Defect Reduction With 8 Muda Concepts in The Throttle Valve Manufacturing of ABC Company

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ABSTRACT

This research aims to examine on how to reduce the defects from the production process of throttle valves used in automobile engines, using the waste reduction technique of MUDA 8, collecting data of defects from the production process, prioritization of the problems, choosing problems to solve, and analyzing the problems with fishbone diagram and rational analysis (5 why analysis).The result reveals that the problems of defective products are dent and scratch marks from residual chips, and from friction of raw materials and loading work pieces before the work piece forming process. The solution for this problem is to install automatic blow molding. Another problem concerns discoloration of the work piece, rich can be solved by changing the lubricant oil used in the pressing process. The aforementioned adjustment causes reduction in defects. Furthermore, MUDA 8 technique has earned more benefits from re-designing in the production process.

Keyword: Defect, Automobile Parts, Muda 8

Introduction

History and importance of quality improvement

From the overall economy point of view, both domestic and foreign automobile markets have changed and are growing drastically, which is accompanied by the implementation of modern technology in industrial development. As a result, there is fierce competition between manufacturers of auto-parts-for example, through providing expense forwarding services, reduction of the product's cost, and improvement of the product's quality-in order to maximize customer satisfaction.

As businesses focus on customers' demand, quality improvement is an important strategy for competition, in order to improve overall quality and to reduce the internal waste

and defects from production, and to minimize customer complaints. Continuous improvement also increases the company's profits.

When businesses deliver auto-parts to their customers, if there are defective parts or if the businesses fail to deliver the parts, the customer's production line can be affected or even have to stop production. The aforementioned problems with production quality lead to additional expenses.

Therefore, businesses must check and evaluate their production quality, in order to precisely answer customer demands, and to analyze the underlying reasons for such defective products, imperfect production processes, and general inability to match customer demands. Therefore, businesses must eliminate defects and things that do not conform to customer requirements, and improve their production process before delivering products and services to customers, in order to ensure that only better products and services will be delivered, and to reduce customer complaints against the company, and to increase the company's competitive competency with its products and services.

From historical data, the Company's defective products cause quite considerable expenses to its customers, in terms of the cost of sorting of work pieces, for instance, for the amount of over 358,501baht in April 2017.

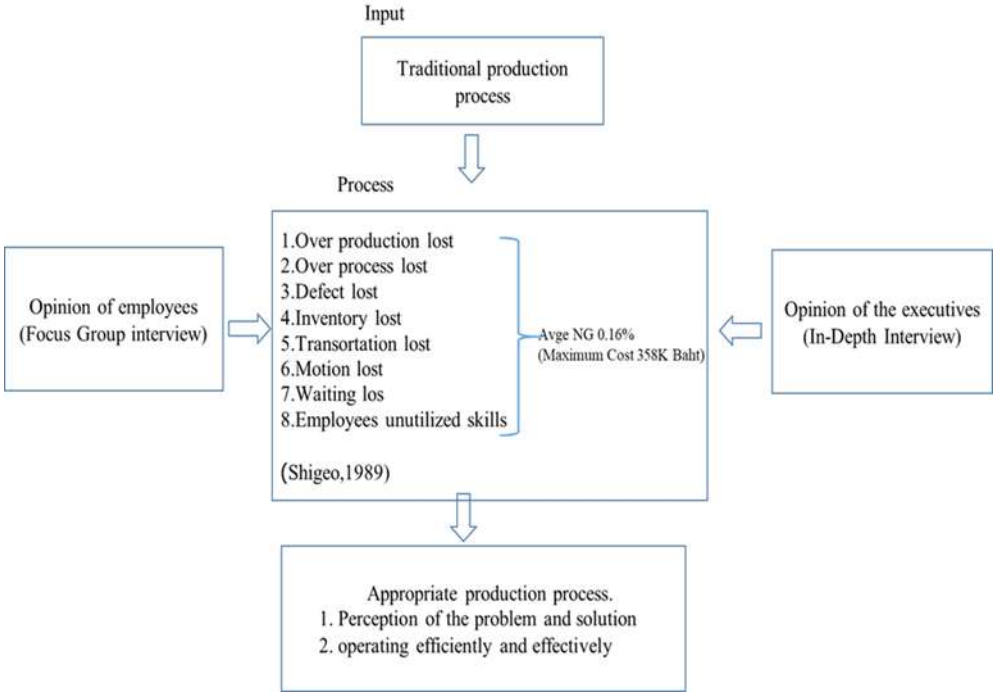
Research Objectives

1. Study the production process of the dai65 throttle valve.
2. Improve the production process of dai65throttle valve, using the concept of MUDA 8.

Research Scope

1. This research focuses on ABC Pinthong industries Co.,Ltd.,in Conburi Province.
2. This research aims to use quality control tools to reduce defects occurring in the production of TH.-V used in cars.
3. The duration of this research is from May to October of 2018.
4. This research covers the subjects of tools and machinery application, quality control theories, and comparing the pre-and post-intervention data.

Conceptual Framework



Literature Review

This research study the reducing defects and waste from the production process of butterfly (throttle) valves is related to the following concepts, theories, and research:

MUDA 8

Wastes were a non-value adding activity that do not benefit the organization or customers (Hines et al., 2008). Toyota had identified three different categories of wastes as follow (Hines et al., 2008).: Muda, Mura, Muri

Muda (Waste)

Muda has defined waste and identified the activity that did not add any value to the customer (Hines et al.,2008). Shingo, s. (1989) recognized the seven wastes form the part of lean in manufacturing. later, Liker, J. (2004) has added an eighth waste in to the Toyota handbook. MUDA or “waste” is a Japanese word. The concept of MUDA 8 stems from the Japanese word ‘Muda’, and it represents “efficiency that does not cause any loss of efficiency during operation, production, or daily life. MUDA 8 represents the foundation of loss that affects production, such as, more time is required, waste of space, poor quality, increased expense, and delayed delivery, etc. These problems affect business directly. Therefore, the operator must try to find the actual underlying cause of such waste, and the solution to solve or reduce the problem. The most important method for improving business efficiency is to

use MUDA 8 to reduce waste. In accordance with MUDA 8, the sources of ‘uselessness’ and ‘inefficiency’ are as follows (Liker, 2004):

1. Over-production loss causes additional costs, such as the cost of raw materials, insufficient storage space, additional costs of storage space for long term preservation of quality, etc.

2. Over-processing loss is caused by unnecessary or redundant processes used during the production or quality control. This problem can be solved by improving the production process and eliminating unnecessary steps during quality control or assurance, as well as eliminating wait time while the machines are working, which causes further problems, including too long production time, unnecessary expense, waste of space in the production process, and inefficient usage of machinery.

3. Defect loss is caused by over-production of waste or defects. If such defective products are mendable, the company may repair and reuse them. However, if they aren’t mendable, they will be discarded and disposed of, and become waste. Such waste causes additional costs, such as the cost of raw materials, the cost of machinery, additional expenses and the cost of labor.

4. Inventory lost concerns the loss of inventory; whereas the inventory must be sufficiently rotated, in order to make sure of a smooth production process or sale. However, if the inventory level is too high, it will cause problems with the business’s liquidity. As increased inventory incurs more expense for storage facilities, as well as other problems, including insufficient storage space, outdated defective products, problems of loss or theft, as well as loss of opportunity for investing the company’s resources in other business objectives. On the other hand, an inventory level that is too low will not be able to match customer demands. As a result, the customer may have to stop his production line, and such stoppage will cause further damage to the production line. The company may ultimately lose the customer.

5. Transportation loss is caused by over-use of transportation or unnecessary movement of products and materials, or a longer distance between various departments; which lead to additional unnecessary expenses and costs, delays in the important production process, too long wait times, and the problem of inconsistent production time and actual time of delivery.

6. Motion loss concerns waste occurring from movement, such as the movement and transferring of workpieces during the production process that isn’t worth the effort. Motion loss can be caused from placing raw materials too far apart from each other or from the

production process, and thus require the operator to move around too frequently or to reach over a long distance. Motion loss can be caused from inappropriate gestures, which in turn increase work fatigue and even lead to further problems, such as accidents, stress, fatigue, waste of time and labor.

7. Waiting loss concerns the waste from spending too much time waiting. Waiting loss causes imbalanced flow of the operation, where subsequent processes have to wait longer for the previous process to complete. Waiting loss can even damage the machinery, or cause further waste as the employees may not be present at the point of raw material processing.

8. Employees underutilized skills; This type of loss occurs as a result of the business's inability to use qualified and skillful personnel properly, and the employee has no opportunity to use his skills. Therefore, the human resource management aims to increase personnel capability, motivate the workforce, maintain employee skills, and allow employees who have high capability to use it to work for the organization.

Quality Tools

Deming has created his philosophy by fourteen points in his book, Out of the Crisis (Deming, 2000).

1. Create constancy of purpose for improvement of product and service.
2. Adopt the new philosophy.
3. Cease dependence on mass inspection.
4. End the practice of awarding business on the basis of price tag alone.
5. Improve constantly and forever the system of production and service.
6. Institute training. On-the-job training must be provided for all employees.
7. Adopt and institute leadership.
8. Drive out fear.
9. Break down barriers between departments.
10. Eliminate slogans, exhortations, and targets for the work force.
11. Eliminate numerical quotas for the work force and eliminate numerical goals for people in management.
12. Remove barriers that rob people of pride of workmanship.
13. Encourage education and self-improvement for everyone.
14. Take action to accomplish the transformation.

In 1951, Dr. Joseph M. Juran has published his Quality Control Handbook. Afterward, in 1954, he contributed to quality through his original ideas on QC 7 Tools as follows: Chart

of causes and effects (cause-and-effect diagram), Pareto diagram, Graphs, Check sheet, Histogram, Scatter diagram, Control chart

Six sigma

Benjapattanapong (2015) six sigma represents a concept of business and operation excellence. Six sigma is a guideline for improving the quality of the business and operations. It is widely used in the present day as part of business development strategy. Six sigma was initially used by Motorola in 1980, as the company focused on reducing its costs and adjusting its operation, in accordance with the company's strategy.

Research Methodology

Population

The population for this research consists of 20 employees who work in the production line of throttle valve products in ABC Co., Ltd. These employees include 1 employee from the PC department, 2 employees from the QA department, 2 employees from the packing department, and 4 executives. The sample comprises 12 employees, namely 9 employees from the production line, and 1 employee each from related departments. One employee and two managers are selected from each process. From the 9 employees, 3 are selected as the participants; these employees work in the production process, including press, blank, cleaning, leveler, and inspection. The author selects 2 employees from each process, 1 assistant supervisor, and 2 top executives, as the latter control overall quality of the entire production process, and these executives also control the production directly. The author arranges a group discussion with these 12 employees, and performs in-depth interview with the 2 executives.

Personnel	Number of populations	Sample number
Production staff	20	9
PC staff	1	1
QC staff	2	1
Packing staff	2	1
Manager QC	4	2
Total	**29**	**14**

Research Questions

This qualitative research aims to investigate the production line of throttle valves, statistical method and improvement process by 8 MUDA concepts which 8 questions:

1. Daily production planning involves 8 types of loss; which spot should be improved and what is the solution for improving the problem?

2. What do you think about the receiving of production orders, inventory stocking, preparation for a production process that uses the machine as infrequently as possible; and about the raw materials preparation for the production process which involves the 8 losses: What points should be improved, and what are the guidelines for improvement?

3. Which types of the 8 Losses do you believe to be concerned with the press molding machine? Which points should be improved and what is your recommended solution for the improvement?

4. Which of the 8 types of losses do you believe to be concerned with workpiece cleaning using cleaning tools? Which points should be improved and what is your recommended method for the improvement?

5. Which of the 8 types of losses do you believe to be concerned with product packing? Which point should be improved and what is your recommended solution for the improvement?

6. Which of the 8 types of losses do you believe to be concerned with quality control? Which point should be improved and what is your recommended solution?

7. Which of the 8 losses do you believe is concerned with collecting the pallets to store at the warehouse? What points should be improved and what is your recommended solution for the problem?

8. Which of the 8 Loss types do you believe to be concerned with the rolling process? Which point should be improved and what is your recommended solution?

Research process

In this research studying the production line of throttle valves, statistical method and improvement process are described in following.

1. Current status; 1.1 Study the production process of ABC Co., Ltd. 1.2 Collect both internal and external quality-related data. 1.3 Prioritize the problems; choose the activity after analyzing the problems.

2. Set the improvement goals.; 2.1 Analyze the problems. 2.2 Set the goals. 2.3 Planning.

3. Data analysis; 3.1 Analyze the problems' causes for improvement. 3.2 Improve the plan and search for the improvement method.

4. Implement the improvement in order to achieve the given goals.

5. Review the improvement results; compare the pre-and post-update data.

6. Specify operation standards and requirements, for example, working under the given standard from the check sheet.

7. Summarize the results; compare the pre-and post-improvement data.

Current status

1. Study the production process of throttle valves (butterfly valve) of ABC Co., Ltd. A throttle valve is the main product used for a vehicle's speed control system. Studying and collecting defective throttle valve components starts from mold installation; verify specific data about brass coil raw material, and coil installation before implementing the production process.

2. Products that will be studied and improved consist of 3 groups of products, namely.; 2. 1 Throttle valves used in motorcycles. 2. 2 Throttle valves used in cars. 2. 3 Metal components.

Therefore, the author chose to improve the defects from 3 series of throttle valves, namely:

- Dai51 throttle valve.
- Dai56 throttle valve.
- Dai63 throttle valve.

These three series of throttle valve are used in automobiles (auto parts) of small to medium sized engines, pertaining to the order and priority of the raw material. These auto parts are very important, because their raw materials are quite expensive. These auto parts work by opening and closing the fuel injection, and allowing the fuel to mix with the air intake, whether while the engine is in idle mode or acceleration mode.

3. Collecting quality-related statistical data

In order to reduce the incidence of defects occurring during the production process of the butterfly throttle valve, researcher interviewed the related employees, namely, employees of the production line; and the supervisors, namely, supervisors of the production line and the manager of the production department. researcher collected quality and defect-related data from the production process from January 2018 to October 2018. Researcher's collected data represents the number of defects found from the production process in each month.

Set the improvement goals.

1. After researcher learn about each type of problem and choose a problem for improvement from the data of selected defects, in order to find the underlying root cause of the problem and thoroughly understand the cause, researcher must first prioritize the processes and then analyze such data for further improvement.

2. The goal of studying throttle valves: as researcher found that the most frequently found defect is discoloration, as mentioned earlier. Researcher set the goal to reduce this defect, and to eliminate dirtiness on the valve by changing to new type of press oil. In accordance with this goal, the targeted defect level is zero, conforming to the company's policy.

3. Operation plan

In order to reduce this defect, researcher prepared the operation plan, as depicted in Table 10, from the improvement plan for reducing the defect as much as possible, and for achieving the company's objective. The next step is to implement the plan, which starts from data collection, specifying operation procedures for the solution and the improvement, and implementing the improved production process, then collecting and comparing pre- and post-experiment data.

TH. Valve discolor process improvement		**Jan-18**				**Feb-18**				**Mar-18**				**Apr-18**			
No.	Activities	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	NG Analysis																
2	Data collection																
3	Experiments																
4	Compare NG data																
5	Conclusion																

Data analysis

Analyzing the causes of the problems

1. Analyzing the causes of the problems for further improvement

Most problems occur from multiple causes and reasons. Researcher used fishbone diagrams and why-why analysis to find these causes, by analyzing the actual data in order to

prepare the prevention plan, in accordance with the Fishbone diagram' s result, or by using the principle of 4M, namely, 1. man, 2. machinery, 3. operation method, and 4. raw material.

The result of analyzing the problem of discoloration of the throttle valve, using the fishbone diagram and the principle of 4M, reveals three main causes: Exposure to rain moisture, Exposure to oil, Dirty work piece.

2. Planning the improvement and finding improvement guidelines

In brass production, using mold pressing, after a period of time, the work piece' s color will change. This is because the raw material is exposed to press oil or humid air. This problem can be solved by installing a hot air blower directed to the press oil that is exposed to the work piece, in order to dry the work piece and to eliminate any moisture.

This independent study aims to study and improve the efficiency and effectiveness of the production process, in order to reduce defects found in the production process of butterfly throttle valves of ABC Co., Ltd., using the principle of MUDA 8.

During the production of this valve, defects occur in many steps. It is necessary to collect suggestions from the employees and related executives about the problems and solutions, and to collect data of the comparative grouping, in order to find the conclusion from the group discussion with the employees and the in-depth interview with the executives.

This study is qualitative research that uses an in- depth interview with a group discussion, data analysis, production plan, observation result, and reflection of the problems

from the production line employees, in order to gather their observations and find the solution, and to improve the production process and reduce defects. The author prepared 8 questions for interview as following:

1. Daily production planning involves 8 types of loss; which spot should be improved and what is the solution for improving the problem?

2. What do you think about the receiving of production orders, inventory stocking, preparation for a production process that uses the machine as infrequently as possible; and about the raw materials preparation for the production process which involves the 8 losses: What points should be improved, and what are the guidelines for improvement?

3. Which types of the 8 Losses do you believe to be concerned with the press molding machine? Which points should be improved and what is your recommended solution for the improvement?

4. Which of the 8 types of losses do you believe to be concerned with workpiece cleaning using cleaning tools? Which points should be improved and what is your recommended method for the improvement?

5. Which of the 8 types of losses do you believe to be concerned with product packing? Which point should be improved and what is your recommended solution for the improvement?

6. Which of the 8 types of losses do you believe to be concerned with quality control? Which point should be improved and what is your recommended solution?

7. Which of the 8 losses do you believe is concerned with collecting the pallets to store at the warehouse? What points should be improved and what is your recommended solution for the problem?

8. Which of the 8 Loss types do you believe to be concerned with the rolling process? Which point should be improved and what is your recommended solution?

The operation

The detail of the group discussion is as follows:

1. Researcher discussed with 9 employees from the production department, 1 employee from the planning department, 1 employee from the QC department, and 1 employee from the WH department about the defects occurring during each step of the production process and about a potential solution to improve such problems on group A.

2. Perform an in-depth interview with the 2 executives, in order to learn the potential solution for reducing the defects occurring in each step of the production process, and the improvement guideline on group B.

3. Researcher brought the results from the group discussion and the in-depth interview to find any similar and different findings, and then compared the findings acquired from the employees and the executive for improving and re-designing the throttle valve production on October 10th 2018.

Details of the discussion group

Details of the discussion group A (A1–A12)

Code	Department/ process	Position	Working life (Years)
A1	Planning	Leader	4
A2	WH	Leader	20
A3	Production	Assist. Manager	21
A4	Production	Leader	11

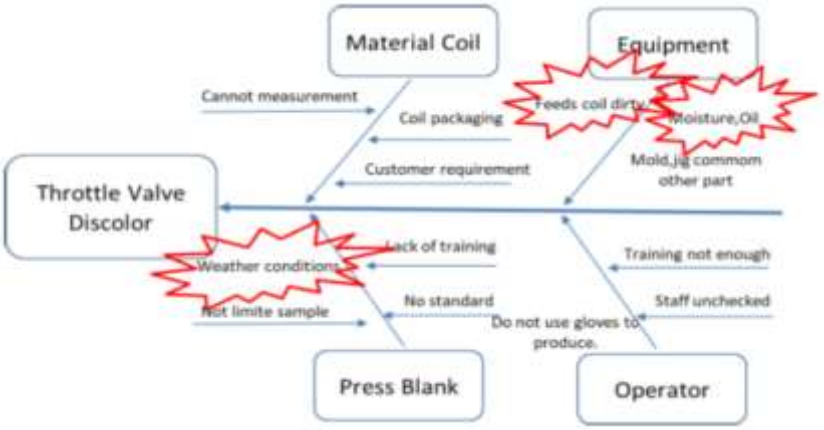
Code	Department/ process	Position	Working life (Years)
A5	Cleaning	Leader	10
A6	Flatness	Assist. Manager	7
A7	Gauge PCD	Manager	4
A8	Reviler	Staff	6
A10	Packing	Leader	11
A11	Packing	Leader	21
A12	QC	Leader	2

Details of the discussion group B (B1-B2)

Code	Department/ process	Position	Working life (Years)
B1	Production	General Manager	20
B2	Production	Senior Manager	5

Analyzing the root cause of the problems

Analyzing the root cause of the problems for further improvement. A majority of the problems may come from different causes, researcher used fishbone diagrams and why-why analysis to find these causes, by analyzing the actual data in order to prepare the prevention plan, in accordance with the Fishbone diagram's result, or by using the principle of 4M, namely, 1. man, 2. machinery, 3. operation method, and 4. raw material. analysis using the fishbone diagram.



Results and Analysis

Summary of the group discussion with A group (A1–A12) and the in-depth interview with B group (B1–B2)

Process	Employees (Group Discussion)	Executives (In-depth interview)	
	A1–A12	B1	B2
Planning	Planning must collaboratively plan the brass production with the production department	Over production; safety stock should be set at 15–20 percent of the customer's order or specification.	Overproduction will cause further problem of rusty workpieces; recommend using Kanban system
Production order	Production department must follow the production plan in order to manage the safety stock within given level	Overproduction; safety stock should be set at 15–20 percent of the customer's order or specification.	Waiting loss; recommend using continuous flow and Kaizen system
Stamping (press)	Defects from rusty workpieces or discolored brass; recommended solution is changing the press oil brand	Rusty workpiece from press oil; recommended solution is changing to new press oil; from original lubricut NB25 to AQUA press AC-9K	Motion loss; recommend solution is changing the layout
Cleaning	Cleaning progress causes most defects, whether rusty or discolored brass; recommended solution is trying several new brands of press oil to compare the results.	Failure to completely wash off the press oil; recommend changing the press oil, from original Lubricut NB25 to AQUA press AC-9K	Transportation loss causes further loss of time for delivery; recommended solution is readjusting the layout to allow continuous workflow.

Process	Employees (Group Discussion)	Executives (In-depth interview)	
	A1–A12	B1	B2
Rebeller	Defects from cleaning process; recommended solution is changing the press oil	Defects from cleaning process; recommended solution is changing the press oil (from original lubricut NB25 to aqua press AC-9K)	Defects from rolling; recommended solution is setting the input direction into the rolling machine to the same direction
Packing	Packing process involves several steps; recommend reducing unnecessary steps and increasing the amount of counting jigs, in order to make this process faster	Using highly skilled employees; recommend arranging training for the employees so they may acquire knowledge and understanding about important points	Packing process involves redundant steps, where workpiece that has been 100 percent checked is subjected to further checks. Recommended solution is canceling redundant checking where specification can be verified instead.
Inspection (QC)	Inspection (QC) time loss during quality control as the employee has to walk a long distance to check the workpieces; recommend changing the layout and placing the tools as close as possible to the checking spot	Redundant checking with the production department; recommend cancellation of checking for products with high Cp and Cpk in their specification.	Unnecessary or too frequent inspections; recommend canceling unnecessary inspections where specification can be verified, using SPC (X-bar R chart, Cp, Cpk) instead
WH	Transportation loss; recommend arranging space near the production area.	Production loss; recommend changing the schedule to 2 shifts (in the morning and in the afternoon)	Transportation loss; recommend changing the layout.

Comparison of the results from the group discussion and the in-depth interview reveals different and similar recommended solutions from the employees and the executives, as follows:

- During the planning process and production order, recommend collaborative planning between the production department and planning department, and specifying the safety stock at 10–15 percent of the customer's order.

- During the pressing process and rolling process, the underlying cause of rust is the press oil; recommend changing the press oil from lubricut NB25 to AQUA press AC-9K, which has better properties as a humidity repellent.

- During QC and WH processes, recommend changing the layout and relocating the measuring tools as close as possible to the checking spot.

Recommendations

The results can be improving the process as following:

1. Planning department employees have to; Verify the raw materials and work-in-progress before planning., Set the safety stock with related departments., Attach the plan with the production order.

2. Production department employees have to; Acquire master plan from the planning department., Issue production order and request the raw materials., Manufacture the product and record the production result on the reporting form.

3. Stamping department employees have to; Prepare the machine., Change the press oil to AQUA press AC-9k and test the production., Check the rusty workpiece and test the production., Report the test result.

4. Cleaning department employees have to; Clean the workpiece as per given work instruction. Use new oil to clean the workpiece. After cleaning, recheck the workpiece, ensure that there are no rusty workpieces.

5. Rolling machine workers have to; Specify the frequency of roller cleaning at once per hour., Specify the rolling direction (in-out)., Record the result on the daily reporting form.,

6. Packing department employees have to; Acquire the workpiece from the rolling machine., Pack the product using JIG Gauge, following the packing standard.

7. Quality control (QC) department employees have to; Randomly check the product placed on the pallet., Record the check result on the inspection data.

8. Warehouse (WH) department employees have to; Acquire and store the product., Prepare the delivery to the customer.

Acquired benefits from re-designing the production process

1. Financial benefit; any reduction of defects occurring during the production process, as described earlier, will also reduce the production cost, the cost of over-time working, and will increase the company's profit.

2. From the above table, it can be seen that reduced defects accounted for a saving of more than 7,265.63 Baht per day; and on a monthly basis, 7,265.63 x 30 equals 217,968.9 Baht per month; and on a yearly basis, 217,968.9 x 12 equals 2,615,626.80 Baht per year. This reduction in cost, when compared to the annual sales of 2017, which was 168 million Baht, accounted for over 1.56 percent reduction in the cost. It can be considered as profits gained from improving the production process of the throttle valve.

Summary of the reduced defects' financial value

Item	Improvement detail	Profit		
		Baht/ day	Baht/ month	Baht/ year
1	Reduce Manpower& Time	7,265.63	217,968.90	2,615,626.80
2	Reduce Defect Cost	7,265.63	217,968.90	2,615,626.80
Total		**14,531.26**	**435,937.80**	**5,231,253.60**

3. Non-financial benefits from the improved production process. After reducing or eliminating the defects, besides financial benefits, there are also other forms of benefits, such as the employees have the opportunity to work as a team in solving the problem, the employees enjoy better quality of life as they don't have to sort the defects that the customer returns to the company, the employees enjoy a better and safer working environment, the employees know that they are participating in solving the problem and therefore feel proud of their work, and feel that they are co-owners of the business; these benefits allow the employees to do better work. The company also gains a new method for further improving the production process, as well as a guideline for solving other problems in the future.

This research successfully creates both financial and non-financial benefits for both the employees and the company, from studying the production process in order to reduce the defects occurring during the production of throttle valves by ABC Co., Ltd. Researcher also recommends a policy for reducing defects from production of throttle valves, namely, recommending increased production quantity per lot, for example, 20,000–40,000 pieces per

lot, in order to clearly see the overall percentage of the defects, and to see if the trend is increasing or decreasing, so the data can be collected for further improvement.

Suggestions for future research

Pertaining to the objectives of this research, to reduce the defect using the concept of MUDA 8, researcher suggests that future research study standard procedures for setting a production plan that uses preliminary data from the sales department, then the planning department may plan the production collaboratively with the production department and the production engineer. This is done to solve the problem of bottlenecks in the process, that is, a process that has high cycle time which causes further waiting loss and redundant work. For the production line, researcher suggests studying the overhaul of machine layout of ABC Co., Ltd.

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