Improving the overall equipment effectiveness (OEE) on the chicken bowl printing machine by using the theory of change perspective

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Abstract. This article discusses how to improve the overall equipment effectiveness (OEE) of the chicken bowl printing machine. OEE is important to measure machine performance in the production process. OEE will affect the costs incurred during production activities, such as product defects, how effective the performance of machines is, and how much time is available for production. The failure-tags analysis was used to identify the category factors causing engine failure. The why-why analysis was used to identify the root cause of the problem, and the theory of change was used to explain what should be implemented by the company to improve the OEE value. In 2020, only December had a value above standard by 95%, based on the Seiichi Nakajima OEE has a good value if the value >85%. The OEE values From January to May were fell from 73% to 34% and then kept increasing to 73% in November. The increase of the OEE value can be achieved by implementing a communication schedule, monitoring and evaluating the performance of maintenance staff to achieve a fast maintenance machine process, and applying maintenance rules and guidelines.

1. Introduction

Industry in Indonesia has progressed over time. Intense competition forces companies to present their advantages compared to other companies. One way that must be done is by producing output that accordance the quality and quantity with the market needs. One of the success rates of the manufacturing industry is determined by the smoothness of the production process. [1] Said that increasing productivity in production is a challenge for companies. The smooth production process will be run well if the machine in the production process runs according to the planned schedule, but unfortunately, in the production process, downtime machine is often happening and make the production stop.

To overcome the occurrence of downtime machines, various efforts have been made by the company, one of which is implementing Total Productive Maintenance (TPM) to prevent and reduce breakdown machines. [2] TPM is a philosophy that originated and was

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developed in Japan and then continues to spread and be applied throughout the world. The purpose of this research is as additional information for companies related to production, to find out the possible causes of the occurrence of machines, so the company knows what the actions needed to obtain OEE values above the standard are. In addition, this study is a continuation of knowing the OEE value of a machine using the theory of change perspective.

2. Literature Review

Total Productive Maintenance (TPM), an important approach to lean maintenance, has been widely used in the manufacturing industry since the 1950s [3]. Manufacturing as a company that makes production keeps maintaining the quality of its TPM handling to keep it above the OEE value standard. [4] explain that all manufacturers are very concerned about the maintenance strategies used in the workshop to avoid downtime because failures directly lead to reduced capacity utilization and therefore reduced productivity. The organization's primary goal is to improve efficiency, lifecycle, and productivity by maintaining better delivery times so that customer satisfaction can be guaranteed. One way to achieve this goal is to implement the concept of Total Productive Maintenance [5].

The implementation of TPM can be measured by using the OEE. OEE is the most common method for measuring production performance, especially for assessing the condition of equipment [6]. It also helps measure losses and corrective actions [7]. Today industrial companies are constantly improving their processes and increasing their efficiency to achieve higher profits [8] by maintaining the machine's performance. Machinery is a key factor in successful production, especially the ability to use production time to produce products that match quality and quantity, [9] and all of those are measured by using the OEE. Therefore, the OEE value can be an effective monitoring and evaluation tool [9].

Interventions are needed to make the machine has the OEE value above the standard. Therefore, the theory of change can be used to package several interventions to improve the OEE value of the machine. The Theory of Change describes how activities are understood and produce different outcomes that help achieve the final intended effect [10].

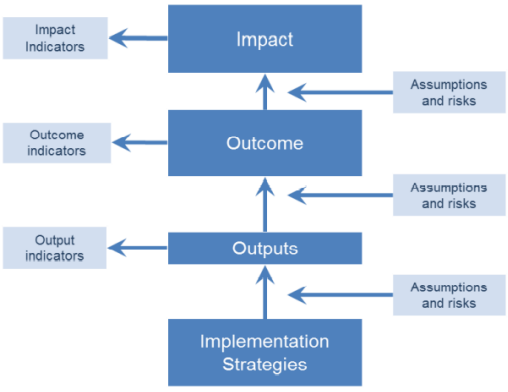

Fig. 1. The principle of the theory of change

3. Methodology

The collection of data and information was carried out in three ways, direct observation in the field, interviews, and literature study through recorded data stored by the company. Data identification and analysis were carried out to solve the problem under study. The steps taken in the data identification and analysis include:

1. F-tags analysis
2. Why-why analysis
3. The theory of change

Failure tags are systems on machines that are downtime. The downtime is caused by a malfunction of a component or a break in a circuit of the machine. Damaged components caused system failure resulting in machine downtime [11]. The Five Whys Technique helps to start at the result, reflect on what caused that, and ask the answer five times. It is a basic and often effective approach to problem-solving that promotes deep thinking by questioning and can be adapted quickly and applied to most problems [12]. The theory of change can be used for strategic planning or program to identify the current condition, the intended situation, and what needs to be done to move from one condition/situation to another condition/situation. It can help design more realistic goals and establish a common understanding of the strategies to achieve the goals. It can also be used to identify which indicators must be monitored and explained to staff [10].

4. Results

4.1 OEE value identification

The ideal condition of the engine can be determined by performing OEE calculations to see the engine performance. The OEE calculation is calculated for one year, from January to December 2020. The Chicken Bowl Printing Machine is classified as a critical unit machine, so OEE calculations must be carried out.

Table 1. OEE value of the chicken bowl 6.5 inch molding machine

Month	Availability (%)	Performance (%)	Quality Yield (%)	OEE (%)
January	98	77	97	73
February	98	85	97	81
March	98	74	95	69
April	98	69	95	64
May	98	36	95	34
June	98	51	96	48
July	96	60	99	57
August	98	60	99	59
September	85	57	100	49
Oktober	98	69	100	67
November	96	76	100	73
Desember	98	98	99	95

The results of the OEE calculation show that for almost one year, the OEE value has been below the established standard based on the Seiichi Nakajima. OEE has a good value if the value > 85%. The company must continue to make improvements to make the production activities run well. Based on table one, the main factor that causes the OEE value to be below the standard is because the performance value is below the average, so this causes the OEE value to be below the standard.

4.2 Root cause analysis of the low value of OEE

Table one shows that the cause of many below standard OEE values is because many performance values are below standard. The flow shop production process caused it. When a machine has downtime, it will cause the other machine not to work. Several elements that cause engine damage are identified in table two.

Table 2. F-tags category

No	Damage Type	F-tags category					
		BCN	OSF	UD	ISL	DW	U
1.	*V Belt on ball mill machine stiff due to exposure to water*			√			
2.	The stripper spring on the press machine lacks oil			√			
3.	wind up on the extruder machine is clogged	√		√			
4.	the oil in the print engine pulley starts to dry			√			
5.	oil on the dryer machine rail that starts to dry			√			
6.	The rubber on the press is torn	√					

Keterangan:
BCN : Basic Condition Neglect
OSF : Operating Standart not Followed
UD : Uncheck Deteriration
ISL : Inadequate Skill Level
DW : Design Weakness
UN : Unknown

The F-tag category indicates that most of the causes of damage are caused by unchecking deterioration which indicates that the check was not carried out properly. The parts that must be replaced continue to work until the damage occurs. In addition, the damage caused by basic condition neglect indicates that the maintenance of the machine is not running properly, so the damage occurs.

4.3 The root causes analysis of the long and frequent of breakdowns machine

After knowing the cause of the small value of performance that impacts the OEE value, the root cause is searched using root cause analysis tools. Based on the root cause analysis, it is known that the root cause of the pretty high downtime on critical machines is because the company pays less attention to employees in the machine repair process.

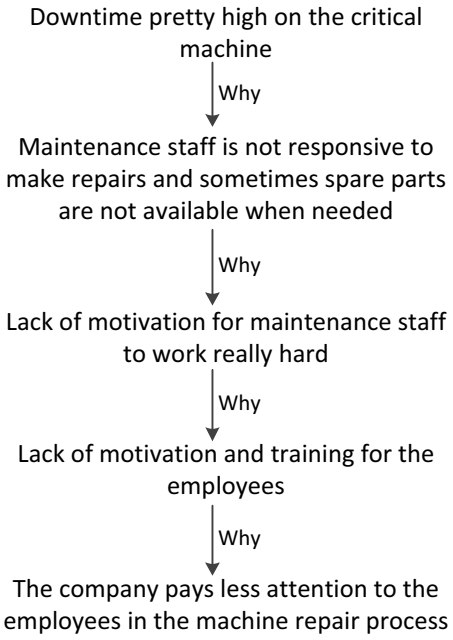

Fig. 2. Root cause analysis of downtime machine

In addition to the problems above, uncheck deterioration and basic condition neglect, which dominate the category of causing breakdown is also analyzed using root cause analysis. From the analysis results, it is known that unchecked deterioration and basic condition neglect that dominate the damage category are caused by a lack of attention and company regulations in the engine repair process.

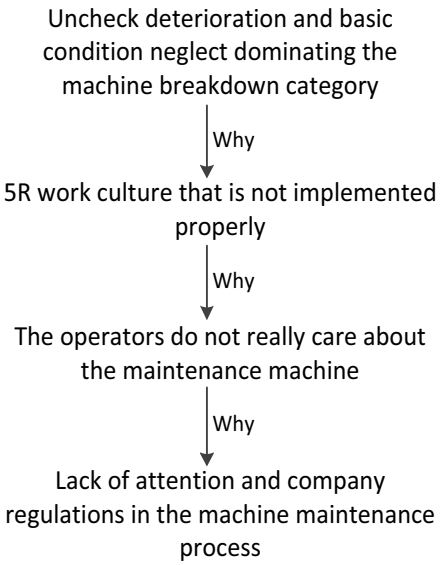

Fig. 3. Root cause analysis of uncheck deterioration and condition neglect dominating

4.4 The theory of change as an effort to increase the OEE value

To increase the OEE value to be above the standard, actions must be taken by the company in an effort for improvement. It starts with scheduling communication and monitoring and evaluating the performance of the maintenance staff. With this implementation, it is hoped that various information to improve the performance of repairing machines will be obtained so that the company will implement the improvement based on the information earned. In addition, the application of rules and engine maintenance guidelines also needs to be implemented. With the implementation of these rules, over time, the employees will get used to running the rules and guidelines for machine maintenance, so a sense of ownership will arise, making the machine more durable (long-lived) and not easily downtime.

Table 3. The theory of change

Intervention	Activities	Output	Outcome	Impact
Scheduling communication as well as monitoring and evaluation of the performance maintenance staff	Communicate with employees on the obstacles faced and monitor and evaluate in carrying out the machine repair process	Information to improve the performance of the maintenance process	Implementation of the improvement of the maintenance machine	Fast maintenance machine process
The implementation of rules and guidelines for maintenance of the machine	Posting the machine maintenance rules and guidelines in the workplace area	Employees follow the rules and guidelines of maintenance machine	Employees are used to following the rules and guidelines for maintenance machines and a sense of ownership arises over the machines being cared for	The machine becomes more durable (long life) and is not easily breakdown

5. Conclusion

To increase the OEE value of the chicken bowl machine, the company must increase the machine's performance value. It can be achieved by implementing a communication schedule and monitoring and evaluating the performance of maintenance staff to achieve a fast maintenance machine process, and applying maintenance rules and guidelines to achieve a machine that has a long life and does not easily downtime.

References

1. A. Amrussalam, P. Budi Santoso, and I. Pambudi Tama, “Pengukuran Dan Perbaikan Total Productive Maintenance (Tpm) Menggunakan Overall Equipment Effectiveness (Oee) Dan Root Cause Failure Analysis (Rcfa),” J. Eng. Manag. Industial Syst., vol. 4, no. 2, pp. 102–108 (2016)

2. R. Rahmad, P. Pratikto, and S. Wahyudi, “Penerapan Overall Equipment Effectiveness (Oee) Dalam Implementasi Total Productive Maintenance (TPM) (Studi Kasus Di Pabrik Gula PT. ‘Y’.),” J. Rekayasa Mesin, vol. 3, no. 3, pp. 431–437 (2012)
3. G. L. Tortorella, F. S. Fogliatto, P. A. Cauchick-Miguel, S. Kurnia, and D. Jurburg, "Integration of Industry 4.0 technologies into Total Productive Maintenance practices," Int. J. Prod. Econ., vol. 240, no. February, p. 108224 (2021)
4. R. Rathi, M. Singh, M. Sabique, M. Al Amin, S. Saha, and M. Hari Krishnaa, "Identification of total productive maintenance barriers in Indian manufacturing industries," Mater. Today Proc., no. xxxx (2021)
5. R. P. Mishra, G. Gupta, and A. Sharma, "Development of a Model for Total Productive Maintenance Barriers to Enhance the Life Cycle of Productive Equipment," Procedia CIRP, vol. 98, pp. 241–246 (2021)
6. T. Djatna and M. R. Ihsan, "A Fuzzy Associative Memory Modeling for Production Equipment Status Assessment," Procedia Manuf., vol. 4, no. Iess, pp. 163–167 (2015)
7. A. S. Relkar and K. N. Nandurkar, "Optimizing & analysing overall equipment effectiveness (OEE) through design of experiments (DOE)," Procedia Eng., vol. 38, pp. 2973–2980 (2012)
8. P. Dobra and J. Jósvai, "Enhance of OEE by hybrid analysis at the automotive semi-automatic assembly lines," Procedia Manuf., vol. 54, no. Det 2020, pp. 184–190 (2020)
9. S. H. Santosa, S. Irawan, and I. Ardani, "Determination of Overall Equipment Effectiveness Superflex Machine Using Fuzzy Approach," Int. J. Artif. Intell. Res., vol. 4, no. 2 (2021)
10. D. Gangloff, "Theory of change," Am. For., vol. 113, no. 3, p. 7 (2007)
11. Borris. Total Productive Maintenance. New York (US): Mc Graw-Hill Companies (2006)
12. O. Serrat, "The Five Whys Technique," Knowl. Solut., no. February 2009, pp. 307–310 (2017)