

An Analysis of Total Productive Maintenance (TPM) using Total Production Ratio (TPR) Method on Alumuinum Die Casting Products in PT XYZ

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Abstract:- PT. XYZ is an Aluminum Die Casting company whose products used by two-wheeled and four-wheeled vehicles. PT. XYZ has a commitment to improve the company productivities and performance improvement at all aspect from effective planning, maximum production and machines’ maximum performance so it produces qualified products to achieve costumers’ satisfaction. In order to maintain the quality and productivity, a factor to be concerned is production machines’ maintenance, in this case Die Casting machines.

This research analyzes the implementation of Total Productive Maintenance (TPM) which is done by using Total Production Ratio (TPR), the result of this research is to know the success ratio in applying TPM on Die Casting machines, where at this moment maintenance of Die Casting machines at PT. XYZ is not at its maximum and average for all the machines, this can be seen at machine number 3 where its TPR value is 84,63% below standard of 85%, meanwhile for other machines their TPR values are above 90%.

This research uses data from the period of March and April, meanwhile it uses assumption for the period of May after maintenance is done to TPM system with a change in value of 10%, with this change the TPR value for each machine is increased especially for machine number 3 the value increased form 84,63% to 85,81%, therefore with such value machine number 3 has met the required standard of 85%.

Keywords:- Total Productive Maintenance (TPM), Total Production Ratio (TPR), Productivity.

I. INTRODUCTION

Maintenance is a combination of every action made to keep an item, tool, or machine and fix them until the machine or tool can be used properly. In the industrial sectors, maintenance could be defined as the action of machine maintenance or equipment manufacture to keep the failure or the machine damage. Equipment or machine is the issue often worried by maintenance and production department, because maintenance department is claimed to make a waste of costs, while the production department is claimed to make damage

but it can make money. Generally, the products produced by humans as operators so that no one is avoided from the possibility of damaged by machine operational processes, but the use of the machine can be extended by doing a good maintenance so that it can be ready to be used any time.

According to Daryus A (2008), the main purpose of having maintenance as follows:

1. To extend the usefulness of the asset.
2. To keep the quality at a level appropriate to meet what is needed by the product itself and the production is not interrupted.
3. To help reducing of consumption and keep storage out of limits and keep the money investment.
4. To achieve the level of maintenance costs as low as possible, with carrying out maintenance activities that may endanger the safety of the workers.
5. To avoid activities that may harm the safety of the workers.
6. Having a close cooperation with the other main functions of an enterprise in order to achieve the main goal of the company i.e. the best possible level of profit and the lowest total cost.

PT. XYZ is the Aluminum Die casting company that owns the 7 (seven) Die Casting machine with details as follows:

No	Machine Number	Machine Capacity
1	M #1	125 Ton
2	M #2	250 Ton
3	M #3	250 Ton
4	M #4	350 Ton
5	M #5	250 Ton
6	M #6	250 Ton
7	M #7	250 Ton

Table 1. List of Machine

The engine of the seven expected downtime $\geq 85\%$ for each machine but the actual downtime during the months of March and April 2018 retrieved data as follows:

No	Machine Number	Machine Capacity	DownTime Machine	
			March	April
1	M #1	125 Ton	6.40%	6.01%
2	M #2	250 Ton	6.63%	5.71%
3	M #3	250 Ton	19.75%	16.62%
4	M #4	350 Ton	10.03%	11.24%
5	M #5	250 Ton	10.54%	11.18%
6	M #6	250 Ton	3.17%	5.38%
7	M #7	250 Ton	4.30%	4.95%

Table 2. The period of downtime machine on March and April

From the data above, it can be seen that the biggest downtime for two months in a row is on the machine number 3. PT. XYZ receives from customers certainly based on purchase order and order of consumer goes to high and varies each month, so that if the machine damaged, it could make a long downtime and could affect the process of the production cannot be run in accordance with a predetermined plan. The company tried to innovate the production systems by applying the Total Productive Maintenance (TPM).

According to Corder (1996), TPM is not only focus on how to optimize the productivity of equipment or materials supporting work activities, but also pay attention on how to improve the productivity of the workers or operators who control the tools and materials. The problem on the productivity and the efficiency of the machine that is currently experienced by PT. XYZ caused of the high breakdown factors so that the production is no maximum. Presently, the management of PT. XYZ would like to know the effectiveness level of aluminum Die Casting machine in order to become an indicator of the success of the TPM implementation, to know the effectiveness level of the Die Casting machine, it should be measured by using Total Production Ratio (TPR) method. The objective of this research is to analyze the TPM implementation in order to know the factors that degrade of Die Casting machine. Therefore, this research is expected to give recommendation for problem solving of the high machine downtime.

II. METHODOLOGY ASSESSMENT

The method of this research describe the steps performed in order to resolve the problem; the research begins by conducting a study of the present condition and then proceeds with the study the library to find the problem as well as the expected results of this research. Flowchart of the methodology of this research looks like in Figure 1:

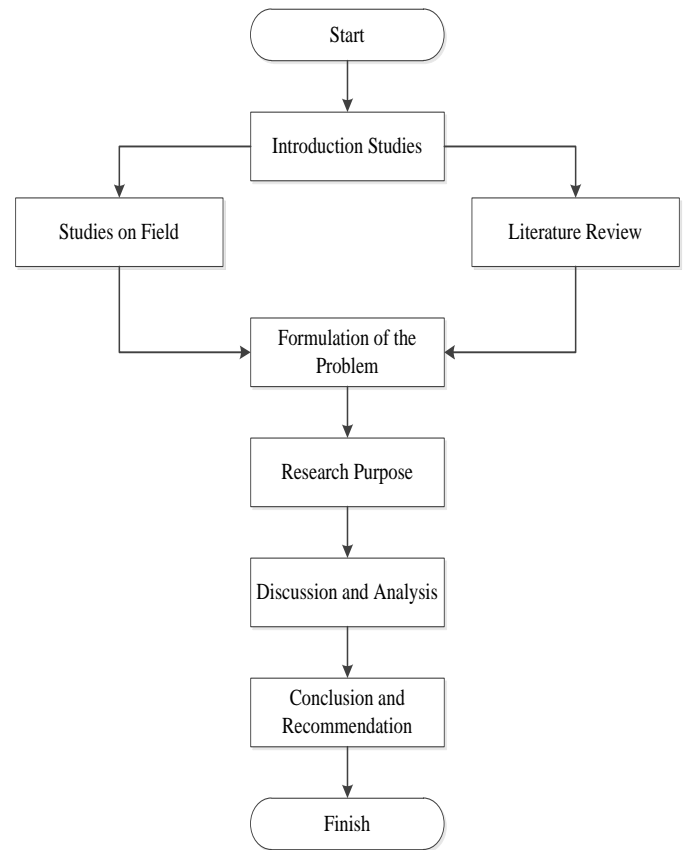


Fig 1:- Methodology Assessment

III. LITERATURE REVIEW

A. Pillars of TPM

In TPM there are eight sections are known as the eight pillars of TPM, eight of these pillars are:

1. Focused Improvement (Kaizen Kobetsu) is doing continuous improvement despite it looks small.
2. Planned Maintenance focused to increase the availability of the machine and reduce the damage of the machine.
3. Education and training trained employees in order to have the ability to perform autonomous maintenance.
4. Autonomous maintenance (Jishu Hozen) is doing the maintenance of the machine used.
5. Quality Maintenance (Hinshitsu Hozen) set the machine in order to minimize the defect so that the target for zero defects can be achieved.
6. Office TPM created an efficient office activity in order to eliminate losses.
7. Safety, Hygen & Environment (SHE) is an activity to make the work area be safe, healthy, and reduce the risk of accidents.
8. Tools management to increase the availability of equipment by reducing resetting time tools (time reset tools), reduce the cost of maintenance of the equipment, and extend the life of the equipment.

TPM pillars can be seen in the picture below:

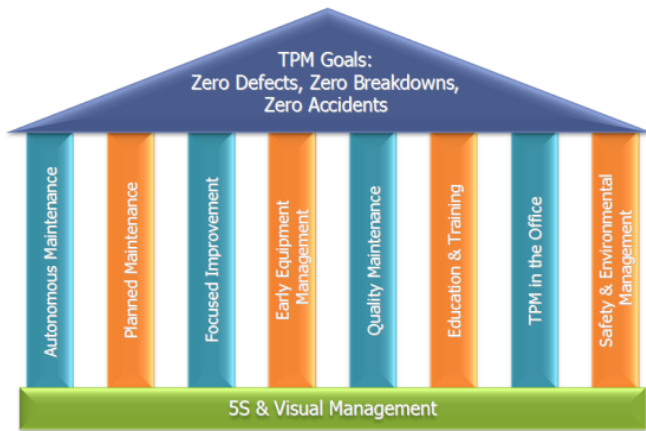


Fig 2:- The Eight pillars of TPM

B. Total Production Ratio

Total production Ratio (TPR) is a ratio that illustrates the effectiveness of the use of equipment seen from the ability of a machine or equipment to produce on demand. The TPR observed the factors constraints or performance of the machine that is how well the level of productivity and the effectiveness of the machinery and equipment used. TPR measurements easier and simpler to do when it compared to using the OEE, the TPR is used as an alternative to replacing the OEE measurement, the TPR is closely related to the OEE measurement that is used comes simplification of multiplication and the OEE measurement itself. The value of the TPR is the multiplication between the operating rate with a value of OEE, while the operating rate is a comparison between loading time and working time. For more details the calculation of the TPR are as follows (Leflar, 2001).

When in a given period of time there is downtime is planned downtime or planned by the company then the loading time will be the same as the effective working hours (working time) so that the comparison value is 1, so the PLA values the result will be the same as the value of OEE.

The value of the TPR be a benchmark the success of TPM as a replacement of the measurement of the value of the Overall Equipment Effectiveness (OEE), the ideal conditions that are used to value the TPR refers to the OEE value of 85% (Leflar, 2001).

IV. RESULT AND DISCUSSION

PT. XYZ is an aluminum die casting company located in the Millennium industrial area, which is, produced the products supplied for the purposes of making the two-wheeled motor vehicles or four wheel. Die casting machine is the main engine of the industry the company. Products produced by PT. XYZ are all aluminum engines starting from the injection, when the machine is damage; it can distract activities of production and can make delivery delays to customers. Die casting maintenance machine was the responsibility of the

Department of engineering that includes maintenance department but in daily use, for the minor treatment is the responsibility of each operator of the machine. The data of working hours required to perform the calculation of the effectiveness of the use of aluminum injection machine can be seen below:

No	Machine Number	Machine Capacity
1	M #1	125 Ton
2	M #2	250 Ton
3	M #3	250 Ton
4	M #4	350 Ton
5	M #5	250 Ton
6	M #6	250 Ton
7	M #7	250 Ton

Table 3. Work Hour

For the effective working hours of the machine with a rest period is done alternately can be seen in the table below:

No	Month	Work Hour/Month (H)	WorkHour/ Month (S)	Output/ Month pcs	CycleTime (S)
1	March	572	2,059,200	595,601	3.46
2	April	572	2,059,200	580,339	3.55

Table 4. Effective work hour of machine

The output of seventh die casting machine in the period of March and April 2018 can be seen below:

No	Month	Work Hour/Month (H)	WorkHour/ Month (S)	Output/ Month pcs	CycleTime (S)
1	March	173	622.800	595.601	1,05
2	April	173	622.800	580.339	1,07

Table 5. March and April cycle time average period in 2018

The effectiveness of the die casting machine calculation by using the method of Total Production Ratio (TPR), with examples calculation as follows:

$$TPR = \frac{\text{Total Quality Part} \times \text{Cycle Time per Part}}{\text{Scheduled Operating Time}} = 100$$

Machine	Average Output	Product Output	DownTime	Work Hour (Second)	Cycle Time (Second)	Total Production Ratio (TPR)
M#1	85.086	79.641	6,40%	1.935.355	24,30	93,99%
M#2	85.086	79.440	6,63%	1.931.075	24,31	93,78%
M#3	85.086	68.282	19,75%	1.719.593	25,18	83,51%
M#4	85.086	76.549	10,03%	1.871.428	24,45	90,88%
M#5	85.086	76.118	10,54%	1.862.860	24,47	90,47%
M#6	85.086	82.389	3,17%	1.995.944	24,23	96,93%
M#7	85.086	81.428	4,30%	1.974.313	24,25	95,88%

Tabel 6. The period of TPR Die Casting machine on March

Machine	Average Output	Product Output	DownTime	Work Hour (Second)	Cycle Time (Second)	Total Production Ratio (TPR)
M#1	82.906	77.922	6,01%	1.942.441	24,93	94,33%
M#2	82.906	78.168	5,71%	1.947.884	24,92	94,59%
M#3	82.906	69.127	16,62%	1.765.743	25,54	85,75%
M#4	82.906	73.586	11,24%	1.851.111	24,16	89,89%
M#5	82.906	73.638	11,18%	1.852.157	24,15	89,95%
M#6	82.906	78.446	5,38%	1.945.083	24,91	94,90%
M#7	82.906	78.801	4,95%	1.962.059	24,90	95,28%

Tabel 7. The period of TPR Die Casting machine on March

Based on the results of the calculation of the TPR on fifth and sixth table for the period of March and April, the value of die casting machine effectiveness on the machine 3 has an average rating of 84.63%. Those values have not

reached the prescribed target of $\geq 85\%$, where the target refers to the JIPM standard (Japan Institute of Plant Management). From the data above, we can look at the chart of the effectiveness of the TPR below.

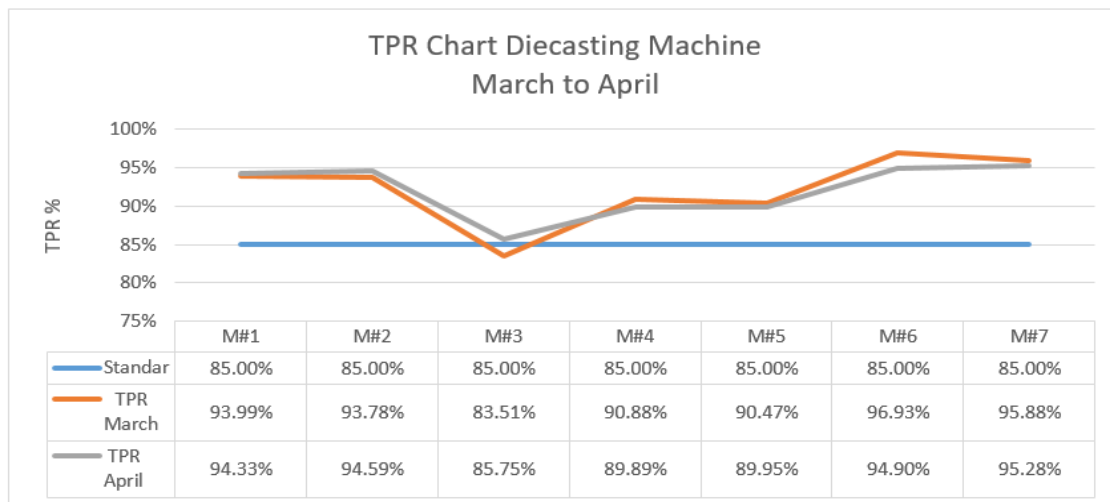


Chart 1. Chart TPR Die Casting machine period March – April

Based on the chart above, it can be analyzed about the maintenance and treatment of Die Casting machines as follows:

1. Machinenumber 3 has the lowest TPR values if compared with six other machines.
2. The TPR values average for machine number 3 on March to April is 84.63%. It is lower than the value of the

standard of $\geq 85\%$. Then the other machine has a value of $90\% > TPR$.

3. The analysis is focused to the machine number 3 whose value is lower than the prescribed standard

From the analysis, we can clarify it using the fish bone analysis to find out the cause factor that make it did not work maximally.

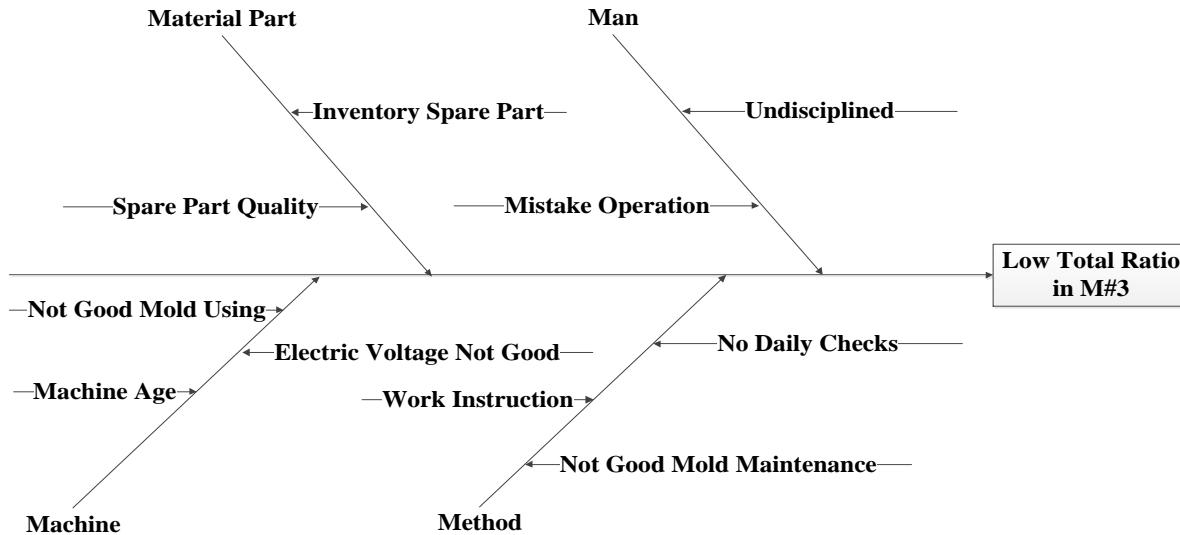


Fig 3:- Fishbone diagram to know the low level of TPR on the machine 3

Based on the fish bone diagram, there are several factors that make the machine 3Die Casting machine did not work maximally. They are described as follows.

➤ *Machine*

- The machine 3 is an old reconditioned machine so that their use cannot be maximized.
- It often occurs down up voltage that causes damage to the electrical component of the machine.
- The mold used already in bad condition, so it causes problems in the production process.

➤ *Method*

- The work instructions are incomplete so that the operator cannot simply maintain the machine.
- Daily checking does not run consistently.
- The maintenance of mold is incomplete.

➤ *Material of Spare Part*

- Sometimes it used bad quality of spare parts.

➤ *Human*

- Mistakes in operating the machine operator
- The operator is not discipline in operating the machine

➤ *Implementation of Improvements*

In the application of the TPM in a company, if the value of the TPR is still lower than the default value, it is need to be repaired in order to achieve the target. After knowing the

machine with the value of the TPR that are still lower than the standard, the maintenance department of the company should repair the system of the TPM.

The following is the proposed improvements will be made:

1. To provide the replacement of spare part routinely in order to prevent the machine damage. If damage occurs, it can be handle immediately.
2. To purchase spare parts in accordance with the prescribed specifications.
3. To provide training to the operator to perform the machine maintenance.
4. To run daily checking consistently before the machine used.
5. To complete the necessary of work instruction in the operation of the machine.
6. To maintain the mold before and after use.
7. To provide voltage stabilizer for maintaining voltage stability.
8. To make the TPR more routine for preventive the machine 3.

By suggesting the improvements, it is assumed that on May will be changed about the productivity of products amount 10% and the decrease of downtime amount 10%. The data can be seen as follows:

Machine	Average Output	Product Output	DownTime	Work Hour (Second)	Cycle Time (Second)	Total Production Ratio (TPR)
M#1	82.429	84.519	5,64%	1.949.245	23,06	94,66%
M#2	82.429	84.543	5,61%	1.949.751	23,06	94,68%

Table 8. TPR machine table after improvement on March

Continued

M#3	82.429	74.764	16,53%	1.767.080	23,64	85,81%
M#4	82.429	80.909	9,67%	1.877.625	23,21	91,18%
M#5	82.429	80.729	9,87%	1.874.183	23,22	91,02%
M#6	82.429	86.091	3,89%	1.982.178	23,02	96,26%
M#7	82.429	85.805	4,20%	1.976.109	23,03	95,96%

By increasing of products amount 10% and the decrease of downtime amount 10%, it can be seen the increase of the

machine 3 TPR machine get 85.81% from all of the TPR value average get 84.63%. There is increase of 1.19 % after making improvements. For the TPR chart can be seen below.

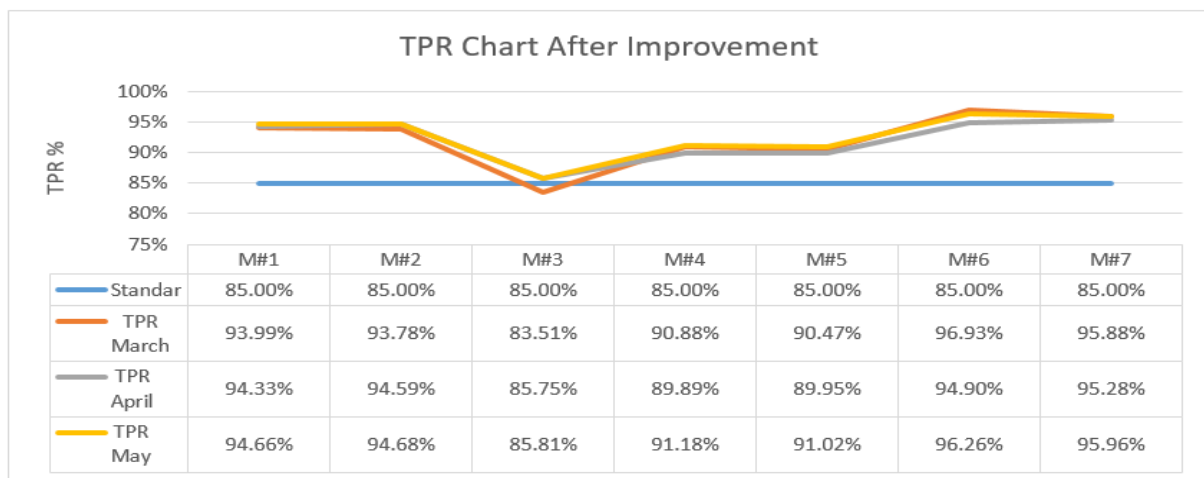


Chart 2. TPR Chart after improvement

- Based on the chart above, it can be analyzed as follows.
- The value of the TPR on the Die Casting machine after making of TPM improvement has increased and the decrease downtime machine.
- By applying the good TPM, it can increase the value of the TPR and can improve the productivity of the production on the die casting machine.

From the data result of TPM improvement of die casting machine, it can be seen that the result of 85.81 is appropriate with standard of $\geq 85\%$.

V. CONCLUSION

The analysis of the TPM by using the method of Total Production Ratio (TPR) on the die casting machine PT. XYZ can be summed up as follows:

1. Die Casting machinery maintenance systems are currently running has not been completed on all of the machines, it is seen on the TPR value of the machine 3 is lower than the other machine
2. With a low maintenance system, it can cause the decrease of the other machines. It can make the productivity of die casting machine declined

To cope the problems above, it should make some improvements to increase the TPR and the productivity of

machine. After making improvements in the system of TPM, there is increase about 10%. Therefore, it made the change of TPR value from each machine, particularly for the TPR of the machine 3 has increased from under 85% to the over 85%.

VI. SUGGESTION

PT. XYZ expected to increase and control the TPM system completely in order to maintain the productivity of machine and maintain the TPR value of each machine in accordance with the standard of the company.

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