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Improvement of Press Process Productivity in Automotive Industry

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***Abstract*: Productivity is one of the things that must be considered in a company, this is related to the capacity of production which leads to customer satisfaction. PT MDA is an automotive company that has a productivity problems in Press Department. Press Department is a place for making the sheet metal of car bodies. The productivity problem is in the 5A line with the lowest GSPH percentage of 88% and the panel front door outer RH is the lowest GSPH contributor with GSPH 506 while the target is 600, so it needs improvement. The method that can be used for this analysis is the PDCA method with a few steps, such as seeking the largest of pareto GSPH's gap, determining the number of target to be achieved, finding the root causes of low productivity, planning the improvements, making the improvements, analyzing the results and also standardizing the process with problem solving tools. From the analysis result with the PDCA method, it can be obtained that the productivity of the panel front door outer RH is low because the robot 1 and 2 getting a longer cycle time. This caused the process to not synchronous. After improvement, the productivity has increased from initial GSPH 506 strokes / hour to 604 strokes / hour from 88% to 101%, and the cycle time of robot 1 and 2 have decreased from 5.5 seconds to 4.5 seconds.**

***Keywords*: Cycle time, GSPH, PDCA, Productivity.**

1. Introduction

The core of every industrial revolution is an increase in productivity, Previous industrial revolutions had a strong impact on the "shop-floor"-level and production processes itself. [1]. PT. MDA is a company engaged in manufacturing, especially in the four-wheeled automotive industry in Indonesia. The number of four-wheeled vehicles usage is increasing every year. This is one of triggers for the acceleration of the four-wheeled automotive industry in Indonesia.

The production process of a four-wheeled vehicle requires a long process that needs and requires precision and speed in each process. Press plant is the initial part of the process of making a car body in PT. MDA, where this department is the place for making a car body that starts from a plate that is pressed so that a part of the body of the car is formed. In order to meet customer satisfaction, of course productivity must reach the target.

Low productivity in the Press Department must be improved so that production capacity increases and productivity targets are achieved. The followings are the Press Department productivity data or GSPH (Gross Stroke Per Hour) percentage data where the GSPH is the number of units produced in one hour, between lines, where there are 4 lines.

Table 1
Productivity GSPH each line

Line	Sep'18	Oct'18	Nov'18	Dec'18	Jan'19	Feb'19	Target Stroke/h	Percentage GSPH/Productivity	Productivity Target
2A	442	443	450	441	431	437	470	93%	98%
3B	480	470	475	480	482	485	480	99%	98%
4A	360	365	355	368	367	360	400	90%	98%
5A	530	532	525	535	528	533	600	88%	98%

Table 2
Productivity Target GSPH (average)

JOB	GSPH Average	Target Stroke/h	Percentage GSPH/Productivity	Productivity Target
K Series	517	600	86%	98%
W Series	562	600	94%	98%
J Series	569	600	95%	98%

Table 3
The gap of GSPH K big stroke

JOB	GSPH (Stroke/h)	Target (Stroke/h)	GAP
K4009	506	600	94
K4010	509	600	91
K4053	512	600	88
K1050	516	600	84
K4056	517	600	83
K4001	527	600	73
K3005	533	600	67

Based on the data above, the lowest productivity is job K4009 / panel front door outer RH. The job is the work process of press panel front door outer RH (the outer plate of the front right door of the car).

The research purposes are:

1. To know the main problem that causes the low productivity of panel front door outer RH.
2. To provide recommendations and improvement solutions so that the productivity of panel front door outer RH is increased and reaches the target.
3. To know the result that can be made after improvement.

2. Literature review

Productivity is defined as the relationship between output and input of a production system [2]. This relationship is commonly expressed as the ratio of output to input. If more

output could be produced with the same level of inputs, the productivity increases [3]. Likewise, if lower inputs can produce a fixed output, the productivity increases too. Productivity is the ratio between tangible output and tangible input. The Deming Cycle, or the PDCA cycle is a continuous improvement model was developed by W. Edward Deming which consists of 4 components such as [4]:

- *Plan:* The stages of identifying and analyzing the problems that happened and the factors that influenced it [5].
- *Do:* Collecting relevant data and implementing a solution and strategies for quality improvement [5].
- *Check:* Evaluating and analyzing how effective the improvement has been made [5].
- *Action:* Making a standardization of the improvement steps that have been made [5].

PDCA (Plan-Do-Check-Action) cycle, also known as quality cycle, is a general process of management model. It was originally conceived by Shewhart in 1930 [6]. The PDCA cycle is divided into four stages, as Plan, Do, Check and Action [7]. The cycle is a comprehensive four stages plan that breaks things down into more manageable tasks. The stages are not clearly separated but closely linked and repeated. After one cycle, it can solve some quality problems and improve the quality level. As a mature model, the PDCA cycle has become one of the most widely used in the market and popular in many different fields where the quality management is regarded as the core at present [8].

The core of the PDCA cycle is emphasizing optimization. By modeling the products or events, it can analyze in four stages to achieve the goal of optimization and improvement [9]. The core idea of the PDCA cycle is related to industrial engineering.

At the same time, PDCA cycle model is simple and feasible, so it can suit to many theories well. And the PDCA cycle is used in many fields, such as production, quality management, medical health and so on [10].

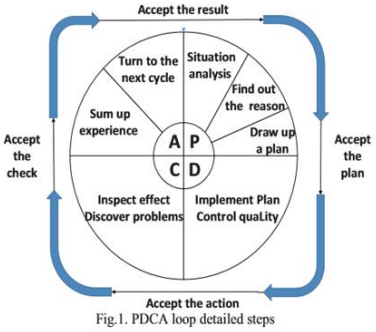


Fig. 1. PDCA loop detailed steps

Seven quality control tools are seven tools that can be used to analyze the problem. The benefits of QC seven tools are to find out the root of a problem and improve the ability of process improvement, so that it can improve competitiveness, decrease cost of quality, and increase price flexibility and increase resource productivity [11].

Here are some quality control tools which will also be used as research analysis tools.

- Check sheet
- Problem separator (Stratification)
- Histogram
- Pareto diagram (Pareto diagram)
- Fish Bone Diagram
- Scatter Diagram
- Control chart

Quality control tools above is highly recommended and must be implemented in manufacturing industry because it has many function to facilitate the analysis stage [11].

A Fishbone Diagram, also called Ishikawa Diagram was created by Kaoru Ishikawa, a quality control expert. It is known as a fishbone diagram because of its shape, similar to the side view of a fish skeleton. Fishbone Diagram was created because of the need to improve the quality of products that is produced. Frequently, in a production process it is felt that the final results not in line with expectations, for example: defective products occur more than specified, the results of sales are small, the quality of competitor's goods is better than our goods, customers prefer competitor products to ours, etc. [12].

From here comes the thought of analyzing and evaluating the processes that have occurred in order to improve quality. Fishbone Diagram is a quality control device that function is to detect problems that occur in an industrial process. The application of Fishbone Diagram is used to identify the factors that influenced it [13].

There are many factors that cause the consumer expectations are not fulfilled. Several factors can be controlled by service providers. Service providers are fully responsible for minimizing misunderstandings and misperceptions that may occur and avoid them by designing services that could be understood clearly.

In this case, the service provider must take the initiative in order to understand the instructions from the consumer, so that the service provider understands what must be given. And explain that productivity is the ratio between tangible output and tangible input. If produce more output with the same amount of inputs, the productivity increases. Likewise, if lower inputs can produce a fixed output, the productivity increases too [13].

3. Processing and result

The production area which has a large number of employees will be analyzed in this study. The chosen research area is in the production department of the press plant. This area was chosen based on the management's decision in the company, because in that area producing panel front door outer RH and having the lowest GSPH calculation and having the biggest problem occurrence rate. The object to be examined is the process of panel front door outer RH.

In the process of collecting data, primary data collection is

carried out by directly observing the production area by interviewing and directly observing the production process and operator behavior at each work station and secondary data collection obtained from the company on front door outer panel press department RH.

Data Collection: The data below is the GSPH Percentage data between lines taken from the company's historical data.

Table 4
Productivity GPSH Target each Line

Line	Sep'18	Oct'18	Nov'18	Dec'18	Jan'19	Feb'19	Target Stroke/h	Percentage GSPH/Productivity	Productivity Target
2A	442	443	450	441	431	437	470	93%	98%
3B	480	470	475	480	482	485	480	99%	98%
4A	360	365	355	368	367	360	400	90%	98%
5A	530	532	525	535	528	533	600	88%	98%

(Source: Data processing)

Table 5
Productivity GSPH (average)

JOB	GSPH Average	Target Stroke/h	Percentage GSPH/Productivity	Productivity Target
K Series	517	600	86%	98%
W Series	562	600	94%	98%
J Series	569	600	95%	98%

(Source: Data processing)

Table 6
The Gap of GSPH K series (Stroke)

JOB	GSPH (Stroke/h)	Target (Stroke/h)	GAP
K4009	506	600	94
K4010	509	600	91
K4053	512	600	88
K1050	516	600	84
K4056	517	600	83
K4001	527	600	73
K3005	533	600	67

(Source: Data processing)

Based on the data above, it could be concluded that the path with the lowest productivity is the 5A line panel roof K series K4009 with GSPH 506 and the highest gap is 94 of the target 600.

A. Calculation of capacity

Calculation of production capacity in industrial press parts is commonly referred as GSPH (Gross Stroke Per Hour), this is interpreted as the ability of a press machine to produce parts in one hour.

Table 7
Result of Calculation GSPH

Name	Total
Total Stroke	9276
DT	176
PT	850
DCT	74
GSPH	506
Target	600

(Source: Data processing)

$$GSPH = \frac{Total\ Stroke}{DT+PT+DCT} x\ 60 \text{.....pers 1}$$

$$GSPH = \frac{9271}{176+850+74} x\ 60$$

$$GSPH = \frac{9272}{1100} x\ 60$$

$$= 506\ stroke/\text{hour}$$

B. Plan

Table 8
Total Production Time

Name	Total (Minute)	Explaination
Press Time	850	Can be changed
Down Time	176	Cannot be changed
Die Change Time	74	Cannot be changed

(Source: Data processing)

Based on the components of the TPT data, the data that can be changed and derived is press time, then that must be processed and derived is the press time of K4009. Determine the number of targets to be achieved. The following is an analysis of the reduction in the target amount of time that must be achieved so that the press time and the GSPH K4009 could be increased from the initial.

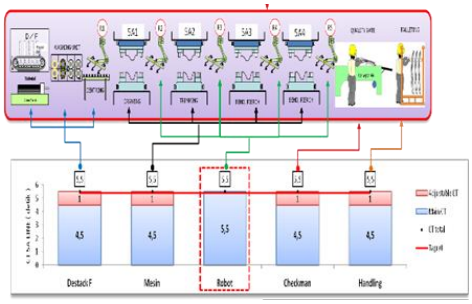


Fig. 2. Process analysis of machine / robot

From the data analysis above, in order to increase GSPH, the 5A line must reduce the cycle time of robot 1 and robot 2 by 18% from the original 5.5 seconds to 4.5 seconds.

Look for root causes that cause low productivity

In this stage we conduct an analysis to determine the causes of robot 1 and robot 2 have a longer cycle time (5.5 seconds).

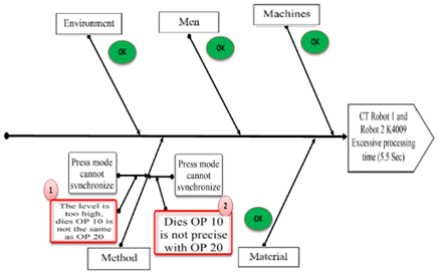


Fig. 3. Fishbone diagram of the old CT robot 1 & 2

From the analysis above, it could be concluded that the robot 1 and robot 2 K4009 have a longer cycle time caused by method factors.

Planning Improvements (5W + 1H)

Table 9
5W+1H Analysis

No	What	How	Why	Where	Who	When
1	The height level is not the same with dies OP20,OP30,OP40	Raise the cushion pin height level to 76 mm and replace the striper bolt on the OP 10 dies	Achieving the same height level dies and processes can be synchronous	Dies OP10	Team Member	March 2019
2	The position of the dies OP 10 (drawing) is not precise with dies OP20, OP30, OP40	Making precision tools on OP 20 so that the position remains center when falling on OP 20	In order to dies position the straight and precision and the process can synchronous	Dies OP20	Team Member	March 2019

(Source: Analysis results)

From the analysis above there are 2 improvement plans for the robot 1 and robot 2 K4009 cycle time problems, first is to increase the cushion pin setting to 76mm and replace the stripper bolt on OP10 dies. And second is to make the part guide on OP20. The following is an overview of the improvement plan for replacing the striper bolt on the OP10 dies and making the part guide.

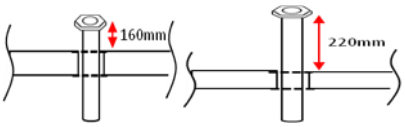


Fig. 4. Replacing the striper bolt become longer

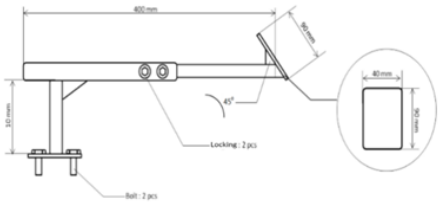


Fig. 5. Part guide design

C. Do

From the analysis there will be improvements, such as:

Increase the cushion pin setting on the OP10 dies and replace the striper bolt with a longer one.

Fig. 6. Put up cushion pin settings

Cushion pin settings are increased by 70mm from the previous machine stroke 220 to 290. Then replace the striper bolt with a longer one.

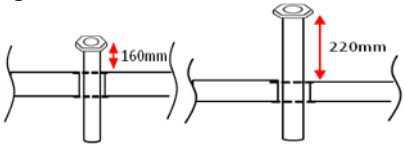


Fig. 7. Replace the longer striper bolt

Making the part guides on the OP20 dies so that the parts remain center when fall into the center of OP20 dies.

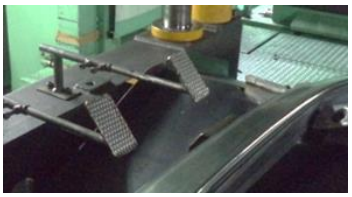


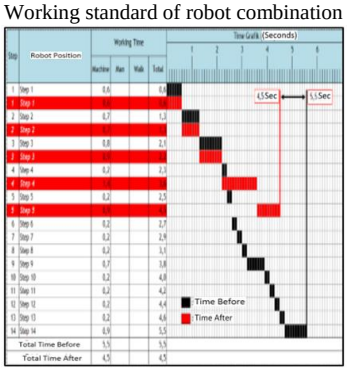
Fig. 8. Condition of OP20 dies after improvement

After improvement of the OP20 dies, the part guide is given so that the parts can fall into the center on the OP20 dies. So the process can be synchronous and the K4009 robot's processing time can be faster.

D. Check

The activity carried out in the Check step is to examine the results of the improvements that have been made. The results of improvement carried out during May 2018 are as follows:

Table 10
Working standard of robot combination



(Source: Analysis Results & Secondary Data)

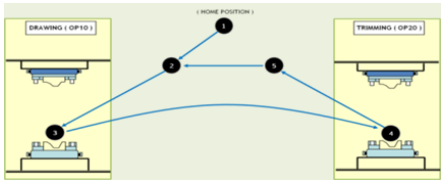


Fig. 9. Robot motion after improvement

After evaluating the timing and robotic motion before and after improvement, the cycle time of robot 1 and robot 2 K4009 decreased from 5.5 seconds to 4.5 seconds so that the productivity of panel front door outer panels RH (K4009) increased.

Table 11
GSPH after Improvement

Name	Total
Total Stroke	9276
DT	156
PT	695
DCT	70
GSPH	604
Target	600

(Source: Data processing)

$$GSPH = \frac{Total\ Stroke}{DT+PT+DCT}\ x\ 60 \text{.....pers 2}$$

$$GSPH = \frac{9271}{156+695+70}\ x\ 60$$

$$GSPH = \frac{9272}{921}\ x\ 60$$

$$= 604\ stroke/\text{hour}$$

Based on the graph and description above, it can be seen that the results of the analysis of GSPH and cycle time before and after the improvement run into a good progress, it is capable to achieve the target. The GSPH 600 target results show an increase from 506 to 604. The productivity of panel front door outer RH also increased from 88% to 101%.

Overtime calculation or working hours:

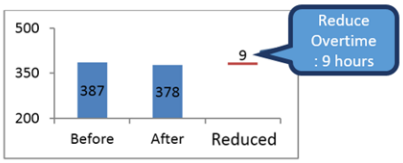


Fig. 10. Decrease overtime graphic

After improvement of the overtime, it makes savings of 9 hours in 1 month. Here is a calculation of the cost savings:

5A Line overtime savings of 9 hours => 20 TUL
Number of MP 5AL => 22 MP
Average income => IDR 8 million / month
Savings =>
=> IDR 20.346.820 per-month

So after improvement, the company can savings cost of IDR 20,346,820 per-month.

E. Action

The following is a standardization of corrective actions that have been summarized as follows:

Table 12. Standardization

No	ITEM	Standardization	KEY POINT	Document Operational	Document Prevention
1	Cushion High and stripper bolt	The process of the Fr Door Outer panel RH cushion height is 290 mm and uses stripperbolt 220	The monitor cushion shows a value of 290 mm Stripperbolt height 220 mm	PCS-II	TPM SOP
2	Precision tools OP 20	The process of the Fr Door Outer panel RH uses precision tools in OP 20	Using 2 precision tools On the inclined plane using the shutter emboss	Precision tools OP 20 SOP	TPM SOP

(Source: Analysis results)

F. Pareto analysis problems

Based on the GSPH percentage data is obtained in Chapter IV, the highest pareto is the largest gap of job K series, namely panel front door outer RH (K4009). And based on collecting and processing of Pareto data is obtained that the highest GSPH gap from K series on line 5A due to robot 1 and robot 2 have a longer cycle time. After knowing the number of causes that occur, next is to prepare the problem solving step.

G. Analysis of Cause Factors

Factors that influenced and caused low productivity cycle time of robot 1 and robot 2 in the panel front door outer RH include:

Method, which has 2 causes, namely:

1. The height level of OP10 dies was not the same as dies OP20 so that the process cannot be synchronous which causes long processing times.
2. OP10 Dies were not parallel to the OP20 dies so the process cannot be synchronous which causes long processing times.

H. Problem Management Analysis

The mitigation analysis of the productivity problems of the low front door outer RH panel using the 5W + 1H method to answer the known root causes of causal diagrams or fishbone diagrams to identify and prevent as much as possible the causes of low productivity.

I. Results of improvement analysis

After improvement the cycle time of robot 1 and robot 2, the panel front door outer RH dropped from 5.5 seconds to 4.5 seconds so the results can be achieved according to the set target of 600 strokes / hour, i.e. GSPH initially 506 units / hour to 604 units / hours in May 2018 and productivity also increased from 88% to 101%. In addition, the 5A line has an overtime savings of 9 hour / month with a total cost savings of IDR 20,346,820 per month.

4. Conclusion

After all stages of the research are carried out, the results of the study can be concluded as follows:

1. The main cause of low productivity of the low panel front door outer RH is the longer cycle time of robot 1 and robot 2 that caused by the height level of the OP10 dies is not the same as the OP20 dies. Then the OP10 dies are not parallel to OP20.
2. Improvements made to increase the productivity of panel front door outer RH with increase the cushion pin setting to 76 mm and replace the stripper bolt with a longer one on the OP10 dies and make the steering part on the OP20 dies, so the process can synchronous.

The results after improvement were made, the cycle time of robot 1 and 2 in the panel front door outer RH dropped from the previous 5.5 seconds to 4.5 seconds. The GSPH panel front door outer RH increased from the previous 506 units / hour to 604 units / hour. Productivity has increased, from 88% to 101%. In the 5A line, there are 9 hours of overtime savings per month with a total cost savings of IDR 20,346,820 per month.

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