Journal of ENVIRONMENTAL Treatment Techniques

J. Environ. Treat. Tech. ISSN: 2309-1185

Journal weblink: http://www.jett.dormaj.com

Productivity Improvement of Carton Manufacturing Industry by Implementation of Lean Six Sigma, ECRS, Work Study, and 5S: A Case Study of ABC Co., Ltd.

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Received: 03/06/2019 Accepted: 08/09/2019 Published: 13/09/2019

Abstract

The objective of this study is to improve productivity by means of lean six sigma, ECRS, work study, and 5S in carton manufacturing industry. The study was conducted from November 2017 to August 2018 from a case study of ABC Co., Ltd. The data were collected from managers and supervisors and the problems were analyzed by brainstorming, cause and effect diagram, and pareto chart. Referring to the results, it was found that production problems occurred from a delayed process in cutting and Die-cut department, messy area in warehouse, delayed and erroneous transportation. Considering the measurement process, the measurement method could be changed from using hand to using pattern. The standard time was then reduced from 21.17 minutes per 100 pieces to 18.10 minutes per 100 pieces, accounting for 14.50 percent of improvement. The lost cutting time was caused by excess movement of worker while sitting and working. So, when the movement was changed from sitting to standing, the worker felt less exhausted and could reduce the standard time from 19.32 minutes per 100 pieces to 15.05 minutes per 100 pieces, accounting for 22.10 percent of improvement. The messy in warehouse had caused erroneous retrieval as well as delayed and erroneous transportation. Once it was improved by cleaning, classifying products and areas with sign boards, the results showed that the cost of loss was reduced from 45,900 THB per quarter to 21,600 THB per quarter, accounting for 52.94 percent of improvement. Employee satisfaction level was increased from 3.20 to 4.60, accounting for 43.75 percent of improvement.

Keywords: Brainstorming; Cause and Effect Analysis; ECRS; Lean Six Sigma; Productivity; Work Study; 5S; Continuous Improvement.

1 Introduction

Presently, productivity improvement is one of the most important to business operation and management, which can be applied in both manufacturing and service industry. Due to fierce competition in all businesses, especially in carton manufacturing industry, which is competitive in aspects of price, product quality, time delivery, and customer satisfaction, cross-border business, electronic commerce business, opening countries and trade zones in both the Eastern and Western countries have become a stimulus for business needs to be adapted to keep up with the changing business circumstances. This new knowledge-based challenge requires effective management tools to assist the organization to meet customer requirements. During the past period, the principles and theories of modern production and quality improvement were always developed.

According to high competition and rapid changing business conditions as well as bottleneck problem in cutting and die department, this study contributes recent studies by examining the productivity improvement by the application of lean six sigma, ECRS, and work study principle to reduce the work process and improve the working method, while setting up a new working area according to the principle of 5S to allow employees in the warehouse to work more easily. In addition, this study attempts to reduce transportation problems, wastes, delays and the number of errors that affect the cost of the company by continuous improvement principles which enable the company to be more competitive in the industry.

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2 Literature Review

Literature review will be gainful for advocating the model described in detail in the next section.

2.1 Productivity

A general definition of productivity is the relationship between the output generated by a production or service system and the input provided to create this output (15). Thus, productivity is defined as the efficient use of resources, e.g. labor, capital, land, materials, energy, information; in the production of various goods and services (2). In addition, higher productivity means accomplishing more with the same amount of resources or achieving higher outputs in terms of volume and quality with the same input (18). Moreover, productivity is viewed in terms of efficiency and effectiveness of work (2).

Since globalization has an effect on continuous competition in all business industry, many researchers have recommended that the definition of productivity as the ratio between output and input as well as the terms of efficiency and effectiveness resulting from the use of that resources is narrow and inappropriate view for measuring the success of the current business (10, 16). Thus, modern notion of productivity includes consideration of social and ecological costs, ability to create value for customers and stakeholders in the supply chain, ability to meet customers requirements that change over time, survival in high competition, and agility and speed in adapting to meet customer needs (10, 16).

2.2 Lean Six Sigma

Lean Six Sigma is the latest generation of improvement methodologies invented during the late 1990s and early 2000s (3). It is an integration of lean and Six Sigma methods. Lean manufacturing focuses on reducing losses but cannot reduce the process variation whereas Six Sigma can reduce the process variation but cannot reduce losses or production time (3, 20). Therefore, both concepts are applied together, called the Lean Six Sigma which aims to eliminate losses in the production process and using statistical principles to reduce variation in the production process.

A DMAIC improvement cycle is the core tool and can be used as the framework for any improvement applications. The completion of one cycle continues with the beginning of the next. A DMAIC-cycle consists of five consecutive steps or phases. First, define step (D) is intended to clearly articulate the business problem, goal, potential resources, project scope and high-level project timeline. This information is typically captured within project charter document. i.e. write down what you currently know, seek to clarify facts, set objectives, and form the project team. Second, measure step (M) aims to objectively establish current baselines as the basis for improvement. This is a data collection step, the purpose of which is to establish process performance baselines. Third, analyze step (A) aims to identify, validate and select root cause for elimination. Fourth, improve step (I) aims to identify, test and implement a solution to the problem, in part or in whole. This depends on the situation, e.g. identifying creative solutions to eliminate the key root causes in order to fix and preventing process problems. Finally, control step (C) is to embed the changes and ensure sustainability; this is sometimes referred to as making the change stick. Once the solution has solved the problem, the improvements must be standardized and sustained over time (4).

2.3 Work study

Work study is an important management tool to achieve higher productivity. It is related to human work, method of doing work and standard of performance. The survival of any organization is dependent on use of the latest technology and efficient methods of production. To improve efficiency of production, it needs effective utilization of plant, equipment and labor. This can be achieved by using work study which studies methods and evaluate the performance. It divides work into smaller elements, studies it, and rearranges it to get the same or greater efficiency at reduced cost.

International Labor Organization (ILO) defines work study as the technique of method study and work measurement employed to ensure the best possible use of human and material resources in carrying out a specified activity. It is also a management service based on method study and work measurement used in examination of human work leading to investigation of all the resources that affect efficiency and economy of situation in order to bring about improvement. Further, ILO states that work study is aimed to minimize cost either by designing the work for high productivity or by improving productivity in existing work through improvement in current methods by reducing ineffective and wasted time (6).

2.4 ECRS

ECRS is an effective approach of the motion study technique used to improve production lines proposed by Mogensen (1932). ECRS represents the four core principles. First, eliminate waste (E) found in manufacturing such as waiting time, unnecessary movement and work step. Second, combine unnecessary work steps (C) to reduce the number of working steps and total processing time. Third, rearrange any process step (R) for reducing distance of moving or the number of movements. Finally, simplify (S) or propose easier method for working or introduce new equipment such as jigs, fixtures, support tools, or machine modification, to support operators.

ECRS is a common technique in motion study; thus, when any process faces with inefficient working condition related to human works, ECRS is firstly considered and gives the effective results after implementation. When ECRS is introduced to improve any process, the results include reduction in processing time and proposing efficient working steps that can reduce unnecessary movement and waiting time. The improvement from ECRS leads to reduction in system cost and energy cost while the processing time is reduced. Furthermore, material cost and waste cost are reduced when the improvements are affected to reduce material loss from inappropriate working methods (8).

2.5 Continuous Improvement

Continuous improvement can be viewed as several aspects. First, continuous improvement is as much a philosophy as a set of specific quality tools and methods. Thus, it would be seemed to be particularly important for managers to have an orientation toward process focusing on the right way

of doing things. Second, continuous improvement can be seen as generic characteristics which focuses on the value of making continuous incremental changes (5). Users emphasize on making small changes, modifying processes, and eventually creating a large cumulative effect (5). Although each small change may not have a measurable impact, the cumulative effect can be quite profound. Third, continuous improvement is viewed as improving method for both products and processes which involve employees from all positions and all departments in the company (14). The objective is to eliminate wasteful practices (17) and achieve lean production (23). Employees continuously chip away the fatty tissues of firm and create lean production processes (17). Finally, continuous improvement is a kind of meditation technique that reveals its profundity only through ceaseless repetition and change (21).

The Deming's quality cycle or PDCA-cycle is used to coordinate continuous improvement efforts. The completion of one cycle continues with the beginning of the next. A PDCA-cycle consists of four consecutive steps or phases. First, plan phase (P) is an analysis of what requires to be improved by taking into consideration areas that hold opportunities for change, e.g. decision on what should be changed. Second, do step (D) is an implementation of the changes that are decided on in the Plan step. Third, check phase (C) is a control and measurement of processes and products in accordance to changes made in previous steps and in accordance with policy, goals and requirements on products. Lastly, act step (A) is an adoption or reaction to the changes or running the PDCA-cycle through again, keeping improvement on-going (4).

2.6 5S Practices

The 5S practice begins each programme of improvement. It is the tool for helping the analysis of processes running on the workplace. The 5S is the methodology of creation and maintaining well organized, clean, highly effective and high quality workplace. Its result is the effective organization of the workplace, reduction of work's environment, elimination of losses connected with failures and breaks, improvement of the quality and safety of work (7). The philosophy of the 5S has its roots in Japan developed by Osada in the early 1980s (9). The name 5S is the abbreviation of five Japanese words including Seri, Seiton, Seiso, Seiketsu, and Shitsuke.

First, Seri (sort) is aimed to sort, organize the workplace, and eliminate unnecessary materials. Through the suitable sorting, it can identify the materials, tools, equipment and necessary information for realization the tasks. Sorting eliminates the waste material (raw materials and materials), nonconforming products, and damaged tools. It helps to maintain the clean workplace and improves the efficiency of searching and receiving things, shortening the time of running the operation. Second, Seiton (set in order) aims to visualize of the workplace and place for everything (e.g. painting the floor helps to identify the places of storage of each material or transport ways, drawing out the shapes of tools makes it possible for the quick putting aside them on the constant places, colored labels permit to identify the material, spare parts or documents etc.). It should execute the segregation of things and mark the places of their storing. Third, Seiso (shine) aims to clean and remove wastes or dust. Regular cleaning permits to identify and to eliminate sources of disordering and to maintain the clean workplaces. During cleaning, it checks the cleanness of machine, workplace and floor, tightness of equipment, cleanness of lines, pipes, sources of light, current data, legibility and comprehensibility of delivered information, etc. Indispensable is the taking care of and maintenance of personal tidiness of the operator. Next, Seiketsu (standardize) aims to be constant place for things, constant rules of organization, storage and keeping cleanness. Worked out and implemented standards in the form of procedures and instructions permit to keep the order on the workplaces. Standards should be very communicative, clear and easy to understand. Regarding this during preparation and improving, it should involve all participants of the process on the given workplace; it means direct workers. The group knows the best specificity of its own activities, and process of elaboration and after that, usage gives them possibility of understanding the essence and each aspect of the operation. In the aim of assuring all the easy access, obligatory standards should be found in constant and visible places. Finally, Shitsuke (sustain) aims to be automatic realization of the above-mentioned rules (19).

Implementing the idea of the 5S will demand from workers the compact self-discipline connected with implementing and obeying the rules of regularity in cleaning and sorting. It leads to increasing the consciousness of employees, and decreasing the number of non-conforming products and processes, improvements in the internal communication, and through this to improvement in the human relations.

3 Research Methodology

The objective of this study is to improve productivity in carton manufacturing industry. The study was conducted from November 2017 to August 2018 from a case study of ABC Co., Ltd. The data were collected from the managers and supervisors and the problems were analyzed by brainstorming, cause and effect diagram, and pareto chart. The current productivity is measured by the ratio between current output divided by current input. After measuring current productivity, the analyzed and improved process were developed by using by means of lean six sigma, ECRS, work study, and 5S. Next, the productivity after improvement was measured by the ratio between output after improvement, divided by input after improvement. Meanwhile, productivity growth was calculated by the ratio between the difference of productivity after improvement and current productivity, divided by current productivity. In addition, employee satisfaction was assessed by questionnaires (5 is extremely satisfied and 1 is extremely dissatisfied). Descriptive statistic was used to analyze employee satisfaction data.

$$\text{Current Productivity} = \frac{\text{Current Output}}{\text{Current Input}}$$

$$\text{Productivity after improvement} = \frac{\text{Output after improvement}}{\text{Input after improvement}}$$

$$\text{Productivity Growth} = \frac{(\text{Productivity after improvement} - \text{Current Productivity})}{\text{Current Productivity}}$$

4 Results and Findings

4.1 Results from brainstorming and cause and effect diagram

Based on the participation and observation study together with brainstorming with managers, supervisors, and relevant employees, the results found that the major product and large order quantity is the carton sizing of 15x12x43.5 centimeter. Thus, this study focuses to the process of this product composed of 6 processes including dividing/cutting, printing, die-cutting, jump/slot, sewing, and gluing. Referring to the defined problem results, it was found that production problems occurred from a delayed process in cutting and die-cut department, messy area in warehouse, delayed and erroneous transportation.

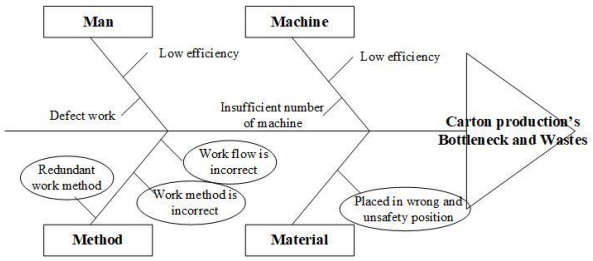

Figure 1: Results from Brainstorming and Cause and Effect Diagram

4.2 Results of improvement in cutting process

Cutting process is the first process of carton manufacturing process. Step of cutting process begins with preparing raw material (large paper), followed by setting up cutting machine, picking up paper and inserting it to cutting machine, cutting paper, measuring size of paper, and transporting to next process. Based on work study, the results presented that there are many pieces of work in process in measurement phase as operators measure all paper by hand using measuring tape. The operators informed that there are many defects if they pass cut paper to next process without inspecting size of paper. ECRS is implemented by simplifying measurement process. Considering measurement process, the measurement method could be changed from using hand to using pattern. The standard time was then reduced from 21.17 minutes per 100 pieces to 18.10 minutes per 100 pieces, accounting for 14.50 percent of improvement.

Figure 2: Current Measurement Method

Figure 3: Improvement Measurement Method

4.3 Results of improvement in die-cut process

Die-cut process is similar to sewing process; however, production time per one piece is significantly slower. Based on work study and interview with three operators, the results found that the lost cutting time was caused by excess movement of worker while sitting and working. So, when the movement was changed from sitting to standing, the worker felt less exhausted and could reduce the standard time from 19.32 minutes per 100 pieces to 15.05 minutes per 100 pieces, accounting for 22.10 percent of improvement.

Figure 4: Current Method of Die-Cut Process

Figure 5: Improvement Method of Die-Cut Process

4.4 Results of improvement in warehouse area

The initial process before cutting process is receiving raw paper crates from the supplier and then transporting raw paper crates from the truck to warehouse area by forklift. After work study, the results presented that raw paper crates located in wrong position, messy and unsafety resulted in delayed and erroneous transportation to the cutting department.

4.4.1 Results of improvement in warehouse area using 5S Practice

First, Seri (sort) was implemented by sorting necessary, unnecessary and empty pallet. Then, unnecessary and empty pallet were moved or eliminated from the way of transportation. Second, Seiton (set in order) was implemented by keeping the pallet according to the frequent and important usage. Written and hanged labels were provided to reduce errors and easy to utilize. Third, Seiso (shine) was implemented by regular maintaining cleanliness, leading to no crumbs that cause problems in the speed and safety of the forklift as well as well sceneries in the workplace. Next, Seiketsu (standardize) was implemented by setting standard time and number of storage, scheduling and planning the storage based on standard quantity and time. Finally, Shitsuke (sustain) was implemented by maintaining the above improved systems, communicating and announcing to all employees that 5S is essential and requires collaboration from workers and the compact self-discipline connected with implementing and obeying the rules of regularity in cleaning and sorting. After applying 5S activities to improve warehouse area, the findings showed that warehouse's employee satisfaction level was increased from 3.20 to 4.60, accounting for 43.75 percent of improvement.

Figure 6: Current Warehouse Area

4.3.2 Results of improvement in warehouse area using Lean Six Sigma

Delayed and erroneous transportation is improved by Lean Six Sigma using waste elimination and DMAIC-cycle. Problem and waste in transportation were defined by using pareto chart which was collected from 270 trips within 3 months. Delayed and erroneous transportation occurred from 151 trips. Problem details are showed in figure 8 and table 1.

Measure phase was implemented by measuring loss of transportation cost. The average loss for 1 trip is equal to 300 THB. Transportation problem came from 151 trips; thus, the loss in transportation accounted for 45,300 THB. Analyze phase was implemented by brainstorming which is presented in table 2.

Figure 7: Improvement Warehouse Using 5S

Table 1: Details of Transportation Wastes

Waste/Problem Details	Number of trips	Frequency (Percentage)	Cumulative Frequency (Cumulative Percentage)
Delayed	90	58.82%	58.82%
Erroneous	36	23.53%	82.35%
Products damaged due to overlapping	27	17.65%	100.00%

Figure 9: Current Carrying Method

Improvement phase was implemented by work study, continuous improvement, and ECRS. Work study was implemented for setting standard time and specifying truck license plate as well as appropriate transportation route. ECRS was implement by rearranging the counting process and simplifying recorded document.

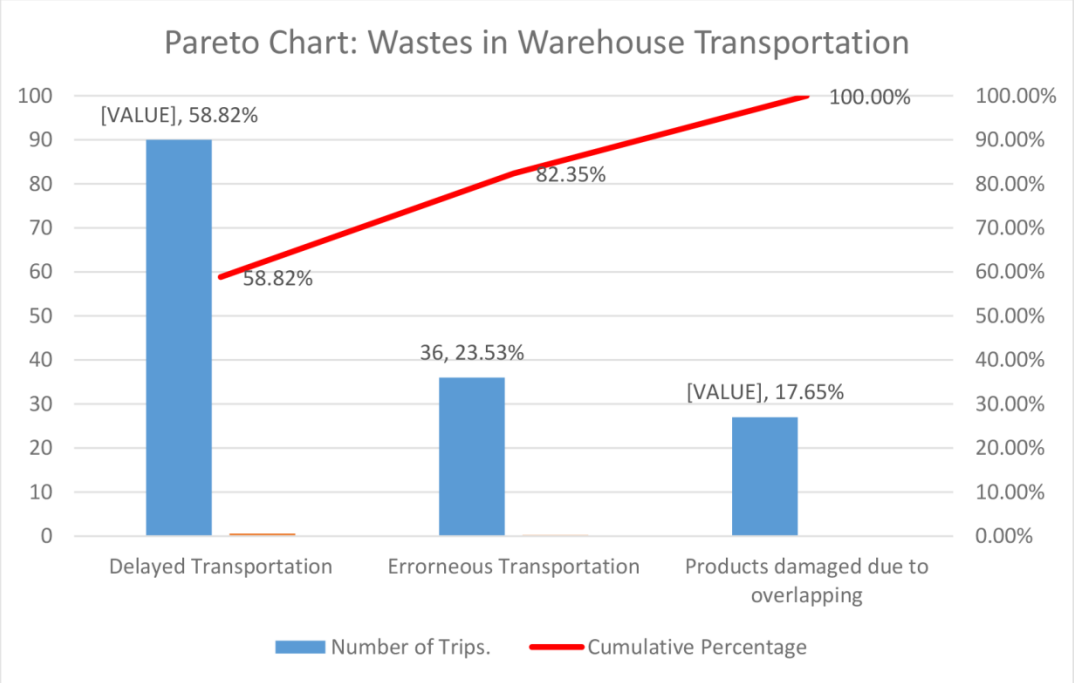

Figure 8: Defined root causes using pareto chart

Table 2: Analyzing Transportation Wastes

Wastes/Problems	Details	Targeted
Delayed	Deliver products to customers later than 30-60 minutes.	Reduce the delayed time from 30-60 minutes to 15 minutes.
Erroneous	Missing or exceeds the order quantity.	There is a control of the product quantity which is correct to order quantity. Count the number while carrying the products to truck.
Products damaged due to overlapping	The products are placed in the wrong position, placing heavy products overlapping light products.	Reduce product damage

Employees must count number of products before departure which is equal to order quantity. In addition, employees need to record number of delivered and remained products for all delivery. At the end of working day, employees must count actual quantity which is equal to remained quantity and the last recorded one Product defect was reduced by arranging the heavy weight products at the bottom, while the light weight products were always located on top. In addition, the paper was placed between the easily damaged products. After implementing improvement method, the results showed that transportation problem reduced from 151 trips to 72 trips. Thus, the loss in transportation decreased from 45,300 THB to 21,600 THB, accounting for 52.94 percent of improvement. Regarding control phase, the satisfied results motivated company to share and apply improvement concept in other remained departments as well as setting standard work instruction and guidelines for both transportation process and other remained processes.

5 Discussions and Conclusion

The purpose of this study is to reduce waste and improve productivity in carton manufacturing industry. Brain storming, cause and effect, and pareto chart were used to identify root causes of wastes, bottleneck, and problems. From the define phase results, the wastes in carton production line occurred from a delayed process in cutting and die-cut department, messy area in warehouse, delayed and erroneous transportation. Thus, work study was applied to study and improve both work method and cycle time. Measurement process is non value added; however, it is necessary process which cannot be eliminated. Thus, ECRS was implemented by simplifying measurement process using measurement pattern instead of measurement by hands, which reduced cycle time from 21.17 minutes per 100 pieces to 18.10 minutes per 100 pieces, accounting for 14.50 percent of improvement. Referring to die-cut process, it is a value-added and necessary process which cannot be ignored. Based on work study, the results showed that the lost cutting time was caused by excess movement of worker while sitting and working. Employees felt tired and fatigued because they had to bend and stretch

their arms while operating machine, resulting in frequent breaks during working hours. Thus, the movement was changed from sitting to standing, and the workers felt less exhausted and could reduce the standard time from 19.32 minutes per 100 pieces to 15.05 minutes per 100 pieces, accounting for 22.10 percent of improvement.

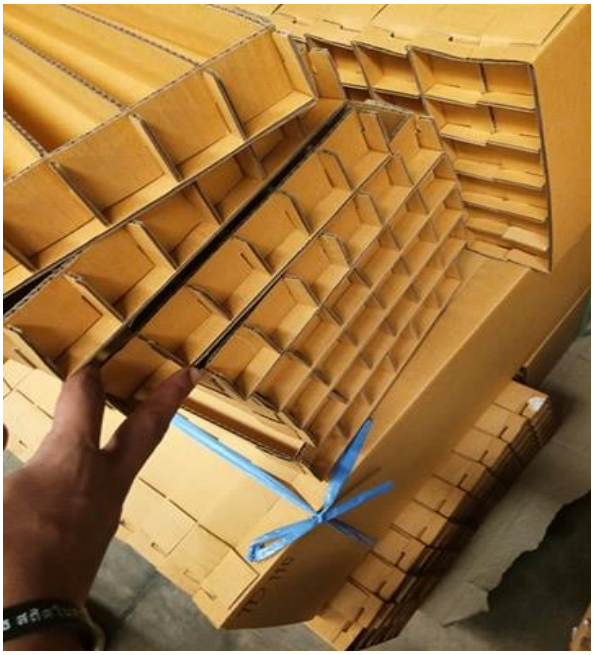

Figure 10: Light Weight on top with paper between the Easily Damaged Products

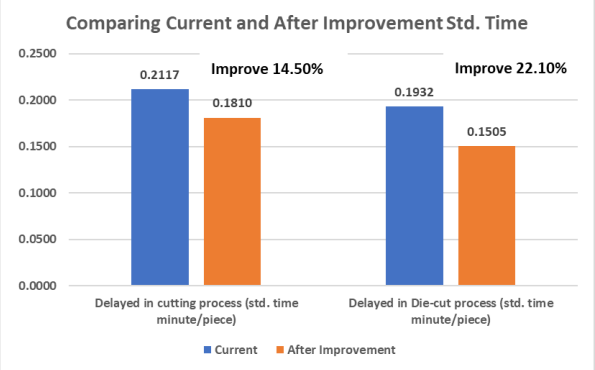

Figure 11: Standard Time

Based on cause and effect diagram, one of the delayed problems in cutting process occurred from delayed and incorrect quantity transportation from warehouse department. Raw paper crates were located in wrong position and messy area caused waste of time for searching raw paper crates and crashing among forklift and messy pallets. Therefore, 5S practice was implemented. Once it was improved by cleaning, classifying products and areas with sign boards, the results showed that employee satisfaction level was increased from 3.20 to 4.60, accounting for 43.75 percent of improvement. In addition, the number of crashing accident was significantly reduced.

Figure 12: Level of Employee Satisfaction

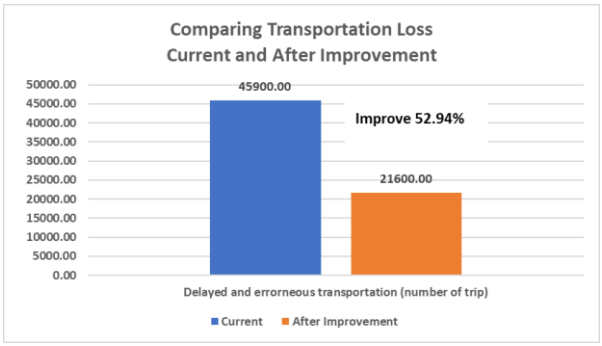

Figure 13: Transportation Loss

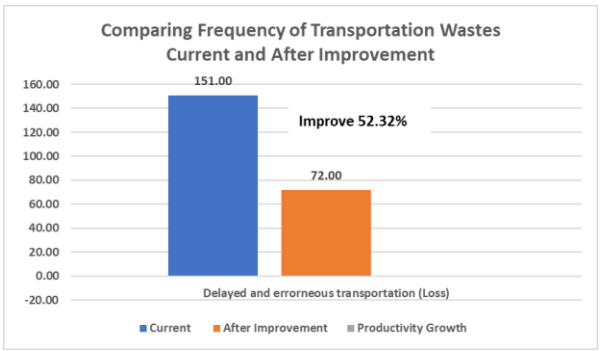

Figure 14: Frequency of Transportation Waste

Employees were familiar and inclined to work in the current method, which makes unsuccessful 5S practice. Thus, company announced and enforced 5S practice as one of the important policies. Meanwhile, managers and employees must follow them strictly, becoming a part of daily work. External customers satisfaction is the most important to successful of any business. Customers frequently feedback that company delivers incorrect quantity and defect products, which leads to both low level of customers satisfaction and high level of transportation loss. Thus, ECRS and Lean Six Sigma were applied. Rearranged counting process and simplified recorded document assisted to correct quantity. Employees must count the number of products before departure which is equal to order quantity. In addition, employees need to record number

of delivered and remained products for all delivery. At the end of working day employees must count actual quantity which is equal to remained quantity and the last recorded one. Defect products occurred from compressed, scratches, and lacerates defects which are eliminated by arranging and simplifying carrying process. Employees must check and manage all shipment products. The heavy weight products are located at the bottom, while the light weight products are always located on top. In addition, the appropriate paper was placed between lays of the easily damaged products. Once it was improved by correcting quantity and reducing defects, the results showed that the cost of loss was reduced from 45,900 THB per quarter to 21,600 THB per quarter, accounting for 52.94 percent of improvement. In addition, the level of external customers satisfaction is significantly increased.

Continuous improvement is known as Kaizen in Japanese. The application of the Kaizen principles supposes a continuous communication between the manager and the employees (vertical communication) and between the employees on the same hierarchical level (horizontal communication). The application of the Kaizen principles involves no major expenses, but only more attention to details and practical ways to do things better and more efficiently. The directly productive employee is particularly encouraged so that they can suggest and make improvements (22). After a detailed analysis, the results have noticed that, even in the areas where no improvements are needed such as warehouse area, there are still plenty of possibilities to improve. A good management of human resources in the organization is one of the strategic objectives of the organization which should be clearly defined and accepted by all members. The continuous improvement principles are the resistance structure that should be built on, so that we can get to a continuous and step by step improvement of the company performance. Problems should not be connected to employees because blaming employees does not solve the problem. Problem solving should use feed-back techniques.

The results demonstrated that the implementation of 5S, work study, ECRS, Lean Six Sigma, and continuous improvement techniques can be applied in small scale industry. These techniques involve with Toyota Production System (TPS) which focuses on the active involvement of all employee categories, aiming to small but continuous development. Lean manufacturing is one of the options to reduce non value-added activity (wastes) and improve operational efficiency of the organization. The efficient implementation of 5S technique leads to improvement in environmental performance and thus primarily related to reduction of wastes in manufacturing. It promotes neatness in storage of raw material and finished products, reduction in accident, and increase of awareness and moral of employees (22). Regarding ECRS concept, all 4 principles are unnecessary to be applied at the same time depending on problem analysis and limitations of each company. The results showed that even though this study applied only three principles (eliminate, rearrange, and simplify), the improvements are in satisfactory level.

The findings demonstrated that Lean Six Sigma, ECRS, work study, Kaizen, and 5S can be seen as an effective technique that can reduce waste and improve business performance which can be applied in any industry as well as any size of company. It can be regarded as the promotion of the improvement techniques amongst the employees and as a training method for the employees. The findings demonstrated, however, that there are obstacles in the effective implementation of the improvement techniques for any improvement purpose. The most significant obstacles identified are related to depletion of communication, gap between the top management and shop floor operators and also the insufficiency of training and consciousness of this activity amongst the employees. Thus, the full advantages of the improvement techniques cannot be experienced in the business sector until all the drawbacks related with application of the improvement techniques are recognized, completely comprehended and addressed. Continuous evaluation in all levels of firms is one major driver to change the improvement culture of the company. This evaluation should be emphasized on the progress and improvement of quantity and quality of products, level of morale and satisfaction of employee, level of quantity and quality of communication, financial performance, and customer satisfaction.

6 Recommendations

There are several recommendations as followed:

6.1 Japanese management and TPS techniques require a top-down approach that becomes part of the corporate fabric. Teaching TPS techniques cannot take place in a classroom or through seminars, but where the operations actually take place. To be effective, everyone must be fully aware of the various forms that waste can take and be constantly vigilant of any opportunities to attack and eliminate these wastes. Senior executives must regularly walk through the operations, observing the activities, asking questions, and demonstrating their commitment to the process. Too often, companies treat these processes as programs that can be started and stopped as needed. They seldom give it the necessary support and time to become part of the corporate culture.

6.2 Though principle of Japanese management and TPS techniques are related to no major expenses, only more attention to details and practical ways is required to do things better and more efficiently together with continuous improvement over time. Thus, it can be applied in both manufacturing and services business. Due to the lower resource investment, it can be implemented in any company like small, medium, and large company.

6.3 There are several Japanese management and TPS techniques. This study applied some of them, i.e. Lean Six Sigma, ECRS, work study, Kaizen, and 5S, the results are satisfied. It is necessary for all businesses to analyze and select suitable tools for their situations which may be similar or dissimilar to this study, for instance just in time (JIT), lean production, six sigma, push-pull system, Jidoka, Poka Yoke, Kamban, 8 wastes, single-minute exchange of die (SMED), Hejunka, Genchi Genbutsu, visualization, respecting employees, team and suggestion system.

6.4 Though Japanese management and TPS techniques are pervasive implementation in worldwide business, European and Western management and techniques are widespread applied as well. Since European and Western management are involved with high technologies, machines,

and innovations, which require high level of investment, a business needs to calculate break event point and payback period before deciding to invest in training course for novel equipment utilization.

Acknowledgements

The author would like to express appreciation to all participants who gave priceless information, including ABC Co., Ltd., for the permissions that enabled the author to successfully carry out this study.

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