

CHAPTER 1

INTRODUCTION

1.1. Background

One of hard disk drive manufacturer which has factory sites in Thailand is applying 24 hours per day and 7 days per week production with 12 hours for each shift. As the duration for one shift is 12 hours, there are two different shifts; day and night shift. Working hour for each shift is from 7 a.m. to 7 p.m. for day shift, and 7 p.m. to 7 a.m. for night shift. The shift operators in production line are all women which grouped into 3 crews; crew A, B, and C. The example of shift schedule for those 3 crews in regular work can be seen in Figure 1.1. Shift schedule showed at Figure 1.1. is from January 2014 to March 2014. Every shift operators is receiving shift schedule in form of card every year for their reminder. In one day, there are 2 crews working, 1 crew at day shift, other crew at night shift, and the third crew is having day off. Based on Figure 1.1., crew B has 4 consecutive work days on day shift continued with 2 consecutive days off and another 4 work days on night shift followed by 2 consecutive days off. This pattern is applied to every crew. Thus, it is showed that the company has 4 work days (work stretch) followed by 2 days off (rest period) with 6 days' work cycle and switching shift after one work cycle. But, this pattern is only applied on regular condition.

Jan-14																																		
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri			
Day	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C			
Night	C	C	C	A	A	A	A	B	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A			
Off	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B			

Feb-14																															
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue			
Day	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A			
Night	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B			
Off	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C			

Mar-14																																		
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri			
Day	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C			
Night	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A	A	B	B	B	B	C	C	C	C	A	A	A			
Off	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B	B	A	A	C	C	B			

Figure 1.1. Shift Schedule

Once the demand increases and cannot be fulfilled by regular work pattern, it will change into 4 days regular work, 1 day overtime, and 1 day-off (5-1 work pattern); or 8 days regular work, 3 days overtime, and 1 day-off (11-1 work pattern) as the worst case. The illustration of current work pattern and other options of work pattern can be seen in Figure 1.2. Currently, total break time on one shift is 1.5 hours or 90 minutes. Therefore, each employee works for 10.5 hours each day which got from 12 hours shift duration deducted by total break time in one shift. When there is overtime, the employees will work as long as regular work. Shown in Figure 1.2., there are 4 elements considered on work pattern; work, OT, OFF, and workweek. The combination between work, OT (overtime), and OFF based on work pattern are repeated continuously without considering week change. Total week displayed in work pattern depends on the pattern for next week. If the pattern for next week is same with pattern on first week, work pattern will not display work pattern for next week. Therefore, there are 6 weeks on current work pattern and alternative 5-1 work pattern, and 12 weeks on alternative 11-1 work pattern. The first day of work on each work pattern assumes to start on Monday. Workweek is total working hours including overtime in one week. This value is calculated on each week in work pattern. This value is also the critical point on creating work pattern because its value must not exceed the regulation. The regulations are given by EICC and Apple. Apple as one of the company's customer publishes Apple Supplier Code of Conduct for its supplier. Moreover, this company and Apple are joined in an organization named EICC (Electronic Industry Citizenship Coalition) that publishes EICC Code of Conduct to be applied by the members and its supply chain. Thus, this company must follow those two regulations which stated that workweek should not be more than 60 hours per week, including overtime (EICC, 2014; Apple, 2013). When the value of workweek is greater than 60 hours, it is highlighted by bold font. The result shows that only workweek for regular work pattern and the sixth week on alternative 5-1 work pattern has fulfilled EICC's and Apple's regulation. Unfortunately, this company is currently applying alternative 5-1 work pattern which most of its workweek exceed the regulation. This problem is categorized as tour scheduling because it is combination of day off scheduling by assigning work day and off day in certain period and shift scheduling by assigning the crews based on shift type and work pattern.

	Week	Day							Workweek (hours)
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Regular Work Pattern	1st	Work	Work	Work	Work	OFF	OFF	Work	52.5
	2nd	Work	Work	Work	OFF	OFF	Work	Work	52.5
	3rd	Work	Work	OFF	OFF	Work	Work	Work	52.5
	4th	Work	OFF	OFF	Work	Work	Work	Work	52.5
	5th	OFF	OFF	Work	Work	Work	Work	OFF	42
	6th	OFF	Work	Work	Work	Work	OFF	OFF	42

	Week	Day							Workweek (hours)
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Alternative Work Pattern	1st	Work	Work	Work	Work	OT	OFF	Work	63
	2nd	Work	Work	Work	OT	OFF	Work	Work	63
	3rd	Work	Work	OT	OFF	Work	Work	Work	63
	4th	Work	OT	OFF	Work	Work	Work	Work	63
	5th	OT	OFF	Work	Work	Work	Work	OT	63
	6th	OFF	Work	Work	Work	Work	OT	OFF	52.5

	Week	Day							Workweek (hours)
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Alternative Work Pattern	1st	Work	Work	Work	Work	OT	OT	Work	73.5
	2nd	Work	Work	Work	OT	OFF	Work	Work	63
	3rd	Work	Work	OT	OT	Work	Work	Work	73.5
	4th	Work	OT	OFF	Work	Work	Work	Work	63
	5th	OT	OT	Work	Work	Work	Work	OT	73.5
	6th	OFF	Work	Work	Work	Work	OT	OT	63
	7th	Work	Work	Work	Work	OT	OFF	Work	63
	8th	Work	Work	Work	OT	OT	Work	Work	73.5
	9th	Work	Work	OT	OFF	Work	Work	Work	63
	10th	Work	OT	OT	Work	Work	Work	Work	73.5
	11th	OT	OFF	Work	Work	Work	Work	OT	63
	12th	OT	Work	Work	Work	Work	OT	OFF	63

Figure 1.2. Work Pattern

In a smaller scope, one day work can be break down into break schedule for one shift. This company gives two times break for shift workers. As explained before, this company currently gives 1.5 hours break or 90 minutes, with 1 hour on the first break and 30 minutes on the second break which can be seen on Break Schedule A in Figure 1.3. In other hand, Break Schedule B showed in Figure 1.3. is proposed break schedule from IE (Industrial Engineering) Department with 2 hours break with 1 hour each respectively. But due to many things should be considered, it has not been implemented yet. The first thing should be

understood on break schedule is the header which represents working hour for one shift. Based on Figure 1.3., the header shows starting time from 07:00 to 18:00 with each column represents one hour. Each header has 4 squares below which represent 15 minutes each. This company has two different kinds of team in the production floor named as regular team and stagger team. Every worker on regular team is grouped based on line of production. Stagger team is responsible to replace one line's work during break time to have continuous production. Therefore, operators as stagger team can do any operations needed to cover during their shift. A group of lines and stagger team which work on the same shift schedule is called as crew. The break time's policy in this company is only one line team on same stagger can has break time at one time and there is no overlapped break time among those line teams. Black marks on several squares in Figure 1.3. represent break time for each line and stagger team; while the white one represents work time. Break time given for stagger team is a little bit different than line team especially break time on start and end of shift because this team is not fully having break at that period but helping on line production as feeder or transporter if needed. Based on Figure 1.3., one stagger on Break Schedule A can handle six line teams on replacing their work during break time. But, one stagger on Break schedule B can handle only for five line teams.

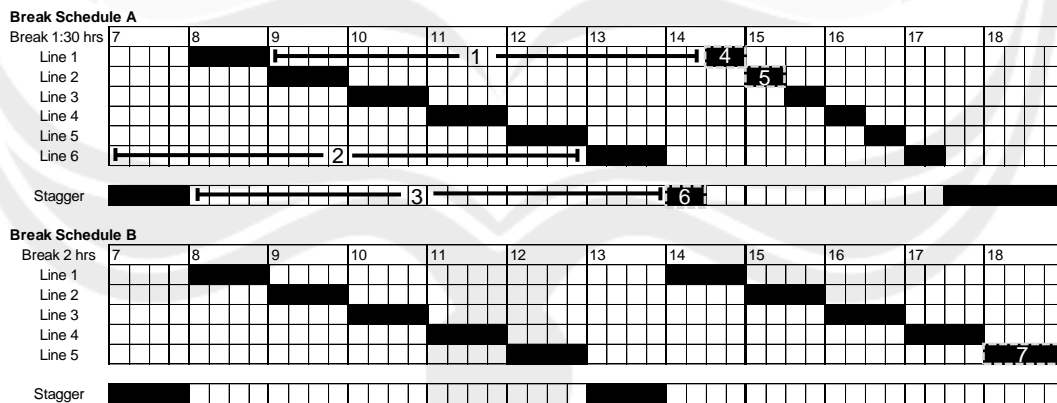


Figure 1.3. Break Schedule for 1.5 Hours Break and 2 Hours Break

Considering on working hours for workers, Thailand's Ministry of Labour (1998) is stated that consecutive work hours should not be more than five hours followed by one hour break. Unfortunately, some parts on Break Schedule A violate the regulation. Those parts are highlighted by numbers in Figure 1.3. Working duration on number 1, 2, and 3 are greater than 5 hours, and break time on number 4, 5, and 6 are less than 1 hour. In addition, Break Schedule B assigns

the last line team to have break time on the end of shift which is highlighted by number 7 in Figure 1.3. This condition should be eliminated because the operators are cannot going home earlier while the others are still working in production line. Therefore, both Break Schedule A and Break Schedule B are needed to be revised. As the problem appeared in break schedule is how to assign break time on shift, it is categorized as break scheduling problem.

In summary, there are two problems appeared in this company; tour scheduling and break scheduling. To find out the contribution of this research, previous researches are reviewed but not only limited on tour scheduling problem but also day off scheduling, shift scheduling and break scheduling problem. On shift scheduling problem, Rekik et al. (2010) have considered multiple breaks by giving 3 sub breaks on 9 hours' shift work with forward and backward constraint and implicit model. On day-off scheduling problem, Alfares has solved 5 work days and 2 off days scheduling problem by implementing dual linear programming (Alfares, 2001); 14 work days and 7 off days scheduling problem by utilizing dual solution and primary-dual relationship (Alfares, 2002), and 3 work days and 4 off days scheduling problem by implementing integer programming (Alfares, 2006). Elshafei and Alfares (2008) also give contribution on solving single shift day-off scheduling problem with sequence dependent labor cost; 3 work days and minimum 2 off days by implementing dynamic programming algorithm. On cyclic scheduling problem, Kaluzny and Hill (2011) have developed shift schedule for officers which work for 4 days and rest for 2 days with 8 to 12 hours work per shift by applying split and stitch method and generating integer linear programming model. Yuniartha (2012) also has developed shift pattern for Front Office staffs which work with 3 types of shift and work for 5 days following with 1 off day. Another literatures from Brusco and Jacobs (2000) had solved continuous tour scheduling problem with 9 hours work per shift and have cyclic work pattern of 5 days' work and 2 days off by implementing GSCF (generalized set-covering formulations) and implicit programming. Laporte and Pesant (2004) also has done research about cyclic scheduling by developing Constraint Programming (CP) for multi-shift rotating schedules with 3 types of shift on one day and can be applied on any types of work pattern. Brunner et al. (2009) also have developed shift construction on scheduling the physicians which work for 7 hour to 13 hours with one hour break per shift and 42 hours to 54 hours in total per week by generating mixed integer programming model.

Based on all the previous references, there is previous research considering multiple breaks and other researches considering work pattern and shift type, but there is no research has considered combination between those two components. Therefore, contribution of this research is application of tour scheduling which is combining between work pattern and shift type and application of break scheduling for multiple breaks in one shift.

1.2. Problem Formulation

Based on the research background described above, then the problems in this research can be stated as: “Consecutive work hours of shift workers is more than five hours which violates Thailand’s Ministry of Labor law; and the total working hours per week for shift workers is more than sixty hours which violates EICC and Apple Supplier Code of Conduct”.

1.3. Research Objectives

The objective of this research is proposing new break schedule to fulfill Thailand’s Ministry of Labor law and work pattern to fulfill Apple and EICC Compliance by creating program on Microsoft Excel.

1.4. Scope and Limitation

The scope and limitation of this research are:

1. This research only focuses on shift workers in production line
2. This research is considering two breaks in one shift
3. Shift types in this research are day shift and night shift
4. Shift length in this research is 12 hours per shift
5. There are three crews assigned in this research
6. Number of headcount is not considered in this research
7. The schedule created is based on Industrial Engineering Department’s point of view