

# CHAPTER 5

## Testing and Analysis of Scheduling System

### 5.1 Scheduling Testing

#### 5.1.1 Design of Tests

##### 5.1.1.1 Sources of data

There are three sources of data used to compare the performance between the developing scheduling method and the existing scheduling method

- 1.) The simulation of production scheduling by using the developing method
- 2.) The simulation of production scheduling by using the existing method
- 3.) The company's historical data: This is the actual production data and also under the existing scheduling method.

##### 5.1.1.2 The selected months for testing

This testing data is chosen from two months in 1999. One has the maximum production and the other has the moderate production. In each source of data show data in both month.

#### 5.1.2 Test Assumptions

5.1.2.1 All machines in the same group have the same efficiency

5.1.2.2 There is no rework in the tested orders nor machine breakdown

5.1.2.3 This testing will allow floor supervisors to adjust the schedule accordingly to the production constraints

5.1.2.4 There are some re-scheduling the sequence of each machine according to the production constraints.

5.1.2.5 There is no any insert orders in each period of scheduling

### 5.1.3 Test Criteria

5.1.3.1 The production lead-time: The amount of time is counted when the order start to the time when it is produced completely. This criterion uses the mean flow time.

$$\text{Mean flow time} = \frac{\text{Sum of flow time}}{\text{The number of order}}$$

5.1.3.2 Work in process in Finishing process: The amount of waiting time during work in process in Finishing process. This criterion uses the mean waiting time of work in process

$$\text{Mean waiting time of work in process} = \frac{\text{Sum of waiting time of work in process}}{\text{The number of order}}$$

5.1.3.3 The machine utilization: The amount of time that machines are in use compares with the available times. This criteria uses the mean working time

$$\begin{aligned} \text{Mean working time} &= \frac{\text{Sum of working time}}{\text{The number of day} \times \text{the number of machine}} \times 100 \\ &= \frac{\text{Sum of working time per day}}{24 \times 60 \times \text{the number of machine}} \times 100 \end{aligned}$$

5.1.3.4 The productivity: The capability of the production to produce the product in a period of time.

$$\text{Productivity} = \text{Sum of the finished orders weight per day}$$

## 5.1.4 Test Results

### 5.1.4.1 Production lead-time: Mean flow time

Criteria	Month of maximum production			Month of moderate production		
	Developed Method	Existing Method	Company Data	Developed Method	Existing Method	Company Data
Mean flow time (day)	5.16	7.04	10	4.32	5.87	6

Table 5.1.4.1 The result of mean flow time

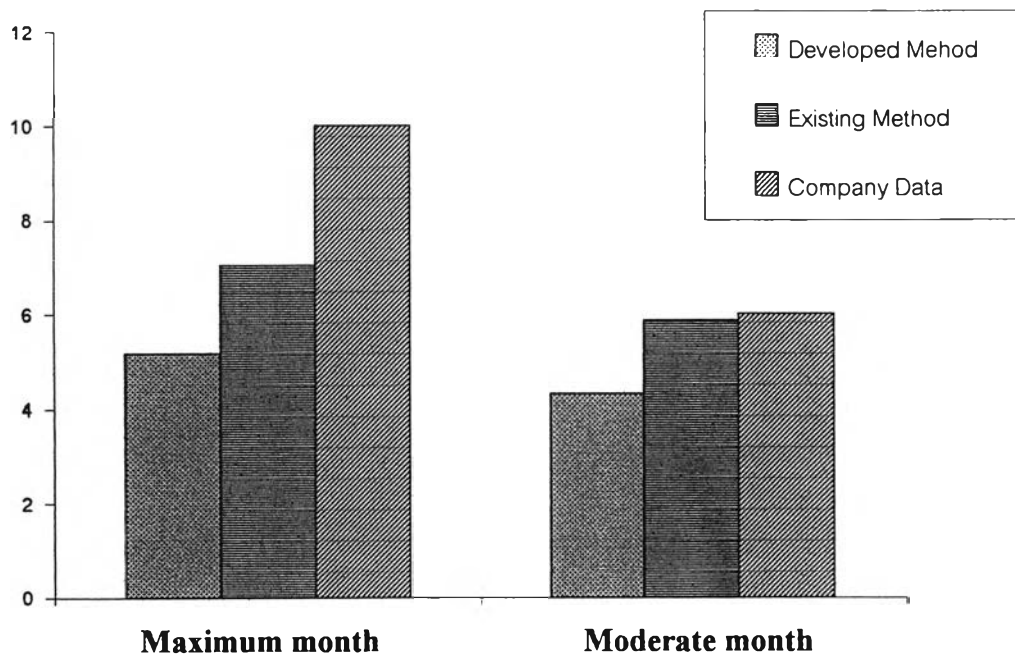


Figure 5.1.4.1 Graph of Mean flow time

## 5.1.4.2 Machine utilization: Mean working time

Criteria	Machine	Month with maximum production			Month with moderate production		
		Developed Method	Existing Method	Company Data	Developed Method	Existing method	Company Data
Mean working time	Dyeing	59%	73%	89%	56%	74%	81%
	Cut Fabric Finishing	69%	52%	54%	63%	50%	51%
	Gas Finishing	84%	68%	59%	77%	61%	42%

Table 5.1.4.2 The result of mean working time

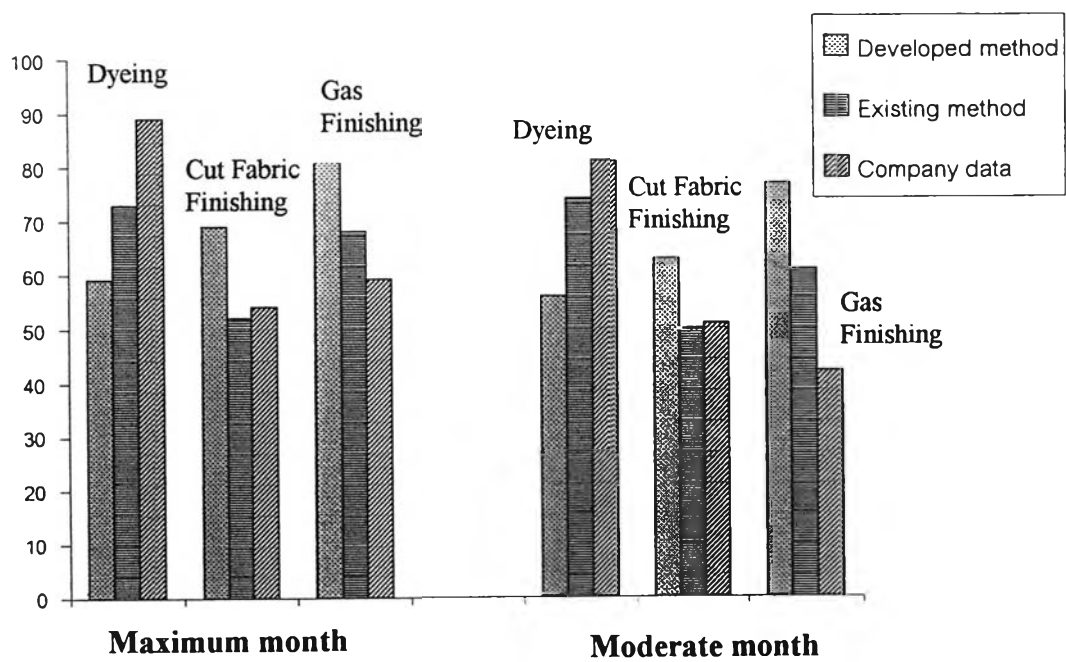


Figure 5.1.4.2 Graph of Mean working time

## 5.1.4.3 Work in process: Mean waiting time of working process

Criteria	Machine	Month of maximum production			Month of moderate production		
		Developed Method	Existing Method	Company Data	Developed Method	Existing Method	Company Data
Mean waiting time (hr)	Cut Fabric Finishing	11.69	14.75	32	8.94	12.3	13.1
	Gas Finishing	22.5	39.3	96	19.5	25.7	24

Table 5.1.4.3 The result of mean waiting time

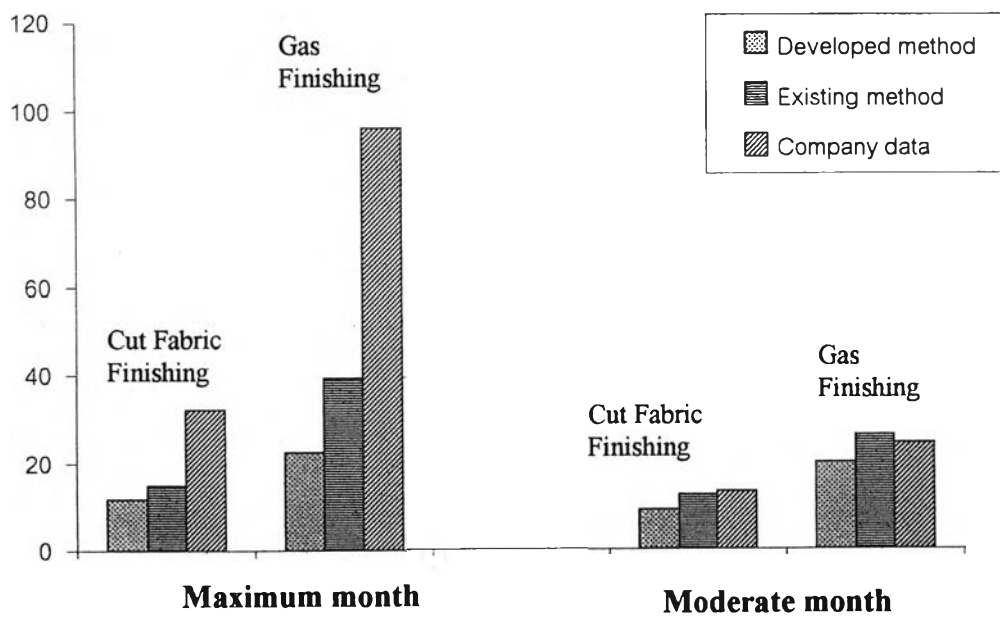


Figure 5.1.4.3 Graph of Mean waiting time

## 5.1.4.4 Productivity

Criteria	Machine	Month of maximum production			Month of moderate production		
		Developed Method	Existing Method	Company Data	Developed Method	Existing Method	Company Data
Productivity (kg /day)	Dyeing	867	1066	1300	688	890	1700
	Cut Fabric Finishing	800	671	540	605	532	460
	Gas Finishing	453	362	280	322	186	147

Table 5.1.4.4 The result of productivity

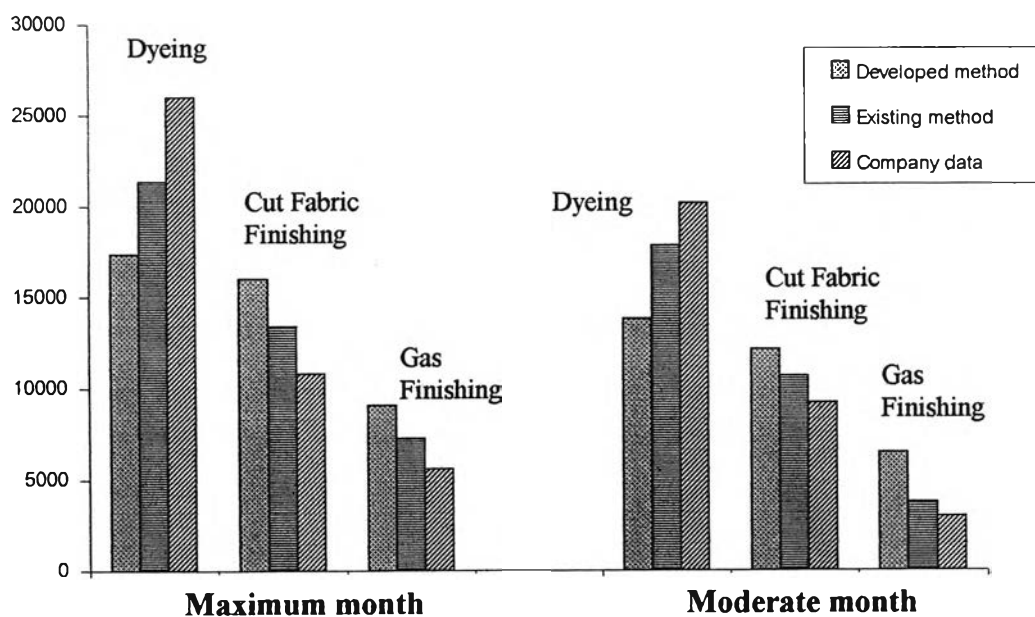


Figure 5.1.4.4 Graph of Productivity

### 5.1.5 Discussions of Test Result

In this study four different types of performance measures in 5.1.3 are considered to test the performance of developed scheduling method compared with the existing scheduling method. The outcome of the new method are discussed below:

#### 1) Production lead-time

The developed method can reduce the mean flow time. This means that the production lead-time is reduced. Although the machine utilization in Dyeing is reduced to balance the production line, but in the Finishing process, it can process the orders more continuously.

#### 2) Work in process in Finishing process:

From the performance measure in mean waiting time of work in process which determine work in process in Finishing process, it can reduce about 50%. These results from the workload balancing technique and lower setup time in Finishing process.

#### 3) Machine utilization:

The performance of machine utilization is shown in the mean working time. The machine utilization of Dyeing machine is reduced because it balances capacity with Finishing process. However, the machine utilization of Finishing machine is improved from lower setup time.

#### 4) Productivity

The capability of the production is higher than the other method. In the same period of time, the developed method can produce the product not only more than the other method, but also higher quality.

## 5.2 Analysis of the Developed Scheduling Method

### 5.2.1 Advantages and Disadvantages of the Developed Scheduling Method

#### Advantages

1. This method combines the concept of sequencing that depends on the constraints of each product and each production, and the theories of scheduling to create a better scheduling method in this industry.

2. It uses the backward scheduling from the high constraints section in finishing to low constraints section in dyeing. This causes all sections have convenient production.
3. All sections are scheduled dependently. So each section schedules concerning the relevant processes.
4. It makes balance workload in production line.
5. It has high response to the policies of the company in Finishing quality and delivery. The same groups of order are processed continuously.
6. It reduces setup time and increases efficiency in Finishing section.
7. This method uses workload balancing technique, so the Dyeing machines use in necessary. It may have some available machines for rework or urgent orders especially in HT group of machine in 400 kg, which mostly the orders are in this range of weight. This method allocates each group of color to each machine. So this is easy to insert the rework orders or urgent orders.
8. Using workload balancing technique, it may have some available machines. This is the spare machine when machines in their group are breakdown. In Gas Finishing machine, They also have a spare machine in this case too.
9. It has timetable of the schedule.

### **Disadvantages**

1. It was backward scheduling and the Dyeing section has to prepare the orders for the Finishing section in time of the schedule in each Finishing machine. It can be effective when the Dyeing section of the company has the higher capacity than the Finishing section.
2. In sequencing of color, it can change the sequence alternatively and in each type of order can be processed more than a group of machine. This method needs trial and error technique to find the best schedule so it needs the computer program.
3. In step 5.1.6 and 5.2.4, it uses mathematics algorithm to separate and combine the orders. This reduces the flexibility or appropriateness in sequencing with the fabric characteristics.



4. In this method, it schedules in each period of time. In Dyeing section also sequences the orders in that period. It increases the chance for reset up the machine in the connection of each period. However, this method classifies the color in two groups of light and dark color. Each machine is allocated to process in only one group of color. They can reduce the problem in reset up in the connection period.

5. Because of each Dyeing machine must be processes only a group of color. In the groups of Dyeing machine, which have a few machines, may have a problem of machine over load and idle, if a group of color has a lot of orders, but the another has a few color. This problem can be solved by readjustment in that group of machine by scheduler. However, mostly the colors of the orders are random in both light and dark color.

### **5.2.2 Comparison of Existing Scheduling Method with the New Method**

After analysis in the scheduling strategies and the advantage and disadvantage in both exiting scheduling and the developed method, in conclusion it can compare in many factors as follow :

1.) The flow of scheduling: They are contrast in flow of scheduling. The existing method uses Forward scheduling that flows like the production flow. The new one uses Backward scheduling that flow from the high constraint process as Finishing process to the low constraints process as Dyeing. This is to improve the workflow of the production

2.) Workload balance: The new method concerns in balancing workflow from Dyeing section to Finishing section to minimize work in process. It also concerns in workload balance in the Finishing section to improve machine utilization and productivity. The existing method does not plan to balance like mentioned above. It tries to produce full capacity in Dyeing section which makes a lot of work in process in the Finishing section.

3.) The relation of each section in scheduling: The old method schedules in each section independently. This causes many problems in the post section as Finishing section such as high work in process or unbalance work load. The

developed method schedules all process dependently to minimize the problems in all section. This improves workflow in the production.

4.) Response the policies of the company: The existing method can response the policy only in producing rework orders urgently. The new one can response in both the rework orders and the delivery in the same group of orders.

5.) The quality of Finishing product: The new method can improve the quality of Finishing product by processing the group of order continuously. This improves the quality by providing the same characteristic of product. The existing method does not concern in this factor seriously. Thus it does not plan to produce the same group of order in nearly time.

6.) Timetable of schedule: This new method emphasizes to make a timetable for helping in production control and inventory control both in dyestuffs and fabric. This is the efficient tool in the production planning. The existing method just sequences the orders

7.) Insert the rework or urgent order, and absorb machine breakdown: Due to the new method try to balance the workload, it has the chance that the Dyeing machine has the idle machine to insert the rework or spare for machine breakdown. Moreover in Dyeing section it processes a group of color (dark or light) to a machine. This also increases the chance to insert the rework order. The existing method uses machine with full capacity. Thus it has low chance to insert the rework order immediately without setup the machine. Furthermore, each Dyeing machine may be dyed from light color to dark color randomly.

8.) Set up time in Finishing section: The existing method schedules in the Finishing section by considering work in process at that time. It does not plan the beginning because it schedules separately. This makes high set up times in Finishing section. The developed method starts to schedule in the Finishing section which has

the high constraints, and relate this plan to the Dyeing section to make the whole effective schedule. This reduces set up time in Finishing section significantly.

Item	Factor	Existing Scheduling	Developing Scheduling
1	The flow of scheduling	Forward Scheduling	Backward Scheduling
2	Production workload balancing	Unbalance	Balance
3	The relation of each section in scheduling	Independence	Dependence
4	Response the policies of the company	Low	High
5	The quality of Finishing product	Low	High
6	Timetable of schedule	Have not	Have
7	The chance to insert the rework or urgent order, and absorb machine breakdown	Low	High
8	Setup time in finishing	High	Low

Table 5.2.2 Compare the result between the existing and these developed method

### 5.2.3 The Effect of the Developing Scheduling Method on Production

The benefits comes from two factors

#### 1.) There is a better production scheduling method

- 1.1) Reduce the setup time in Finishing process
- 1.2) Improve machine utilization and productivity
- 1.3) Reduce work in process inventory
- 1.4) Reduce the inventory of finished goods
- 1.5) Solve the problem in material handling (pushcarts)
- 1.6) Improve the quality of product
- 1.7) Improve moral of the workforces
- 1.8) Reduce the production lead-time
- 1.9) Reduce the production cost

2.) There is a timetable of production schedule

2.1) Give the clear timetable in the production to due with the customers and appoint the due date

2.2) Improve the performance of shop floor control

2.3) Improve the performance of production preparation

2.4) Reduce the inventory of dyestuffs

2.5) Reduce the inventory in fabric warehouse