



## **DEVELOPMENT OF A SIMULATION AIDED SCHEDULING FOR PACKAGING PROCESS AT TEACHING FACTORY**

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

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## 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 Bachelor of Manufacturing Engineering (Hons.). The member of the supervisory committee are as follow:



## ABSTRAK

Projek Tahun Akhir ini berkaitan dengan penjadualan dengan menggunakan Simulasi untuk proses pembungkusan di Teaching Factory. Matlamat kajian ini adalah untuk membangunkan teknik penjadualan bantuan simulasi untuk operasi pembungkusan Teaching Factory dan untuk mengenal pasti keberkesanan dengan betul dalam proses pembungkusan. Oleh itu, pengetahuan mengenai perancangan pengeluaran termasuk teknik penjadualan adalah penting untuk melaksanakan kajian ini. Projek ini menerangkan kepentingan peraturan penghantaran seperti masa pemprosesan terpendek (SPT), masa pemprosesan paling lama (LPT) dan tarikh tamat awal (EDD) dalam meningkatkan prestasi TF. Keberkesanan setiap peraturan dibandingkan dan diringkaskan untuk menentukannya berdasarkan ukuran prestasi dengan menggunakan rumusan matematik. Simulasi akan digunakan untuk membangunkan model dan melihat bagaimana sistem berubah dan sejauh mana ia akan berfungsi apabila berlakunya perubahan dalam pembolehubah. Perisian Tecnomatix Plant Simulation digunakan untuk mensimulasikan pemodelan sistem dalam TF dan untuk mengenal pasti masa setiap produk dengan menggunakan carta gantt. Keputusan menunjukkan bahawa peraturan masa pemprosesan terpendek (SPT) berprestasi baik dalam meminimumkan purata masa harian, meminimumkan bilangan kelewatan kerja, meminimumkan bilangan kelewatan dan memaksimumkan bilangan purata hari lebih awal

## **ABSTRACT**

This Final Year Project is dealing with the Development of a Simulation Aided Scheduling for Packaging Process at Teaching Factory (TF). This study aims to develop a simulation aid scheduling tool for TF packaging operation and to identify the effectiveness of a proper planned of sequence operation by using dispatching rule. Therefore, knowledge regarding production planning, including the scheduling technique, is essential to carry out in this study. This project describes the importance of dispatching rules such as shortest processing time (SPT), longest processing time (LPT) and earliest due date (EDD) in improving the scheduling in TF. The effectiveness of each rule is compared and summarized to determine their performance measure by using a mathematical formulation. Discrete Event Simulation will be used to develop a simulation model that can be used to figure out on how the system change and how well it will work as well as the changes in the process variables. Tecnomatix Plant Simulation software used to simulate the system modelling in TF and to identify the makespan of each product by using gantt chart. The result shown that shortest processing time (SPT) rule performs well in minimizing the average flow time, minimizing the number of job delays, minimizing number of lateness and maximizing the number of average days early.

## DEDICATION

Only

my beloved father, Abd Razak Bin Ahmad

my appreciated mother, Norain Binti Md Nor

my adored sister and brother, Fadila and Fikri

for giving me moral support, encouragement and also understanding



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## LIST OF ABBREVIATIONS

TF	-	Teaching Factory
DES	-	Discrete Event Simulation
GMO	-	Global Maintenance Order
VMS	-	Value Based Maintenance
RMO	-	Reliability Maintenance Order
PM	-	Preventive Maintenance
MOGA	-	Multi Objective Genetic Algorithm
GUI	-	Graphical User Interface
SPT	-	Shortest processing time
LPT	-	Longest processing time
EDD	-	Earliest due date
FIFO	-	First in first out
FCFS	-	First come first serve





# CHAPTER 1

## INTRODUCTION

### 1.1 Research Background

Nowadays in today's market competition, ongoing research in production planning and control is critical for achieving a competitive advantage in the marketplace. Due to fluctuating market demands, manufacturing is challenging since companies must produce with the fewest resources possible to provide high-quality products and promptly adapt to market demands. The users expected us to supply them with greater quality, flexible orders, lesser pricing and quick responsiveness (Erengüç *et al.*, 1999). Production planning and scheduling can also optimize and control the entire supply chain. Production planning and control are concerned with all of the actions that takeplace during the packaging process at TF UTeM. It includes estimating production, handling materials, developing production schedules and scheduling other jobs. This is one of the essential parts of deciding how to manage the resources such as equipment, utilities and manpower among competing activities over a given period to accomplish one or more goal (Hien *et al.*, 2022). As a result, it is critical to keep up with the latest technologies, approaches, and tactics in order to ensure a regular flow of production process. The important aspect in a production planning and control system is to establish a production flow that is correctly coordinated so that there is no need to rush orders to meet deadlines owing to a disorganized plan.

Effective production planning and scheduling is very good for all industries, because it leads to production efficiency, lower labor costs, and less energy and waste (Georgiadis *et al.*, 2021).

Simulation-based scheduling is the use of a digital model to simulate the flow of a real-world process. Simulation-based scheduling means that schedules for several hours to a day are made by running simulations. It is heavily reliant on the capacity to generate simulation models that accurately describe the packaging process. Due to the growing variety of product, smaller orders, shorter delivery time and a limitation of workers might cause the task of planner in the packaging process become difficult. People always use scheduling method to make sure they use up all of their limited resources over time. The purpose of scheduling is to minimize the packaging time and reduce cost by telling the production capacity when to finish the output, how many people to make it and on which equipment to use. In the decision-making process, there are one or more outcomes are maximized through the use of scheduling.

Simulation may be defined as imitation of a dynamic process within a model to arrive at results that may be transferred to real system (Bangsow, 2016). Simulation is a low-cost, safe, and quick tool for analysis. By using simulation modelling, real-world issues can be safely and effectively addressed. Besides, it can be proved that simulation can help to see how the packaging process flows from the beginning to the end. These studies will describe how the simulation will be used as a planning and scheduling tool. The simulation software approaches in these studies is Discrete Event Simulation (DES) (K Glanz, 2015). DES software also can be applied to improve the productivity (Raed El-Khalil, 2015). DES software can also be used to figure out on how the system change and how well it will work as well as changes in the process variables such as number of workers that will affect the packaging process. Other than that, it attempted to increase production and predict the amount of time needed to meet the needs of clients.

## 1.2 Problem Statement

The packaging process at TF are getting more complex and facing more challenges due to the increase in customer requirement. The packaging process is an important part in the production flow process because it involves the quality of product. Product packaging serves to protect the product inside the packaging. The packaging process is important to be completed accordance to the customer specification.

The problem to be addressed through this study is when the packaging process at TF has higher customer requirement that cause a wide variety of incoming product comes in every week. The goal of this study is to find out how often new products come in each week and figure out which ones need to be finished first. The production planning at TF is ineffective since it cannot track and determined how long it will take to complete every incoming product and how to priorities which products must be completed in a timeframe within a week that given by supplier. It is hard to figure out the way to standardize the number of workers needed each day in two shifts as to finish orders in one week without being delayed.

In addition, it is impossible to determine the average time needed to complete the packaging process for any product because of a few factors. As demand for the product increases, there are not enough workers to fulfil all of the factors that influenced the product to be completed on time. The main cause of delay product in TF because of the ineffective scheduling which was arranged manually based on their experience. The worker that must be assigned for the work is a part time worker causing the number of workers each day can be different where it can be a major problem issues that product cannot be completed on a timeframe. A lower work rate can lead to the poor performance of workers which in turn might affect the quality of packaging process and its delivery time.

The inconsistent number of workers each day is because the part time worker did not show up on the day and time that they are supposed to come due to some reason causing the less efficiency in the packaging process and it can cause the number productivity in the packaging process to become low. A company total factor of productivity may also be affected by the utilization of part-time work (Devicienti *et al.*, 2018). The variety of incoming product and quantity for each product is different in each week causing planner cannot targeting the amount of worker needed each day in order to

complete the order.

Besides, the packaging procedure for each of the product is definitely not same and it will be based on the standard operating procedure (SOP) from customer that need to be followed. This condition necessitates a rise in the number of workers to handle the complex product with detailed packaging. Packaging had to be completed in order to meet strict quality control standards. The complexity of product can be a major problem where planner needs to come out with a solution to predict the assigned worker at given time.

### 1.3 Objective

- a) To develop a simulation aid scheduling tool for TF packaging operation.
- b) To identify the effectiveness of a proper planned of sequence operation by using dispatching rule.

### 1.4 Scope

The Scope of this research are as follows:

- a) The simulation software will be used to visualize make span or lead time to complete the packaging process for each product
- b) The simulation software used is Discrete Event Simulation technology to model the physical process of packaging process at TF.
- c) The scheduling based on dispatching rule of SPT, LPT and EDD.
- d) The products packaging was categorized into six family product which is Elastic, Snap fastener, Ball pin, Safety pin, Circular needle and Hook

## 1.5 Important of Study

The finding of this study will redound to the potential benefits that can be gained by TF after completion of this study. The packaging process at TF concerns itself with determining the amount of product to be completed in a given time period. Developing the scheduling technique during this study has become important to enhance the packaging process. The effective project scheduling plays a crucial role in ensuring the product successfully completed their packaging process within time frame. This scheduling technique can help to ensure that the production and operations are carried out as planned and resolve any issues if it is not followed the plan. In addition, by using this scheduling technique it can help to establish and controls the amount of time needed to complete each of the product and ensure that all of necessary resources and workers are in the right place and in the right time. Based on the simulation that has being developed in packaging process at TF which include the input data such as, numbers of workers each day, quantity of product, deadline for the product to complete can help in order to come out witha Gantt chart that can show each job flow through the system and can increase the productivity. This Gantt chart can help the planner to make any changes to the schedule that the simulation makes by adjusting all of the input. Using this scheduling technique, the issue related to the shortage of part time worker can be resolved by determined the number of workers needed per shift and prepared with the available part timer to complete all of the incoming product within timeframe.

## **Chapter 2**

### **LITERATURE REVIEW**

#### **2.1 Product Packaging**

Packaging can be described as the process of designing and creating a container for a product. The package is the covering used to store, transport, and protect the product from external influences such as sunlight, moisture, and damage (Lee and Lye, 2003). There are three different types of packaging. Primary packaging is the part that comes into direct contact with the product such as perfume bottles. Secondary packaging is made up of one or more primary packages and is used to protect the product. It is normally discarded when the product is used or consumed. Following the previous example, this would be the cardboard box that contains the perfume bottle. Lastly, there is tertiary packaging, which is made up of the first two. Its function is to protect the product throughout the commercial chain. Its job is to distribute, unify, and protect products all along the commercial chain. This would be the cardboard box that contains several bottles (Ampuero and Vila, 2006).

##### **2.1.1 Packaging procedure**

People often wonder how to package something. The right steps and methods can go a long way in the packaging process. Regardless of the products that need to be shipped, it should be expected that the product will arrive at destination in the same condition as it is shipped. In order to maintain the safety of product, there are a few packaging procedures that need to be followed.

(a) Organize

A workspace should be big enough to move the package around and close enough to all the packaging materials that need to use. In an ideal situation, the space should have shelves to hold a wide range of materials, since different types and sizes of products will need different materials.

(a) Measure

Before selecting the box for the product, it is very important to measure the product. Add approximately 2 inches to the width, height, and length of the product to determine the optimal box size. This ensures that it will have sufficient space to wrap each product and fill the box with additional cushioning to protect products during transport.

(b) Select

During this stage, it is crucial to select a right box that suitable with product.

(c) Protect

After selecting the packaging of product, it is important to protect the product. There are many types of protective packaging that can be used such as bubble wrap. In order to choose the protective packaging, it is crucial to consider type of product that suit with the protective packaging.

(d) Seal

Now when the product is properly protected and fits into the right size box, it is crucial to seal up the box in order to secure it. Never use cellophane or duct tape to seal the box because neither of it is strong enough. Instead, find the right tapes or glue to seal the box. Make sure the product is completely sealed before shipped it out.

(e) Label

Labelling is the last step in the packaging process. It is important to place a right labelling on top of the box and double check the recipient address again to prevent from mistake in labelling.

### **2.1.2 Importance of packaging**

First impression is really important and product packaging is often considered the first element that customer wants to see. As a result, many companies must never underestimate the importance of product packaging. The significance of product packaging is varied and may go a long way toward providing a good first impression and enduring brand loyalty. There are four type importance in packaging such as protect the product, display and promotes the product, attract buyers and differentiate the product from competitors.

Packaging is important to keep the product safe. The packaging must keep the product safe when it is being shipped from the factory to the retail shop and keep it from getting damaged even though it is on shelf. It is important for product packaging to be reliable and strong. Several companies use seals and locks to keep people from messing with their products and make sure they stay safe and protected. The product packaging is the better ways to protect inside product as a consumer always want their product to function well.

One more useful thing about packaging is how it promotes and reveals the product inside. For example, product such as food may contain a list of ingredients and information about how healthy they are and for other product they will be an instruction on how to set up and use the product. It is very important to put some information about the product for people to see it because it helps to manage their expectation and can make customer satisfied with the product. The more information provided regarding the product, the better the buyer understands what they are purchasing.

When determining the importance of product packaging, it is essential to consider requirements of the consumer. Eventually, the objective of designing any product is to attract people and convince them to purchase it. It is crucial to select a suitable packing material with a highest quality as well as design and colour that will attract consumer to buy the product. The packaging of a product reflects the product itself and the brand as a whole. Therefore, while developing product packaging, many companies perform significant consumer research to ensure that their packaging is appealing and compelling.