CHAPTER I INTRODUCTION

I.1. Background

In manufacturing operations, production system is certainly an important aspect. Thus, company should do the planning and production control well in order to have satisfactory system. One of the production planning process is scheduling. This process is one of the main process in production planning. The urge of doing the scheduling process is due to scheduling is the details of the planning process.

PT. XYZ is a well-known garment and textile industry. This company is located in Bandung and already expand its business internationally. The customers of this company come from many countries in Europe, Middle East Asia, and South East Asia. Thus, as the company grow larger, it needs good production planning and control to compete with the other textile industries.

PT. XYZ produces a variety of products that can be divided into two general types, they are dyeing fabric and printed fabric. The raw material of these product appeared to be from similar kind of fabric, which is grey polyester. These products pass through several machines with different techniques. In general, there are three processes that should be passed by the products, they are,

Preparation	:	In preparation, the raw material is unrolled from the packing rolls, washed, wrung, and weight reduced.
Processing	:	In processing phase the material is processed based on the final product that want to be produced. The main processes are dyeing and printing.
Finishing	:	In finishing, the product that has been produced is inspected and packaged.

Additionally, the type of the fabric can affect the types of machines and techniques that will be passed. Therefore, the importune character of final product alter the machines and techniques used in the production. These matters induce the differences on generating the schedule for every order. However, based on Figure 1.1., it is shown that in the beginning and the end of process, every types of products and fabrics passing through the same process. As explained before, there are three general phase in which the material need to pass, accordingly, in preparation phase

and finishing phase the material undergoes the same process. Consequently, there are queue on the several machines and longer completion time.

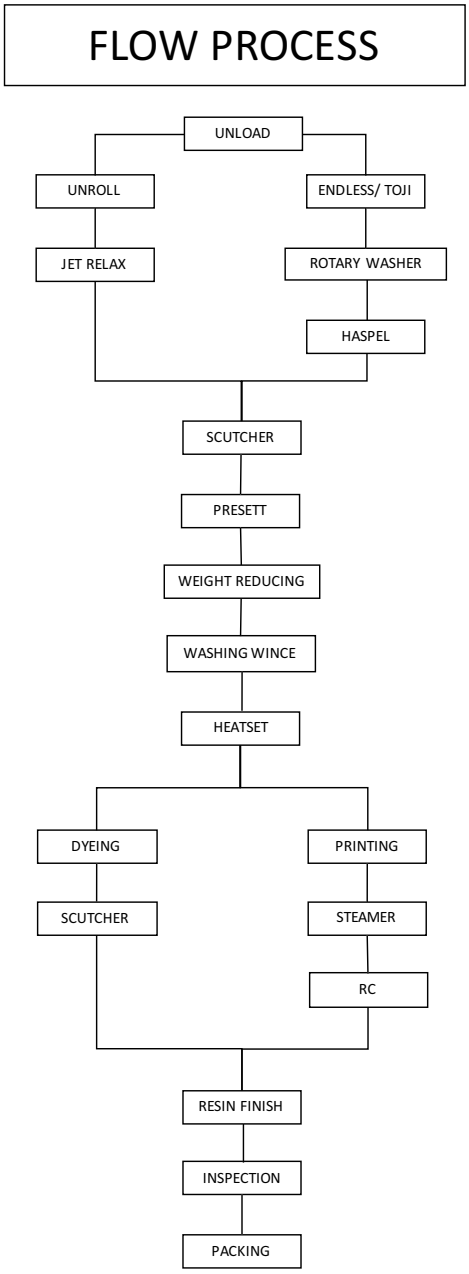

Figure I.1. Flow Process of Dyeing and Printing (source: PT. XYZ, 2017)

Based on the flow process figure above, there are two variety unload process, which are unroll and endless/ toji. The selection of the the process depends on the type of the material used. If the material used is chiffon or crepe then it go through the endless/ toji process, while the other material can go through the unroll process.

Table I.1. Data of Order in PT. XYZ(source: PT. XYZ)

Year	Month	Total Order (m)	Delivered (m)	Not Delivered (m)	Not Delivered (%)
2016	January	2,050,081	1,291,670	758,411	37%
	February	2,080,405	830,710	1,249,696	60%
	March	2,124,754	1,382,666	742,088	35%
	April	2,928,598	2,056,332	872,266	30%
	May	2,985,360	2,622,358	363,002	12%
	June	1,459,756	1,354,144	105,612	7%
	July	943,037	731,051	211,986	22%
	August	1,237,267	793,289	443,978	36%
	September	1,187,802	797,698	390,105	33%
	October	1,419,858	801,623	618,235	44%
	November	1,967,479	1,179,948	787,531	40%
	December	1,891,074	998,179	892,895	47%
2017	January	2,670,605	1,546,188	1,124,417	42%
	February	1,231,438	771,502	459,936	37%
	March	3,481,558	1,655,313	1,826,245	52%
	April	1,592,854	1,015,407	577,447	36%
	May	3,140,787	1,180,367	1,960,420	62%
	June	1,015,292	787,445	227,848	22%
	July	644,149	263,707	380,442	59%
	August	1,214,064	855,256	358,807	30%

Then, referring to Table I-1, listed the total order, the delivered order, and the not delivered order from January 2016 until September 2017. Thus, from the table can be known that most of the products exceed the specified due date. This matter can impact the company reputation.

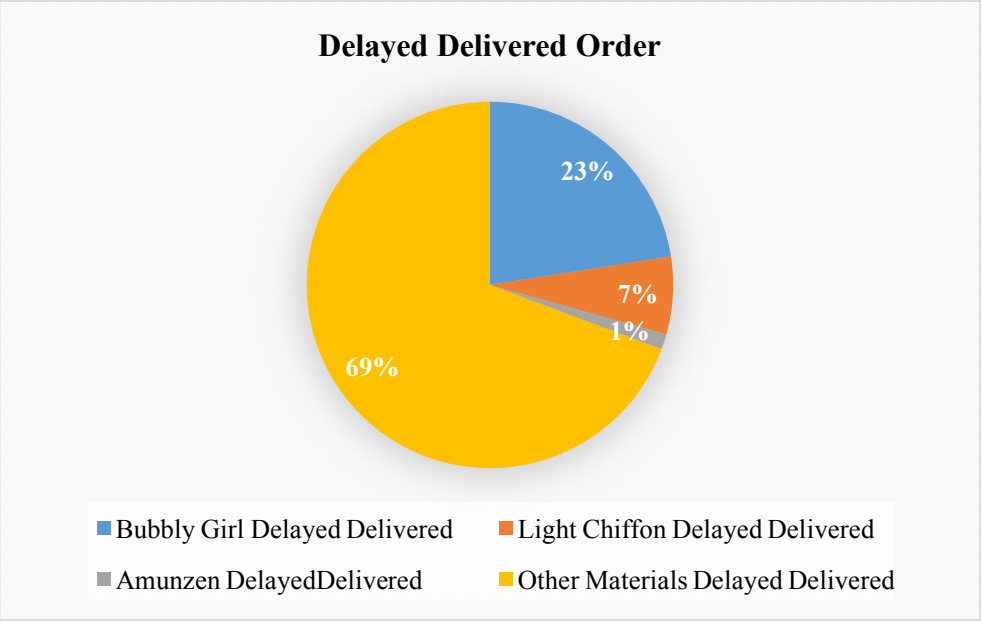

Figure I.2. Top-3 Highest Delayed Delivered Order Based on the Material (source: PT. XYZ)

PT. XYZ produces several type of products which also comes from different material. As shown in Figure 1.2. on January 2016 until August 2017 the Top-3 highest delayed order based on the material are Bubbly Girl, Light Chiffon, and Amunzen, which is has the percentage of delayed delivered order are 23% (3,231,007 m), 7% (983,016 m), and 1% (192,449 m) of all total delayed delivered order (14,351,368 m) in January 2016- August 2017.

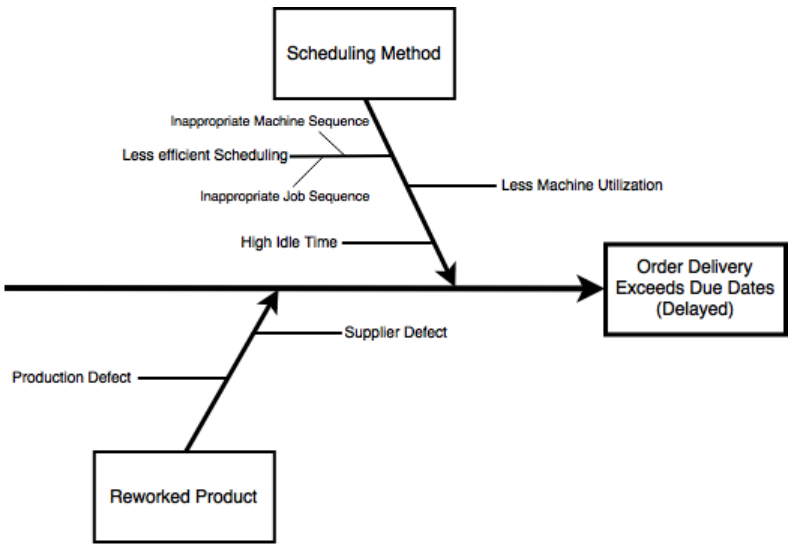

Figure I.3. Fishbone Diagram for problem of Order Delivery Exceeds the Due Dates in PT. XYZ

As described in previous paragraph, large number of products are delayed to be delivered. The root cause of delayed problem can refer to the production. As described on Figure I.3., some of the causes are reworked product, which leads to defect product, and scheduling method. The problem for defect product has been solved in another research. Then the other reason, current scheduling method in PT. XYZ is not efficient. The current scheduling process is done everyday for every machines.

Table I.2. Data of Available Time in PT. XYZ (source: PT. XYZ)

Year	Month	Working Day	Machine Working Hours
2016	January	26	624
	February	25	600
	March	27	648
	April	26	624
	May	26	624
	June	26	624
	July	26	624
	August	27	648
	September	26	624
	October	26	624
	November	26	624
	December	27	648
2017	January	26	624
	February	24	576
	March	27	648
	April	25	600
	May	27	648
	June	26	624
	July	26	624
	August	27	648

Also, there is the data of available time from January 2016 – August 2017 that can be found in Table I.2. as the concern to do scheduling. Those data are

obtained as the PT. XYZ presents, the machine working hours per month and working days.

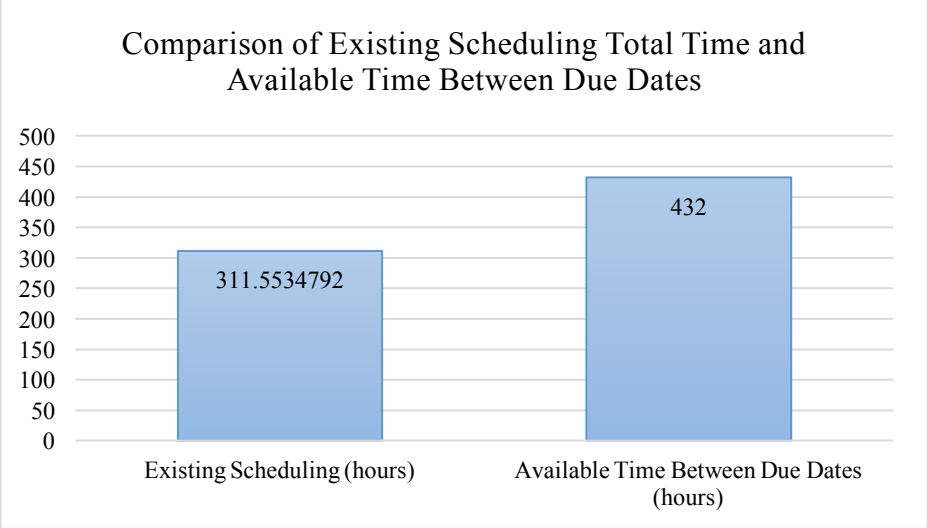

Figure I.4. Comparison of Existing Scheduling Total Time and Available Time Between Due Dates

Based on the Figure I.4. the comparison of existing scheduling total time and available time between the due dates meets the availability. However, the demand of existing scheduling only consists of the top-three highest demand which are Bubbly Girl, Light Chiffon, and Amunzen. The total time is high considering the other materials and another processes.

In addition, the difficulty of designing an efficient scheduling in PT. XYZ is due to considering several constraints. Firstly, considering precedence constraint, the sequence of the job has to meet the flow process of the material. Then, considering the sequence-dependent setup time for each machines in PT. XYZ. Setup time for machine is a notable element for production scheduling in every sequence of flow, and it possible to simply use up 20% even more of usable capacity of machine if not appropriate managed (Pinedo, 1995). Further, the production completion time and machine setups are impacted by the production mix also production sequence. On the one side, processing in a large batch raise the machine utilization and reduce the total time of setup. Otherwise, it also raises the flow time. Indisputable, the existing of tradeoff amongst machine utilization and flow time by deciding batch size and scheduling. Issues in scheduling with sequence-dependent

setup times are by the whole of the most challenging classes of the issues (Pinedo, 1995).

Furthermore, the process in PT. XYZ is not entirely processed by the series machines as if the other general production flow shop. Rather of m machines in series there are c stages which at every stage there are number of parallel exact similar machines (Pinedo, 2016, p. 15). This production scheduling in PT. XYZ is considered as the industry with the hybrid flow shop scheduling type.

Table I.3. Setup and Unloaded Time Data Per Machine (source: PT. XYZ)

Machine	Setup Time (mnt)		
	Loaded Time (mnt)	Unloaded Time (mnt)	Total (mnt)
Unroll	15	15	30
Jet (Creping)	15	15	30
Endless	15	15	30
Rotary Washer	15	15	30
Haspel	15	15	30
Scutcher	15	15	30
Stenter (presett)	15	15	30
BO Fact	15	15	30
Washer	15	15	30
Stenter (heatset)	15	15	30
Jet (Dyeing)	15	15	30
Printing	15	15	30
Steamer	15	15	30
RC Machine	15	15	30
Stenter (resin finish)	15	15	30

As the character of hybrid flow shop scheduling, the machine's setup time in this textile industry is consequently produced time lags for the other machines. A time lag is described as the time between the end of the processing of one job at a certain machine inside one stage and the starting point in the next stage that the job is processed (Javadian, 2012). This impact obtains the waiting time for the work-

in-process material because of the setup time and the parallel machines. Also, a job in existence often composes of a massive quantity of products with the equal specifications, like an amount of ceramic tiles or an amount of bolts and nuts. In many industries, the beginning of an operation at a stage has the potency of delay because the preceding operation must need time to dry or cool down. (Javadian, 2012).

As cited from Zandieh et al. (2006) that Mori et al. cited that the benefits of IA and other probabilistic optimization algorithms such as genetic algorithms are elaborated as follows:

1. IA acts on the memory cell, which assures quick convergence against the global optimum.
2. IA has a closeness calculation routine to exemplify the variety of the real immune system.
3. Self-adjustment of the immune reaction can be exemplified by the help or elimination of antibodies production.

The suggested algorithm combines an efficient mutation to cooperate the pursuit for a near-optimal solution. The new mutation transfers the best solutions established so far in the following generation. The new mutation redeploys the best solutions found so far in the subsequent generation (Zandieh et al. 2006).

I.2. Problem Formulations

The problem formulations of this research are stated in the form of question below:

1. How to determine the job and machine sequence in PT. XYZ to reduce the makespan using Immune Algorithm?
2. How is the the comparison between the proposed scheduling and existing scheduling?

I.3. Research Objectives

As the existing problems have been drawn, the objectives of this research are:

1. Determine the job sequence in PT. XYZ to reduce makespan using Immune Algorithm.

2. Compare the result between the proposed scheduling and existing scheduling.

I.4. Research Limitation

This research has to meet its limitations; they are:

1. Due date of each order is 3 weeks.
2. The characteristic of material is the same.
3. The characteristic of machines with mutual process is the same.
4. All of existing machines are used.
5. Batch size is specified by the company.
6. Production capacity each day is specified by the company.
7. Do not schedule the printing block.
8. The number of machines are determined by the company.
9. Proposed scheduling is only based on the calculation obtained.

I.5. Research Benefits

The benefits of this research are:

1. As a suggestion to PT. XYZ in minimizing the total makespan in the production process.
2. As a suggestion to reduce delays in deliver product to customer of PT. XYZ.

I.6. Writing Systematics

This research is elaborated by the following systematics of writing:

CHAPTER I Introduction

This chapter describes the research background based on the issue raised, problem formulation of the research, objectives of the research, limitation of the research, and benefits of the research.

CHAPTER II Literature Review

This chapter contains the literatures related to the issues raised in this research, including the past studies that examined mutual issues. The literatures are used as the theoretical basis for solving the problems.

CHAPTER III Research Methodology

This chapter describes the conceptual model and steps to conduct research including research object, formulation of the issues raised, techniques in data collection, research models development, data processing steps based on the model that has been selected and conclude. This chapter contains the method in this research, conceptual model and the systematic in solving the problem.

CHAPTER IV Data Collecting and Processing

This chapter contains the required data collection for this study. Thus, the collected data will be processed based on the method selected by this research.

CHAPTER V Data Analysis

This chapter describes the analysis of the data that has been collected and obtained. The analysis includes the comparison between the existing scheduling and the proposed scheduling.

CHAPTER VI Conclusion and Recommendation

This chapter discusses about the conclusion based on the series studies. Further, in this chapter will be included the recommendation for any further research.