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# Production Process of Fertilizer Tank Valve of Corn Planter

Thassaphong Nanthamajcha
*Srisongkham Industrial Technology Collage, Nakhon Phanom University 48150, Thailand*

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**ABSTRACT:** The production process of fertilizer tank valve set for corn planting machine and the improvement of the production process by using process chart and fishbone diagram as tools to analyze the problems that occur. Study the solution by using the method of changing the production process. Apply the solution to improve and collect and collect data after the improvement. The statistics used for analysis are mean (X), standard deviation (SD). The results of the study found that out of the total production of 360 sets, there were three problematic production processes: material cutting process, which took 3.5 hours; the production process by CNC machine, which took the longest time, taking 33.86 hours; and the fertilizer tank welding process, which took 5.21 hours, for a total of 42.57 hours. The improvement guidelines consisted of changing the materials and cutting machines from stainless steel sheets by scissor cutting machines to stainless steel bars. The automatic band saw machine reduced the production time to 2.67 hours, the change of production process from CNC machines to single-die cutting production process reduced the time to 2.66 hours, and the improvement of the workstation according to ergonomics in the fertilizer tank welding process reduced the time to 4 hours. The improvement resulted in a total production time of 360 sets, a reduction of 78.08 percent from the original production, in which the production process with molds was able to reduce the production time the most, taking 2.66 hours from the original 33.86 hours.

**KEYWORDS:** Improving the production process/ Fertilizer tank valve set of corn planting machine products/ Production time, production cost.

## I. INTRODUCTION

The fertilizer tank valve set is a part of the stainless steel fertilizer tank of the corn planter. The corn planter is one of the main products that generates income for Machine Auto Parts Co., Ltd. It has been around for more than 8 years, produced and exported both domestically and internationally, with an average sales volume of 900 corn planters per year. Each year, the production process costs increase and there are more competitors in the market. From working in planning and improving the production process of agricultural machinery, it was found that the production process has high costs and production time. Therefore, it is necessary to find a way to improve the production process to reduce costs and production time. From studying the production process, it was found that the production of the fertilizer tank valve set is very expensive and takes too long. The fertilizer tank valve set is a part of the stainless steel fertilizer tank of the corn planter. It functions to adjust the amount of fertilizer flowing out, whether it is less or more.

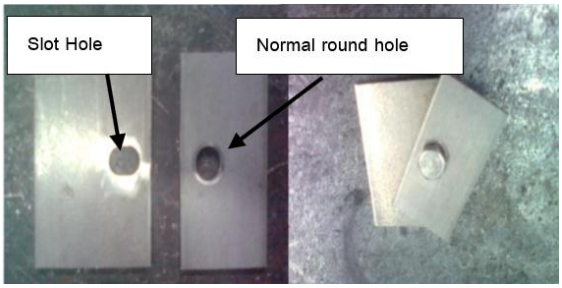


**Fig 1.1** Fertilizer tank valve used to control the amount of fertilizer being poured.

From Fig 1.1, the production process of fertilizer tank valve has 3 production steps, which are classified as follows:

1. The process of cutting materials into pieces using scissors cutting machines
2. The process of drilling holes and milling slots using CNC machines controlled by computer systems
3. The process of welding and assembling fertilizer tanks using employees to weld

From what has been said, it is believed that if we find a way to change the production process or improve the production process, it will reduce production time and production costs

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## II. Experimental Design

### 1. Study the current process

In the production of corn planting machines, it is produced in batches, in which a total of 90 machines are produced in one batch. Each corn planting machine has one fertilizer tank and in the fertilizer tank there are 4 sets of fertilizer tank lids, 4 of each (1 round hole type and 1 slot hole type). Therefore, 360 fertilizer tank lids must be produced per batch, totaling 720 units. The production process is detailed as follows.

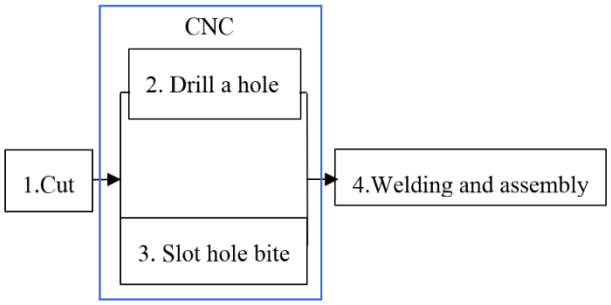


**Fig 1.2** shows the current process

### 2. Material cutting process

In the material cutting process, the material is a stainless steel sheet measuring 1.50 meters x 3 meters, 2 millimeters thick, cut by drawing a layout on the stainless steel sheet. The details of each step are as follows:

| List | Number of people | Distance (meters) | Time (minutes) | Symbols | Note |
|---|---|---|---|---|---|
| Moving stainless steel plate | 2 | 6 | 3 | | Step 1 |
| Take measurements for the slot holes | | | 15 | | |
| Draw lines on stainless steel plates | | | 30 | | |
| Take measurements for round holes | | | 12 | | |
| Draft on stainless steel sheet | | | 28 | | |
| Move up on the scissors cutter | | 1 | 5 | | Step 2 |
| Make long cuts | | | 50 | | |
| Check the workpiece | | | 2 | | |
| Make cuts into pieces | | | 58 | | |
| Check the workpiece | | | 2 | | |
| Store | | | 5 | | |
| **Sum (∑)** | 2 | 7 | 210 | 6 2 2 1 | |
| **Average ( $\bar{X}$ )** | | | 19.09 | | |

**Table 1.1** Process Chart shows the material cutting process

From Table 1.1 Process Chart of the sub-process steps in the material cutting process, it was found that there were 2 employees working, with a total of 11 steps. Of the 11 steps, 6 steps were performed: 2 steps for material movement, 2 steps for inspection, and 1 step for material storage. The total distance of movement was 7 meters. The total working time was 210 minutes or 3.5 hours, with the cutting and slicing step taking the longest time, 58 minutes. Therefore, it is necessary to improve the process.

### 3. The production process with CNC machines controlled by a computer system

In the drilling of holes with a CNC machine, there will be fixtures for holding 10 pieces of work that drill round holes at the same time and 6 pieces of work that drill slot holes at the same time at the same time, which are detailed as follows:

| List | Number of people | Distance (meters) | Time (minutes) | Symbols | Note |
|---|---|---|---|---|---|
| Open the machine door | 1 | | 0.1 | | Step 1 |
| Place the workpiece into the fixture | | 0.5 | 0.4 | | |
| Tighten the fixture screws | | | 0.3 | | |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Close the door and turn on the machine | | | 0.3 | | | | | | |
| Employee waiting for machine to work | | | 6 | | | | | | Step 2 |
| Open the machine door | | | 0,1 | | | | | | |
| Tighten the fixture screws | | | 0.3 | | | | | | |
| Remove the workpiece | | 0.5 | 0.4 | | | | | | |
| Check the workpiece | | | 0.2 | | | | | | |
| Storage of workpieces | | 0.5 | 0.1 | | | | | | |
| **Sum (∑)** | 1 | 1.5 | 8.2 | 5 | 2 | 1 | 1 | 1 | |
| **Average ( $\bar{X}$ )** | | | 0.82 | | | | | | |

**Table 1.2** Process Chart in the normal round hole drilling process

From Table 1.2 Process Chart in the process of cutting slot holes, it was found that there was 1 employee working. There were 10 steps in total. Of the 10 steps, 5 steps were performed: 2 steps for moving materials, 1 step for inspecting, 1 step for waiting for employees, and 1 step for storing materials. The total distance of the movement was 1.5 meters. The total working time was 8.2 minutes. The step where employees waited for the machine to work took the longest waiting time of 6 minutes. In one work cycle, 6 pieces of work can be held at a time. Therefore, in the total production of 360 pieces, the employee will have a total of 540 minutes or 9 hours of free time.

From Table 1.2 Process Chart in the process of drilling ordinary round holes Process Chat In the process of cutting slot holes, we can find the production time. Obtained from the cycle time of both production steps as follows:

- The cycle time of both production steps is 7.2 minutes and 8.2 minutes. The total cycle time of CNC

production is 15.4 minutes per production of 10 pieces for drilling round holes, totaling 720 pieces, and 6 pieces for milling slots, totaling 360 pieces.

- In 1 production lot, 72 sets of fixtures can be inserted for drilling round holes and 60 sets for milling slots. The total production time of the CNC production process is (72 + 60) x 15.4 = 2,032.8 minutes or 33 hours and 52 minutes.

**4. Fertilizer tank welding process**

In this fertilizer tank welding process. There are 3 sub-processes as follows:

1. Welding the nut head to the fertilizer tank cover with a normal round hole.
2. Assembling the fertilizer tank cover with a normal round hole and the fertilizer tank cover with a slot hole.
3. Welding to the fertilizer tank.

| List | Number of people | Distance (meters) | Time (minutes) | Symbols | Note |
|---|---|---|---|---|---|
| Insert the fertilizer tank cap into the fixture. | 1 | | 0.1 | | Step 1 |
| Tighten the nut | | | 0.1 | | |
| Do welding | | | 0.2 | | |
| Tighten off the nut | | | 0.1 | | |
| Sent it to be assembled with another piece of tongue | | | | | |
| Waiting for assembly | | | | | |
| **Total working time of 1 person** | | | 0.75 | | |
| Assemble with another piece of tongue | 1 | | 0.25 | | Step 2 |
| Sent to connect to fertilizer tanks | | 1 | 0.15 | | |
| Waiting for assembly | | | 0.1 | | |
| **Total working time of 2 person** | | | 0.5 | | |
| Bring the fertilizer tank from the fertilizer tank department | 1 | 1 | 0.25 | | |
| Put the fertilizer bucket up on the ground | | | 0.1 | | |

**Table 1.3** Process Chart shows the sub-processes in the process of welding and assembling fertilizer tanks in 1 lot before improvement.

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Connect the fertilizer tank cover tongue to the first fertilizer tank | | 0 | 0.33 | | | | | | |
| Connect the fertilizer tank cover tongue to the second fertilizer tank piece | | | 0.33 | | | | | | |
| Connect the fertilizer tank cover tongue to the third fertilizer tank piece | | | 0.33 | | | | | | |
| Connect the fertilizer tank cover tongue to the 4th fertilizer tank | | | 0.33 | | | | | | |
| Put the fertilizer bins together | | | 0.25 | | | | | | |
| Check | | | 0.15 | | | | | | |
| Storage of workpieces | | | 0.1 | | | | | | |
| **Total working time of 3rd person** | | | 2.17 | | | | | | |
| **Sum (∑)** | 3 | 3 | 3.42 | 10 | 4 | 2 | 1 | 2 | |
| **average ( $\bar{X}$ )** | | | 0.19 | | | | | | |

From Table 1.3, the process chart shows the sub-processes in the process of welding and assembling fertilizer tanks in 1 lot before the improvement. It was found that there were 3 employees working with a total of 18 steps. Of the 18 steps, 10 steps were performed: 4 steps for moving materials, 1 step for inspecting, 2 steps for waiting for employees, and 1 step for storing materials. The total moving distance was 3 meters. The total working time was 3.42 minutes. The production time per lot was 5 hours and 13 minutes, with a production capacity of 17.5 pieces per hour. The project team therefore studied the time by recording the time at the end of the last sub-process in welding fertilizer tanks, which was placing fertilizer tanks together. A total of 30 pieces were recorded.

## III. Results and Discussion

### 3.1 Results of the process data analysis

**Table 1.4** shows the results of the time data analysis before the process improvement.

| Order No | Production process steps | Time (hours/lot) |
|---|---|---|
| 1 | Sheet metal cutting process | 3.5 |
| 2 | Round hole drilling and slot milling process | 33.86 |
| 3 | Assembly process | 5.21 |
| **4** | **Sum ( ∑ )** | **47.57** |
| **5** | **Average ( $\bar{X}$ )** | **14.19** |

* 1 lot equals 360 sets

From Table 1.4, the sheet metal cutting process takes 3 hours and 30 minutes per lot, the drilling and slot drilling processes take 33 hours and 52 minutes per lot, and the welding process takes 5 hours and 13 minutes per lot.

**Table 1.5** shows the results of the analysis of time data after process improvement.

| Order No | Production process steps | Time (hours/lot) |
|---|---|---|
| 1 | Sheet metal cutting process | 3.5 |
| 2 | Hole punching process with mold | 33.86 |
| 3 | Assembly process | 4 |
| **4** | **Sum ( ∑ )** | **9.33** |
| **5** | **Average ( $\bar{X}$ )** | **3.11** |

The production process time can be summarized as follows:

- Sheet metal cutting process After changing the material to stainless steel bars and using a saw machine to cut 5 lines at once, the production time can be reduced to 2 hours and 40 minutes or 2.67 hours per lot, which is 23.71% less production time than the old model.

- Punching holes with a mold After changing to production with a mold, the result is that the mold takes 2 hours and 40 minutes or 2.66 hours to produce, which is a production capacity of 270 pieces per hour, which can produce 92.11% more than the CNC machine.

- After improving the production cycle, the production time is stable at 22.5 tanks per hour. increased from the original 17.5 tanks, showing that

employees' fatigue decreased by 22.22%. Pro duction cycle time was reduced to 2.65 minutes per piece, which decreased by 22.51% when production cycle time was reduced to 2.65 minutes per piece. Therefore, Producing 1 lot of 90 tanks will take a total of 238.5 minutes or 4 hours.

## VI. Conclusion

This project focuses on improving the process and production process of the fertilizer tank valve of the corn planter to reduce time and cost in the production process. Starting from the study of the production process in each work station in each process, it was found that all three processes took a lot of time and cost in total production, with an average time of 14.19 hours/lot and an average cost of 35.95 baht/piece. After that, the process and production process were improved by changing the type of material used for cutting from stainless steel sheet metal to stainless steel rods and changing the machinery used for cutting. Changing the process of drilling holes and milling slots from the original CNC machine to a mold and improving the working posture and work station according to ergonomics in the fertilizer tank welding and assembly process. After improving the new work process, the production process time and cost were reduced from the original. The average time was 3.11 hours/lot, which is 78.08 percent, and the average cost was 23.59 baht/piece, which is 34.38 percent.

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