance, customer flexibility will need the manufacturers to handle with customers while mix flexibility will need them to handle the machine. The flexibility is also related to the ability of the machine to produce rapid changeover by reducing the internal activities.

## CHAPTER 2

### INTRODUCTION

#### 2.1 Preliminaries

Ruchi Mishra (2018) stated that the meaning of flexibility is the ability of firms to quick changing from one product to another product without loss of efficiency and it was concluded as the main element of the manufacturing strategy. Besides that, Korchi (2018) also wrote that flexibility is the capacity to change the surroundings or respond to unpredictability with minimum cost, time and effort with maximum performances. Similarly, as identified by Scherrer-Rathje (2014) claims that the capability to change or react with little penalty in time, effort, cost or performances is known as flexibility. So, to sum it up it was agreed that time, effort, the cost is the essential element needed to be more focused in order to maintain or improve the flexibility in the production line.

In the assembly system, the major dimensions of manufacturing flexibility are based on fulfilling volume, mix and new product flexibility (Asadi, et al., 2015). Therefore, flexibility is required in the assembly system because of the lot size and the lifecycle of the product are decreasing with multiple variants (Jackson, et al., 2017). Based on the findings, it is very important to have rapid changeover while changing the product because it will give a huge impact to sustain the flexibility in industries. Besides, the flexibility not only focuses on the product itself as it may have different variations. For example, the product is a carbonated drink and it has various types of flavors such as strawberry, orange, ice cream soda, grape and mix fruit which are classified as the variant of the product.

In order to sustain the flexibility and fulfill the customer demand, the flexibility in the production line need to be increased through efficient changeover. It is important to note that the changeover can be improved through the Single Minute Exchange Die (SMED). Boran (2018) claims that the SMED methodology is one of the tools of lean manufacturing which can provide to minimize waste and increase flexibility in the process of manufacturing. Hence, SMED plays an important role to improve flexibility through rapid changeover.

## **2.2 Manufacturing Flexibility**

As a matter of fact, manufacturing flexibility assign organizations which have the capability to change the levels of production quickly, to grow new products rapidly and more often and also to improve the organization's capability to face the challenge from competitor while at the same time gains the acceptable levels of cost and quality (Khalaf, 2018). Fredriksson, *et.al.*, (2014) synthesis of the reflection of manufacturing flexibility is the capability of a firm to respond to their customers' needs changes and unanticipated changes come from the pressure of the competitive. Complementary to this statement, with the manufacturing flexibility, the level of production line of the product will run faster and can also reduce wastage of cost and time while further enhancing the effectiveness of the product.

Small wonder that majority studies of the manufacturing flexibility had given more attention to definition, measurement and the relationship between manufacturing flexibility and its drivers and enablers. Nevertheless, there are several studies available on numerous adoption concerns of manufacturing flexibility such as flexibility awareness, the rate of adoptions, barriers to its adoption and also applying practices to gain high manufacturing flexibility (Mishra, 2016).