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Labor productivity improvement for Thai SMEs: a case study

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ABSTRACT
This study aims to support Thai SMEs to increase the competitive advantages. The Department of Skill Development (DSD), Ministry of Labor (MOL), Thailand granted a labour productivity improvement projects throughout Thailand. With 8 selected Thai Small and Medium Enterprises (SMEs) in Pathumthani province, the Industrial Engineering (IE) faculty members work closely with the companies to improve their labor productivity. The study shows that common challenges and problems faced by Thai SMEs include a high defective rate, an overload and over stock warehouse, a lack of inventory management, an imbalanced production line, a long distance of material and labor transportation, an insufficient working standard, a low output and a poor working environment. The improvement process involves in 3 main themes which are the improvement of working methods, the waste reduction, and the inventory management. For a case-studied company, the mean score of pre- and post-tests were 12.74 and 16.87, respectively. The statistical t-test shows a strong evidence ($t = -23.07$, $p = 0.00 < 0.05$) that the training provides knowledge and experience to employee in the area of quality mindset, 7 wastes and Kaizen. The labor productivity is increased 5.27%. The cycle time is decreased 38.24%. The moving distance is reduced 11.63%. For waste reduction purpose, there is an improvement of 86.98% of loss, 21.21 % reduction of inventory items, and a saving of 18.57% in transporting distance.

Keywords: labour productivity, productivity improvement, employee empowerment, kaizen, SMEs

1. Introduction
Small and Medium Enterprises (SMEs) inhabit an important role in the prosperity of national economy. Reasons for placing high significance to strengthen the SMEs performance are listed in a number of articles and studies [1, 2]. SMEs plays an important role in supporting large scale manufacturing firms. It provides employment opportunities to people and facilitating a more equal income distribution. Furthermore, higher capabilities of SMEs enhance competitive advantages, entrepreneurship, economic-wide efficiency, innovation and aggregate productivity growth.

However, with the limited resources, SMEs are challenged with the issue of productivity and quality programs. There are seven factors affecting those programs and these are top management's education/ training level and priorities, costs and actual performance, lack of support from external agents, human resources' overload, aversion to change, lack of resources, as well as, culture and training [3].

Researchers and practitioners around the world have studied and conducted researches to understand the SMEs key success factors. The Turkish Productivity Center had succeed in implementing productivity improvement projects which contributed to a useful model for other similar agencies to create intervention programs at national and regional levels [4]. Marcus Assarlind has studied Swedish medium-size enterprises and suggested that the interventions should focus on management and employees collaboration to gain trust and commitment [5]. SINTEF Industrial Management organization in Norway introduced the Quality Improvement Programme (QIP) with the emphasis on education, planning and organizing, reactive problem solving process, company -wide work unit analysis and continuous improvement initiation [6]. Another empirical study in Northern India revealed that the continuous improvement strategies can contribute to enhance the manufacturing performance significantly [7]. Salheldin mentioned that in Qatar SMEs, the key success factor at the operational levels includes higher degree of employees' empowerment, employee training, employees' involvement and quality supplier [8]. Last but not least, a study in Chinese SMEs suggested that with a greater attention to human resource practices, the better influences to the firm performance and growth potential [9]. Andreichuk stated that the smaller companies can be successful in strengthen employee support and involvement due to fewer management layers and fewer people to convince the benefits of change [10].

In Thailand, labour is a main factor to drive the nation economy and industry development. Requirement for labour at the moment is not only numbers of employees, but also qualified skills. Labour productivity is crucial to define the nation competitiveness due to its nature to show how efficient the human resources is utilized. In the past 10 years, Thai labour productivity is lower than other nations in Asia. The main reasons are a lack of skilled labour who has the competency to work with advanced technology, a misunderstanding about quality, and a lack of resources and proper trainings in manufacturing sector [11].

Thai Ministry of Labour (MOL) has initiated the labour productivity improvement scheme since 2012. Each year, Thai SMEs companies can apply to this fully funded program for labour productivity improvement. MOL received annual budget around 68 Billion Thai Baht to implement projects with more than 200 Thai SMEs in 20 business groups ranging from agricultural, manufacturing to services [12]. Thai SMEs are categorized by numbers of employees. A small-sized enterprise has 50-200 employees, where a medium-sized has more than 200 persons.

The department of Industrial Engineering (IE), Faculty of Engineering, Rajamangala University of Technology Thanyaburi (RMUTT), Thailand has faculty members who have expertise with various experiences in collaborating with the industries especially the productivity and quality improvement. The IE department works with the Centre for Skill Development 14 (CSD14) and 8 SMEs located in Pathumthani province.

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The objectives of the study are to determine the challenges and problems faced by SMEs as bases for improvement themes and topics to develop an improvement process using one company as sample to analyze the productivity improvement using the employee training outcome, labour productivity, and waste reduction.

3. Materials and methods

For each company, a productivity improvement team is set involving 3 parties, they are 1-2 persons from CSD14 as a project coordinator, 3-4 IE faculty members as industrial consultants and 6-8 company managers and supervisor as an enterprise team. The collaboration is shown in Figure 1.

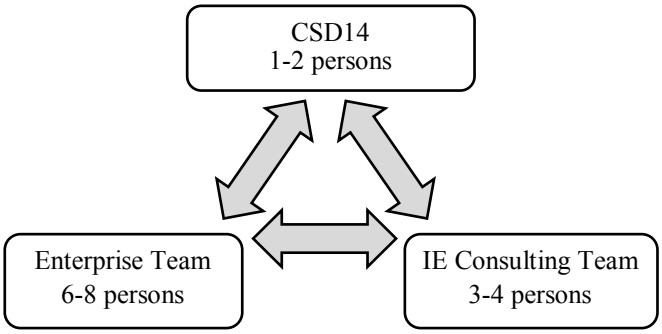

Figure 1. Working team component.

The methodology comprises of 3 main stages. The first stage is a company visit and a meeting with corresponding supervisors. The shop floor observation and conversation with employee permit information gathering to define challenges and problems faced by Thai SMEs. A monthly company visit allows the team to have a meeting with the management team, gather background data, define a working scope, set a working plan and assign the corresponding staff.

The second stage applies the Industrial Work Study and 7 Quality Control (7QC) Tools to develop improvement process. The key performance indicators (KPIs) are discussed for measuring the goal achievement.

The third stage emphases on the in-house training to plant the knowledge on quality mindset, 7 wastes and Kaizen to shop floor workers and supervisors. The hands-on training is arranged in the way that the employee can work in group to propose an improvement in their routine work. The sharing session provides learning opportunities for employee from different functions. Pre-test and post-test scores and questionnaire survey are collected and tested statistically to validate the training effectiveness.

The pre- and post- labor productivity and percentage of productivity improvement calculations, percentage of waste reduction and the improvement of Key Performance Indicators (KPIs) are used to analyze the productivity improvement. A labor productivity, percentage of productivity improvement and percentage of waste reduction can be calculated using the following formulas:

4. Results and discussion

$$\text{labor productivity} = \frac{\text{output (units)}}{\text{labor hour (hours)}} \quad (1)$$

$$\%\ \text{Labor Productivity Improvement} = \frac{(\text{labor productivty after} - \text{labor productivty before})}{\text{labor productivty before}} \text{x} 100\% \quad (2)$$

$$\%\ \text{Defect Reduction} = \frac{(\text{defect rate before} - \text{defect rate after})}{\text{defect rate before}} \text{x} 100\% \quad (3)$$

4.1. Challenges and Problems

In order to define challenges and problems faced by SMEs, a series of company visits, meetings and discussions with supervisors, observations at the shop floor where the production take place are conducted thoroughly. Table 1 shows the information of 8 selected SMEs in Pathumthani provinces that participated in the project.

Table 1. Company information and working scope

No.	Size	Products	No. of Employees
1	S	Cosmetic	183
2	S	Cardboard box	139
3	S	Bottle caps	129
4	S	Automotive parts	71
5	M	Die cast parts	369
6	M	Instant drinks	275
7	M	Wood products	225
8	M	Surface coating	98

Figure 3 shows an example of the meeting with corresponding people.

Figure 3. Meeting with the company management.

Figure 4 shows an example of the shop floor observations and data gathering.

Figure 4. Observation at the production line.

The data collection and preliminary analysis with a Pareto chart, a Cause and Effect diagram and a number of process charts show that the main challenges that those companies faced are high defective rate, overload warehouse and inventory, unbalanced production line, high moving distance, insufficient working standard, low output and poor working environment.

4.2. Improvement processes

Using one company as an example to develop improvement processes, a case study company is an Original Equipment Manufacturer (OEM) for aromatherapy and spa products from organic raw materials. Data collection and preliminary analysis lead to the discussion to set an improvement scope and measurement KPIs.

The 1st improvement process focuses on how to improve working methods, the data shows delays in several mixing processes. Moreover, there is cumulative of long distance of material transfer between operating stations. This causes the

actual cycle time to be higher than the expected cycle time from the planning department. The Eliminate – Combine – Rearrange – Simplify (ECRS) technic is applied to improve the working method. The mixing process is scheduled to finish before noon to eliminate the delay at lunch time break. The company arrange an early delivery with the ice supplier to eliminate waiting time and reduce the cycle time. In order to reduce the transferring distance, the working stations are rearranged. More water supply outlets are installed to eliminate unnecessary moving.

The 2nd improvement issue emphases on how to reduce waste from the production line. The data shows high loss in the production line which causes the production department to produce a buffer stock. Analysis from a flow process chart, a man-machine chart and a C&E diagram show that the ingredient in the mixing formula is lost along the production line. The main causes are (1) too many changes of containers, spatulas, mixing blades between production stations, (2) pauses between mixing process due to work lunch break, (3) a small batch production and (4) workers' quality mindset. The quality mindset and 7 wastes are implemented so that the employee are more careful with the material loss during changes. The employee are scheduled to take turn having a lunch break so that the production line can continue. Another improvement point is to involve cycle time and customer delivery due date when releasing the production plan.

The 3rd scheme of improvement concentrates on how to improve the supply chain management (SCM). Using the ABC analysis, the findings shows that the warehouse is overloaded with dead and slow stock. Warehouse space usage is not efficient. 5S technique (Sort, Set in order, Shine, Standardize, and Sustain) is applied to tackle the problem. The dead and slow stocks are removed. The inventory shelves are rearranged according to the usage frequency, weight and moving distance. The items that are frequently used is located near the weighing room.

Table 2 shows working scope, data collection and analysis tools at a case study factory.

4.3 Productivity Improvement

Table 2. Working scope, data collection and analysis tools.

Theme	Problems	Data collection and analysis
1. Working Methods Improvement	Delays in mixing processes and long distance of material transfer	Flow process chart, Man -machine chart
2. Waste Reduction	High loss in the production line	Flow process chart, C&E diagram)
3. SCM	Inventory and warehouse management	ABC analysis and Warehouse layout

4.3.1 Employee training outcome

Employee is vital for sustainable work improvement, thus employee training is needed to enhance worker knowledge and skills. As discussed with the management and staff of the company, the topics that most appropriate to boost a labor productivity improvement and a waste reduction are quality mindset, 7 Wastes and Kaizen for continuous improvement. An in-house training is conducted with a target to cover all employees from every department. Figure 5 shows an atmosphere of the training. Table 3 shows distributions of participated employees at the case study company.

In order to measure the training outcome quantitatively, a pre-test and a post-test are conducted before and after the training. A statistical hypothesis test using a SPSS program is carried out to investigate a different between mean scores of the pre-test and post-test at the significance level of 0.05. Table 4 shows that the mean score of the pre-test and post-test are 12.74 and 16.87, respectively. The SPSS output is shown in Table 5, there is a strong evidence ($t = -23.07$, $p = 0.00 < 0.05$) showing that the training is able to improves employee knowledge in the area of quality mindset, 7 Wastes and Kaizen. For qualitative measurement, the observation during the training and a questionnaire are used. The result shows that the employee can apply the theories into practice and contribute to several proposal to improve working methods within their accountabilities

4.3.2. Working methods improvement

Figure 6. Employee training.

Table 3. Data of employees participated the training.

Item		N= 144	
		n	%
Gender	Male	35	24.3
	Female	109	75.7
Work Experience	< 3 yrs.	54	37.5
	3 - 5 yrs.	53	36.8
	> 5 yrs.	37	25.7
Department	Market	6	4.2
	Warehouse	12	8.3
	Quality control	15	10.4
	Quality assurance	1	.7
	Human resource	9	6.3
	Accounting	2	1.4
	Maintenance	4	2.8
	Production	69	47.9
	Production planning and control	14	9.7
	Research and development	12	8.3

Table 4. Pre-test and post-test mean scores

	Mean	Std. deviation	Std. error mean
Pre-test	12.74	1.99	0.16
Post-test	16.87	1.41	0.12

Table 5. A Paired t-test.

Paired differences					t	df	Sig. (2-tailed)
Mean	Std dev.	Std. error mean	95% confidence interval of the difference				
			Lower	Upper			
-4.13	2.15	0.18	-4.49	-3.78	-23.07	143.00	0.00

As stated previously that there are delays in several mixing processes and long distance of material transfer between stations. By applying the ECRS technic to eliminate delays, rearrange delivery schedule and reduce moving distances, Table 6 shows the result of pre- and post-improvement KPIs. The labor productivity is increased from a production of 6.64 kilograms/hour to 6.00 kilograms/hour, which accounted for 5.27% improvement. The cycle time for a batch production is decreased from 5.3 hours to 4.7 hours, which accounted for 38.24% improvement. Lastly, the moving distance is reduced from 251 meters to 155 meters, which accounted for 11.63% improvement.

Table 6. KPIs for labor productivity improvement.

KPIs	Pre-improvement	Post-improvement	% improvement
Labor productivity	6.64 kg/hr	6.99 kg/hr	5.27
Cycle time	5.3 hrs	4.7 hrs	38.24
Distance	251 m	155 m	11.63

The percentage of labor productivity improvement can be calculated from the equation (2).

$$\%\ \text{Labor Productivity Improvement} = \frac{(\text{labor productivty after} - \text{labor productivty before})}{\text{labor productivty before}} \text{x100\%}$$

$$\%\ \text{Labor Productivity Improvement} = \frac{(6.99\ \text{kg/hr} - 6.64\ \text{kg/hr})}{6.64\ \text{kg/hr}} \text{x100\%} = 5.27\%$$

4.3.3. Waste Reduction

Root causes of the wastes are many changes of production equipment between production stations, a long pause due to lunch break, a small batch production, and a quality mindset. After the training to improve employee mindset and an implementation of 7 Waste technic, the objective to reduce waste is achieved as shown in Table 7.

The percentage of waste reduction improvement can be calculated from the equation below:

$$\%\ \text{Loss Improvement} = \frac{(\%\ \text{loss before} - \%\ \text{loss after})}{\%\ \text{loss before}} \text{x100\%}$$

$$= \frac{(12.73\% - 1.66\%)}{12.73\%} \text{x100\%} = 86.96\%$$

The % of material loss is reduced from 12.73 kg/batch to 1.66 kg/batch, which accounted for 86.96% improvement.

Table 7. KPIs for waste reduction.

KPIs	Pre-improvement	Post-improvement	% improvement
% Loss	12.73 kg	1.66 kg	86.96

4.4. Improvement in SCM

With the problems in inventory excess in the warehouse, 5S technique (Sort, Set in order, Shine, Standardize, and Sustain) is applied to remove the dead and slow stocks and rearranged the inventory shelves with regards of the usage frequency, weight and moving distance. Table 8 demonstrates the result.

The numbers of inventories are reduced from 1,411 items to 1,113 items, which accounted for 21.21 % improvement. The moving distance is reduced form 210 meters to 170 meters, which accounted for 18.57 % improvement.

Table 8. KPIs for SCM improvement.

KPIs	Pre-improvement	Post-improvement	% improvement
No. of inventory	1,411 items	1,113 items	21.21
Distance	210 m	170 m	18.57

Supporting SMEs is one of the top priorities for Thai government to stimulate the economy and national prosperity. The remaining challenges for SMEs are (1) limited capital that affects the investment in advanced technology for manufacturing in the industry 4.0 era (2) lack of skilled labor and (3) high employee turnover rate.

Major driving policy includes (1) special economic zone for SMEs (2) border zone for special investment (3) area-based SMEs to alleviate high labor density in big cities and (4) develop skilled labor through trainings.

The similar projects funded by the government are necessary to constantly develop human capital, work and operational systems. Moreover, short-, medium- and long-term continuous monitoring schemes are required to sustain the change and strengthen competitive advantages of Thai SMEs.

5. Conclusion

The objectives of the study are accomplished with high achievement and satisfaction of the participated SMEs. The challenges and problems faced by SMEs are stated and acknowledged by the involved stakeholders. Using IE theories and technics such as Industrial method study and work measurement, ECRS, 5S, 7Waste, Inventory and Warehouse management allow the team to propose improvement processes. The labor productivity improvement, waste reduction and SCM improvement can be analyzed quantitatively and qualitatively.

Labor productivity helps not only increase the efficiency of the organization, but also can be used to evaluate employee performance and rewarding system. With proper training, the employee gain fundamental practice to work efficiently and effectively leading to higher productivity. Another key success factor is an involvement of the management team shown in this study. All eight SME owners and management teams fully supported the improvement plan and committed to the proposed implementation. One key success factor to changes and improvement is the support and commitment from the company management.

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