CHAPTER V

RESULTS AND EVALUATIONS

In this chapter, the results of the new system is evaluated and compared with the results of the current system. The metrics are used to measure the improvement in this thesis are line efficiency and productivity index. Moreover, the proposed layouts are also evaluated their effectiveness by using four approaches, cost comparison, productivity evaluation, space utilization, and factor analysis. The results and evaluations are explained in detail as follows:

Results and evaluations of the new system

Inspection

After implementing the new supply method, the results of the new inspection time are evaluated the compared with the current system in Table 5.1 as follows:

Table 5.1: The result and evaluation of the new inspection time

Item	Current system	New System	% Difference or remark
Standard inspection time (sec)			
Inspection for external customer	110	99	-10.0%
Inspection for ITC	66	55	-16.7%
Inspection manpower			
Inspection for external customer	6	7	-
Inspection for ITC	5	4	-
Total inspection manpower	11	11	-
Cycle inspection time (sec)			
Inspection for external customer	18.33	14.14	Bottleneck is eliminated
Inspection for ITC	13.20	13.75	

As shown in the Table 5.1, inspection time reduced 10% in case of inspection DY for external customer and 16.7% in case of inspection DY for ITC. The current inspection manpower is relocated based on the improved inspection time that results in reducing cycle time of inspection DY for external customer for 18.33 sec to 14.4 sec. Consequently, the bottleneck problem due to inspection DY for external customer is eliminated.

Subassembly

After the re-layout of the current subassembly, the real non-added value movements are eliminated. The results of the new subassembly are evaluated the compared with the current system in Table 5.2 as follows:

Table 5.2: The results and evaluation of the new subassembly

Item	Current system	New System	% Difference or remark
Standard subassembly time (sec)			
DY size 14"	22.24	20.79	-6.5% ⬇
DY size 20",21"	33.59	30.18	-10.2% ⬇
Productivity (output/person)			
Daily output	8,400	10,000	1,600 ⬆
Total subassembly manpower	12	12	-
Daily output/ person	700	833	19.0% ⬆

As shown in Table 5.2, the total subassembly time reduced 7% in case of producing DY size 14" and 10% in case of producing DY size 20"&21". This improvement leads the current subassembly operators which work based on one-piece-flow concept to be able to produce 10,000 pieces DY/ day, or the other words, results in 19% productivity improvement.

Assembly line

After designing the new workstations of the assembly lines by using line balancing technique, the new balancing assembly is evaluated the line efficiency and productivity and then compared with the current assembly system to determine the improvement as shown in Table 5.3.

Table 5.3: The results and evaluation of the new balancing assembly

Item	Current system	New system	% Difference or remark
Line efficiency (%)			
DY Type 1	87.23%	95.58%	9.6%
DY Type 2	82.87%	93.20%	12.5%
DY Type 3	77.33%	94.29%	21.9%
DY Type 4	79.63%	91.26%	14.6%
DY Type 5	85.53%	95.72%	11.9%
DY Type 6	82.29%	93.35%	13.4%
DY Type 7	85.83%	94.47%	10.1%
DY Type 8	76.54%	91.44%	19.5%
DY Type 8	91.78%	94.13%	2.6%
DY Type 9	87.24%	91.13%	4.5%
DY Type 11	82.34%	93.86%	14.0%
DY Type 12	84.30%	91.06%	8.0%
Average line efficiency	83.58%	93.62%	12.0% ↑
Productivity (output/person)			
Daily output	8,400	10,000	1,600 ↑
Total assembly manpower	99	102	3 ↑
Daily output/ person	85	98	15.5% ↑

As shown in Table 5.3, the average efficiency of assembly lines increases from 83.58% to 93.62%, or the other words, 12% line efficiency improvement derived from new balancing. To achieve output 10,000 piece DY/ day, although one more operators per shift are required to attach magnet in case of producing DY size21", the daily outputs increase with the rate higher than that of the manpower. So, it results in 15.5% productivity improvement of assembly line.

Evaluations of the proposed layouts

In this thesis, the study is to propose the new alternative process layouts and compare the theoretical results from the new process layout to existing process layout in order to help the company to make decision for implementation the proper layout to suit to specific situation in the future. To measure the effectiveness of the proposed layouts, both quantitative and qualitative approaches are used as follows:

Quantitative approaches

Cost comparison

The evaluation is calculated based on the assumption as follows:

- Direct labor wage is 194 Baht/ person/ day
- Maintenance activity needed for new conveyor lines is 1 man-day/ 2 months and maintenance staff wage is 300 Baht/ person/ day
- Lighting consumes power 288 W/ 36 m^2, air conditioning consumes power 6 KW/ 36 m^2, and conveyor motor consume power 4 KW/conveyor.
- One power unit (KW-hr) cost 2.14 Baht
- Interest rate 7.5%
- Re-arrangement and line conveyor costs are estimated from subcontractor of the company

The evaluation of cost comparison can be summarized in Table 5.4 as follows:

Table5.4: Evaluation of the proposed layouts by cost comparison

Annual cost (Baht)	Cost comparison (Current — Proposal)		
	Layout#1	Layout#2	Layout#3
Range of capacity expanding (units/day)	8,000-10,000	10,000-13,000	10,000-13,000
1. Factory cost			
- Labor cost	0	0	-139,953
- Maintenance cost	0	0	+1,800
- Utility cost			
- Power (lighting)	-31,950	-15,975	0
- Power (air conditioning)	-221,876	-110,938	0
- Power (conveyor motor)	0	0	+73,958
- Interest	0	0	- 22,848
Factory cost comparison	-253,826	-126,913	-87,042
2. Investment cost			
- Re-arrange cost	+100,000	+100,000	+70,000
- Handling equipment			+250,800
Investment cost comparison	+100,000	+100,000	+320,800
Total annual cost comparison	-153,826	-26,913	+233,757
Payback period	0.4 year	0.78 year	3.7 years

Productivity evaluation

In this approach, the effectiveness of the proposed layouts are measured in terms of materials handling distances (as shown in the detail of travelling distances in the drawing on pp67-69), and such distances are also estimated based on historical movement data in SOE to be handling man-hour required per day. The handling man-hour saving of each proposed layout is one of the good measures to find the productivity improvement due to more effective layouts which the results can be summarized in Table 5.5 as follows:

Table5.5: Evaluation of the proposed layouts by productivity evaluation

Range of capacity expanding (units/day)		8,000-10,000	8,000-10,000	10,000-13,000	10,000-13,000
Handling distance (m)/ day		Current	Layout#1	Layout#2	Layout#3
From	To				
H-coil section	Subassembly	3,744	1,079	1,234	
Subassembly	H-coil stock area	333	133	-	-
V-coil section	V-coil stock area	603	258	283	-
H-coil stock area	Assembly line	599	259	465	-
V-coil stock area	Assembly line	1,447	679	1,357	-
Materials	Assembly line	600	180	240	105
Total handling distance (m)/ day		7,326	2,588	3,578	105
Handling man-hours/ day		Current Layout	Layout#1	Layout#2	Layout#3
From	To				
H-coil section	Subassembly	2.08	0.60	0.69	-
Subassembly	H-coil stock area	0.19	0.07	-	-
V-coil section	V-coil stock area	0.34	0.14	0.16	-
H-coil stock area	Assembly line	0.33	0.14	0.26	-
V-coil stock area	Assembly line	0.80	0.38	0.75	-
Materials	Assembly line	0.33	0.10	0.13	0.06
Total handling man-hours/ day		4.07	1.44	1.99	0.06
% Handling man-hour saving		0%	65%	51%	99%

Space utilization

This approach is used to evaluate the effectiveness of the proposed layout on the basis of allocated space. Because DY process has no activity concern the vertical space, only floor space criterion in term of square meter are used to evaluate which the results can be summarized in Table 5.6 as follows

Table5.6: Evaluation of the proposed layouts by space utilization

Space (m^2)	Layout#1	Layout#2	Layout#3
ange of capacity expanding (units/day)	8,000-10,000	10,000-13,000	10,000-13,000
Manufacturing area	756	852	972
Saving area	216	120	0
% Improvement	22.22%	12.35%	0.00%

Qualitative approach

Factor analysis

Moore (1962) proposed the factor analysis that is the approach used to measure the effectiveness of the plant layout in qualitative term. After considering qualitative objective of DY process, the important factors are selected to evaluate the effectiveness of the proposed layout as follows:

1. Easy to capacity expansion
2. High flexibility
3. Minimum congestion and safety
4. Good working condition
5. Easy to supervision and quality check
6. Easy to maintenance
7. Potential to make higher quality product
8. Appearance

To ensure that the evaluation best fit for the company's objective and direction, all factors are weighed by asking the top management. And the alternative layouts are evaluated by rating their effectiveness factor by factor by production engineer who is accountable owner of DY process. The results are shown in Table 5.7 as follows:

Table5.7: Evaluation of the proposed layout by factor analysis

Factor	Weight	Rating and rating multiplied by weight		
		Layout#1	Layout#2	Layout#3
1. Easy to capacity expansion	9	O = 1	E = 3	E = 3
		9	27	27
2. High flexibility	9	E = 3	E = 3	O = 1
		27	27	9
3. Minimum congestion and safety	8	I = 2	E = 3	A = 4
		16	24	32
4. Good working condition	7	O = 1	I = 2	E = 3
		7	14	21
5. Easy to supervision and quality check	8	O = 1	I = 2	A = 4
		8	16	32
6. Easy to maintenance	8	E = 3	I = 2	O = 1
		24	16	8
7. Potential to make higher quality product	9	E = 3	E = 3	A = 4
		27	27	36
8. Good appearance	6	I = 2	E = 3	E = 3
		12	18	18
TOTAL		130	169	183