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Literature Review of the Implementation of Total Productive Maintenance (TPM) in various Industries in Indonesia

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A B S T R A C T

This research is a literature review from various journals with the theme Total Productive Maintenance which is implemented in various companies in Indonesia. The purpose of this paper is as a means of sharing and learning between companies that can be taken as a brainstorming theme related to machine performance within a company, which may not occur between companies that problems outside of the machine problem. The OEE factor of the machine is one of the parameters that is the goal which results in poor machines performance. The research method is to search journals from various sources that have keywords related to TPM. The number of journals found from 2015 to 2020 were 60 journals which were finally iterated to become 46 journals to be selected for this paper. The concept of Pareto and Root caused Analysis (4M + E) is a helpful tool in concluding the literature review in this paper, while the TPM Pillar will provide a solution guide for each problem that has been summarized in 4M + E which will be classified from each problem to be the solution of the problem. that has been found. The conclusions of this literature review are related to this new card problem which is the focus of attention. It is the result of operator changes associated with the contract system which causes this change to be properly prepared at the time the new operator works. The previous operator's method that has been good needs to be transferred to the operator that will enter. However, this is often a big gap with the preparation of this skill transfer and the fatigue factor of operators who have side jobs, with the proliferation of online-based applications causing business operators to seek additional income so that their main work is neglected.

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1. INTRODUCTION

Total Productive Maintenance is a system used to maintain and improve the quality of production through maintenance of work equipment and equipment such as machinery, equipment, and work tools. The main focus of TPM is to ensure all equipment and equipment are in the best condition so as to avoid damage or delays in the production process. This is a company strategy so that the machines and equipment used are always inefficient and effective performance so that it will reduce the impact of failure in the process in order to reduce operational costs in the company. (Ruslan & Prasmoro, 2018).

TPM originated in Japan in 1971 as a methodology for increasing machine availability and output through more efficient utilization of maintenance and production resources. The objectives and benefits of TPM according to (Agustiady & Cudney, 2016) are to increase job satisfaction in the following ways: Reduction of damage, reduced quality problems, reducing safety / environmental incidents, reducing costs, increasing throughput, competitive advantage, minimizing emergency maintenance and unplanned. Whereas the four main goals of TPM are to avoid waste in a rapidly changing environment, reduce production costs, produce low batch quantities at the earliest possible time, and goods delivered to customers must be defective.

In implementing TPM, steps need to be carried out so that it can run consistently, through its 8 pillars to provide guidance in implementing TPM. The eight pillars of TPM are as follows: Autonomous Maintenance, Planned Maintenance, Quality Maintenance, Focused Improvement, Early Equipment Management, Training and Education, Safety, Health and Environment, TPM in Administration (Amaruddin, 2020).
In addition to implementing its 8 pillars, TPM also has a key to success in minimizing losses that occur when production runs. To minimize this loss, every company needs to have reliable equipment so that the production process can run smoothly. One of the parameters of good equipment is having a good Overall Equipment Effectiveness (OEE) value (Aminah & Theresia, 2018). In this OEE calculation, the equipment parameter has 3 machines reliability parameters and has 6 losses (six big losses), namely: (1) Downtime losses, which consist of: breakdown losses/equipment failures and setup and adjustment losses, (2) Speed Loss, which consists of: idling and minor stoppage losses and reduced speed losses, (3) Defect Loss, which consists of process defects and reduced yield losses.

Total Productive Maintenance is a system used to maintain and improve product quality through the maintenance of work equipment and supplies such as machinery and equipment. The main focus of TPM is to ensure that all equipment is in the best condition to prevent damage or delays in the production process with the reason that almost all companies want to implement TPM as a whole, at least to carry out proper preventive maintenance. TPM is a type of activity required to maintain or restore equipment, machines, or systems with conditions in which it can operate to achieve maximum benefit. Maintenance is a very important part of all industries. Maintaining plant equipment increases quality and quantity. The TPM philosophy focuses on the availability and efficiency of equipment to (Atul Pandey, 2019): (i) Maximizing the use of existing facilities, (ii) Increase the output rat, (iii) Reducing production costs, (iv) Total participation of all employees from top to bottom to achieve the goal of disability and zero disability.

The main difference between TPM and other concepts is that the operator must also be involved in the maintenance process. Therefore, implementing TPM is very important to ensure that the instruments are always updated and functioning properly. The purpose of implementing TPM is to increase the overall efficiency of the machine and achieve the specified results. TPM is an innovative approach to maintenance that optimizes equipment efficiency, eliminates defects, and promotes the maintenance of autonomous operators through daily activities in the workshop. The implementation of the 8 TPM milestone is carried out in stages, including (Dandage et al., 2019): (1) 5S, (2)

Autonomous care (Jishuhozen), (3) Kobetsu-kaizen, (4) Planned maintenance, (5) Quality care, (6) Exercise, (7) TPM Office, (8) Safety, health, and environment.

Measurement of the effectiveness of machines or work equipment as measured in OEE can be identified by six big losses, namely (Frima et al., 2019): (a) Equipment failure caused by damage to equipment that requires repair, so that it will result in lost costs of good product, spare parts costs and sporadic loss (b) Set-up and adjustment occur when there are changes in an operation, such as material changes, product model changes, equipment changes, and others, (c) Idling and minor stoppages can occur due to machines process obstruction which causes the machine to stop (idle), (d) Reduces speed losses occur due to a decrease in machines speed from normal speed conditions (normal), (e) Scrap and rework is caused by a product that is not produced in accordance with the expected specifications, which requires the product to be reworked, (f) Start-up losses due to the length of time the machine starts running until it gets to a normal condition and the product meets specifications
The following is previous research on total productive maintenance described in Table 1.

2. RESEARCH METHOD

The method used in this research is to review national journals that discuss the implementation of TPM. The discussion of this study will discuss from the perspective of TPM both from Pillar and OEE in various industries in Indonesia and it is hoped that it can conclude a picture of the experiences that have been implemented to improve OEE performance in various industries in Indonesia.

The data used in this study is data in the form of problem data that results in low OEE from several Indonesian companies to be used as a guide or guide when facing the same problem as a reference for finding the root causes of problems in brainstorming. The search for the root of the problem from the point of view of 4M + E from various different industries with different root causes to form a conclusion that can be used as a review point for other industries if the same possible causes occur. This is explained in Fig. 1.

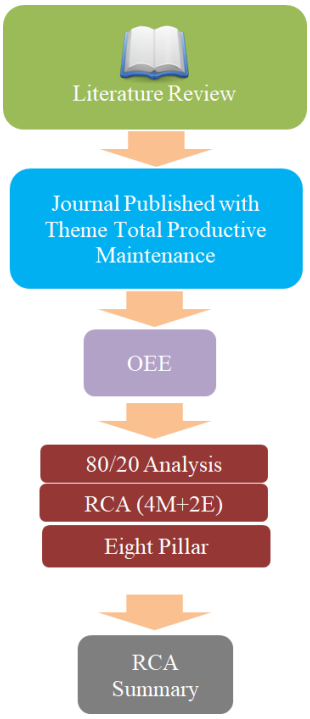

Fig. 1. Study framework

Table 1. Existing literature review of TPM implementation

No	Paper Identity	Research object	Result
1	Adhiutama et al., 2020	Aircraft Industry	In this study, the problem of defective spare parts causing delayed delivery, and the company must bear the logistics costs themselves, with autonomous maintenance OEE can increase from 7% to 57%.
2	Amaruddin, 2020	Automotive component industry	Based on the results of the analysis with a maximum value of 10, Autonomous Maintenance 4.6; Focused Improvement 7; Planned Maintenance 6.6; Quality Maintenance 6.6; Training and Education 6.5; Safety, Health and Environment 8.5; Office TPM 10, Development Management 6.6.

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
3	Aminah & Theresia, 2018	Construction Equipment Industry	This study aims to provide a proposal for a small lathe 2 machine that has a performance with an OEE value of 29%. To increase OEE on this small lathe 2 machine is to provide a special cutting tools holder for this machine and it is hoped that the tool time will not happen again and can increase OEE.
4	Anggraini et al., 2017	Animal Feed Industry	Increase OEE on press machines that have a productivity value difference of 15%, The value of Overall Equipment Effectiveness (OEE) on the press machine for the 2014 and 2015 periods experienced an increase in productivity, where the difference in the increase in the productivity value was 15.68%.
5	Anthony, 2019	Steel Industry	This study proposes improvements to the cold leveler machine to increase the current OEE by 82%. From the results of the problem analysis, it was found that the cause of the decline in machine performance was the reduced speed losses and equipment failure losses. Some of the proposals put forward focus on 3 pillars, namely autonomous maintenance, quality maintenance, training and education.
6	Apriatno, 2015	Furniture Industry	The most dominant factors for the high setup and adjustment losses and idling minor stoppage losses are the factors of machines / equipment and humans or workers who have not implemented the TPM concept. Improvement efforts to increase the value of OEE are by implementing Autonomous Maintenance in increasing the ability and involvement of operators and making standard work instructions or SOPs on operating and maintaining electroplating machines and modifying electroplating machine components.
7	Bakti & Kartika, 2019	Automotive Industry	Increase OEE value from 63%, To increase OEE on the drum test machine by making improvements to increase productivity through the TPM method, namely by improving the maintenance system to reduce the breakdown loss factor that occurs, then paying attention to maintenance / repair schedules and replacement of these components so that breakdowns can be minimized, and the availability of spare systems
8	Bastanta et al., 2018	Plantation	Increase the current steam turrbin machine OEE value by 65.08%. conduct operator training in maintaining, cleaning machines and the surrounding area. make replacement of machine spare parts with original parts. do the oil change according to the SOP is 10,000 hours.
9	Dewanti & Putra, 2019	Paper sandpaper industry	This study aims to measure the current OEE value of the sandpaper printing machine at 35.9%. Analyze the problem using a fishbone diagram. The main problem is defect losses that contribute 40% to OEE. From the causal diagram, it can be concluded that the cause of defect losses is starting from the operator not knowing the initial standard of the machine because the machine is not standardized, then there is no SOP in doing the work so that the operator relies on feeling for the set up.
10	Diniaty & Susanto, 2017	Palm oil industry	Increase the current OEE value of the Ripple mill machine 77.028%. In order for the Overall Equipment

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
			Effectiveness (OEE) value to increase, companies are advised to carry out fertilization thoroughly on company plantations, maintain the availability of raw materials by increasing the number of suppliers, provide training to farmers on how to properly care for oil palm and carry out regular watering of oil palm for meet the needs of water absorbed by oil palm. Using a rotor bar with a higher material hardness level and using a samble disc with a higher material hardness level and cleaning the machine early before the machine operates
11	Frima et al., 2019	Garment Industry	This study aims to increase OEE in single needle, single needle chain stitch, and zig zag machines which currently have low OEE values due to speed losses due to accumulation of raw materials around the workstation. , there is a decrease in the level of operator accuracy when the time is going to break and go home. Improvements are made by adding material handling equipment and cleaning regularly when arriving or leaving the work area. related to the machine, it is necessary to do further research related to extending the life of the machine. Purchasing machine parts with very good quality so they are not easily damaged and Providing training to operators or technicians and giving sanctions to operators or technicians if they do not follow established procedures
12	Firman et al., 2018	Palm oil industry	This study aims to improve the boiler machine with the current OEE of 65.16% due to high idling and minor stoppages and reduced speed losses in the boiler machine. Based on the results of the analysis the causes of these two factors are the machine: dirty and untidy engine, the engine does not operate due to sudden damage and unoriginal components. Humans: negligent operators, lack of initiative, undisciplined, lack of training. Environment: reduced water supply, erratic weather. Material: Limited raw material. Method: not yet running the TPM.
13	Hafiz & Martianis, 2019	Diesel Power Generation Industry	level measurement work effectiveness of Caterpillar Type 3512B machine with Overall Equipment Effectiveness (OEE) at PT. PLN (Persero) ULPLTD Bengkalis PLTD Big Chart in the period December 2018 - March 2019 is 46%, this is due to machine damage such as radiator pipe leakage, damage to injectors and power outages.
14	Hairiyah et al., 2019	Palm oil industry	This study aims to increase OEE in the first press machine with the current condition of 68.26%. The low OEE value of the first press machines at the KCP PT. X is caused by several factors, namely the age of the machine that is old so it often gets damaged, the maintenance process takes a long time, and the quality of the processed kernel is low.
15	Hamdy & Pratiwi, 2015	Rubber processing industry	This study aims to provide a suggestion to increase the current OEE of 69.64% for breaker machines. cause The overall equipmant effectiveness (OEE) score is in the low category. The cause of the low OEE value is due to the high total delay time during the production process, which has an impact on decreasing SIR production. The cause of problems with the Breaker machine is that the machine often dies because it is clogged, this is because the blade on the machine is not sharp, damage to the conveyor and

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
			damage to the Breaker machine part. As for the improvements that should be made by the company is to perform maintenance on the Breaker machine more often. Extra care needs to be done on the sharpening of the blade, given the frequent blockages due to the less sharp blade of the Breaker machine
16	Hamid et al., 2018	Electrical industry	This study aims to provide a recommendation to improve the sb-16 turning star machine to increase the OEE value in the range of 69.97% -70.68%. Analysis of the causes is the idling factor & minor stopages and ineffective Reduce Speed of 52.51% and 40.66%. The proposed improvement for idling stop is human: provide guidance and tighten operator supervision of discipline and thoroughness, material: checks related to standards must be more thorough in order to follow existing standards. Machine: Check bearings regularly and provide special lubricant to bearings and check Clamp Material periodically by ensuring the position of the clamp is precisely installed in the position of the material and replacing clamps that are thirsty. While the improvement for the speed losses factor is human: Given knowledge of duties and responsibilities and given periodic training on machines / equipment. Machinery: Involves the operator in preventive maintenance as well as the transfer of knowledge and skills from the engineering department to the operator and the manufacture of standard installation settings according to field conditions Material: It is necessary to check from the supervisor of the operator to be more careful in sorting materials that meet the standards. Method: Implementation autonoumous maintenance to focus on machine maintenance
17	Haradito et al., 2019	Canned food industry	In this study, the objective of this research is to provide recommendations for the repair of several engines (Washer, Blancher, Cooling, Grading, Sorting, Slicing, Exhaust, Semmer, Retort). The causes of this problem are idle & minor stoppages losses and setup & adjustment losses, which represent 76.34% and 23.08%. The proposed repairs are Machinery: Take advantage of a carefully determined check schedule and There is a need for a safety in the machine so that small mold does not enter the engine gap. Meanwhile, for the Setup and Adjustment Losses factor, a suggestion is given by checking periodically more than what has been scheduled to reduce disturbance to the machine. Material: More stringent checks and planning for material acceptance so that there are no losses during processing
18	Haryono & Susanty, 2015	Textile industry	This study aims to provide recommendations for improvements to increase OEE in ring frame machines with an OEE value of 89.64%. From the Pareto diagram, the dominant factor of six big losses is reduced speed loss of 82.1%. Based on the fishbone diagram, it is suggested that the improvement to be made is the addition of a dofing department employee when doing machine setup
19	Iftari, 2015	Gas Industry	The main cause of the decline in equipment availability at PT Pertamina Gas Area JBB is due to the realization of the

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
			maintenance schedule not as planned due to spare part problems. Second. Companies need to implement TPM which includes focused maintenance, autonomous maintenance and consistent planned maintenance programs so that the availability of gas distribution reaches the target
20	Kholil et al., 2016	Coal Mining Industry	The cause of low OEE in ship operations in the mining industry which currently has an OEE value of 80.58% is idling & minor stoppage which has an effect of 2.69% and Reduce Speed Losses of 0.45%. In addition, the thing that can be optimized from the calculation of availability rate is breakdown losses, which is 1.91%. The proposed improvement is that training and crew supervision need to be improved, making standards for the implementation of maintenance and installation of screens so that wood does not enter the ship
21	Krisnaningsih, 2015	Can packaging industry	The cause of OEE in the General line area which currently has an OEE value of 65.43% is the category of set up & adjustment losses of 62.84%, Machine analysis results: Because imports require a relatively long time and dome material between one supplier and another has The quality spec is different so that it requires special treatment when setting the seamer, the new model requires a relatively long process.
22	Kristono & Hudori, 2018	Construction industry	This study aims to determine the value of OEE in bondeck iron production machines with current conditions of 53.29%. Based on the results and discussion above, it can be concluded that the Overall Equipment Effectiveness (OEE) value on the bondeck iron production machine is 53.29% in January; 48.23% in February; and 58.88% in March. This shows that the company is only able to produce products from this bondeck iron production machine, approximately half of the total product that should be produced. Thus it is necessary to make improvements to the equipment maintenance system to improve the performance of these tools.
23	Latif & Purnomo, 2020	Palm oil processing industry	This study aims to determine the OEE value on the screw press, which is currently in the range of 61,742% - 81.75%. The main factor is that the Performance Efficiency value cannot be said to be ideal or good because in January-December it is below the standard, which is less than 92%.w the OEE value on a screw press in the range of 61.742% - 81.75%
24	Livia & Fewidarto, 2016	Electronics industry (digital cameras)	the cause of the OEE value which currently reaches 70.4%. due to the low value of performance efficiency and availability. The proposed improvement is to make or re-function the cleaning room, by making a partition on the border of the entrance to the Section SMT production room. related to the human factor is to re-form the Small Group Activity (SGA) team as a forum to share knowledge, skills and experiences related to machine operation and maintenance and carry out training through a thorough and in-depth assessment process to get an idea of the types, forms and methods of training necessary to meet competency needs in the future. preventive

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
			maintenance activities are not running optimally. Preventive maintenance is aimed at preventing damage to tools and machines in a short span of time, under their technical age, so that a longer breakdown maintenance time is required.
25	Magdalena & Ginting, 2019	Telecommunication Industry	Increase OEE sheating machine with OEE This study aims to increase the current OEE of the sheating machine by 26.02%, the method used is the fishbone diagram and FMEA. From the results of the fishbone diagram that causes low OEE is the Six Big Losses factor, it states that the biggest losses are in Idling and Minor Stoppages (38.02%) and Reduced Speed (19.46). repairs made by carrying out machine maintenance periodically
26	Mulyo & Hermansyah, 2018	Pharmaceutical industry	This study aims to provide a suggestion for OEE improvements in reverse osmosis machines, which are currently in the 38.2% - 45.3% range. From the results of the fishbone diagram, the problem of low OEE is the reduced speed factor of 30.31% and the yield scrap loss of 53.37%.
27	Nurfaizah et al., 2014	Electrical Appliance Industry	The low OEE on the Dobby 50 machine is dling and stoppage minor losses, reduced yield, and reduced speed losses. Which supports 80% low OEE on machines that are currently 45.55%. The proposed TPM design starts with implementing 12 Steps
28	Nurprihatin et al., 2019	Food industry	This study aims to increase the OEE on the current WP-ATB 08 engine is 71.27%. From the results of the analysis of six big losses which caused the low OEE from the breakdown losses factor. The proposed improvement is to implement the 8 pillars of TPM. The implementation of this TPM begins with training for Factory Managers, Head of Supervisors, and Managers, Head of Section Supervisors, Section Supervisors and Assistants, Operators, Assistant Operators, Workers. The training schedule for 6 months has been arranged so that all departments and employees understand the implementation of TPM%
29	Nursubiyantoro et al., 2016	Textile industry (leather gloves)	This study aims to measure the level of effectiveness on the atomic press machine which is still in the average 55.24% which is low. The focus of improvement of the problems that caused the loss factor of the Hydraulic Atom engine was the low average performance ratio of 62.11% because it was influenced by idle and minor stoppages and speed losses that occurred in the engine. Proposed improvements must apply Total Productive maintenance (TPM) through a maintenance program by recognizing symptoms of press machine failure, making setup adjustments in atomic hydraulic press machines, understanding problems that occur in pressing and cutting.
30	Prabowo et al., 2020	Machinery Service Industry	This study aims to measure the level of effectiveness of grinding machines with an OEE value of 90.73%. Grinding machine loss factor is an average Quality Ratio of 98.54% because it is influenced by the Startup Reject and Reject factors that occur in the engine work results. The proposal submitted by the company needs to evaluate the results of the quality of the machine work so as to

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
			improve the quality of the machine work and minimize rejects. There is a need for training on product defects and maintenance systems for operators and maintenance personnel so that during the process they can manage their work in terms of machine maintenance
31	Pradana et al., 2013	Industry (bottled drinking water	This study aims to provide recommendations for improvements in reducing the level of damage that often occurs in automatic bottle filling machines from the efficiency value (OEE) of the machine which was originally 82.42% up to 98.97%. The problem is caused by the break down losses factor. The improvements made are: a. Standard Operational Procedure (SOP) SOP is based on the concept of 5S and safety, health and environment b. Check List. Recommendations for improvement in the form of a check list are made as a guide in carrying out routine checks. The check list is based on the concept of autonomous maintenance or independent maintenance that can be performed by the operator. c. Creating a Working Group The creation of a working group is a suggestion for improvement based on the concept of the kaizen pillar.
32	Praharsi et al., 2015	Shoe Sole Industry	This study aims to reduce the damage to injection molding machines by 38%. Based on the results of the analysis, the components that cause problems with the injection molding machine are calculated as oil seals that contribute 55% to machine A and 75% to machine B. The repairs made are by implementing preventive maintenance using the age replacement method to find the optimal replacement life. From the results of the repairs can be seen in table 12 before and after repairing machine damage based on the previous average number of hours 7.29 hours / month to 7.08 hours / month
33	Pratama et al., 2020	Automotive component industry	In this study, the aim of this research is to increase the OEE in one stroke die machine 30T hydraulic body from 37.35% to 58.82%.
34	Priyono et al., 2019	Refined sugar industry (food)	Based on the calculation results, the OEE value is still 56.44%. From the fishbone analysis results, improvements were made to the implementation of 5S. Furthermore, for the critical area of the dryer cooler, the biggest cause of engine failure is the normal wear and tear category, which is 39% of the total damage that occurs in the critical work area, the second cause of damage is 29% (lack of cleaning, loose tension, and lack of lubrication) is resolved when an autonomous maintenance program is running
35	Putra & Achmadi, 2020	Steel pipe industry	This study aims to reduce engine breakdown to increase the OEE of the slitter machine, which currently has an OEE value of 75.9%. There are two components that are still unfavorable and below world class standards, namely availability of 77.3% and quality of 98.7%. And from the results of the analysis of six big losses, it was found that the dominant losses to the low value of availability were set up and adjustment with a percentage of losses of 20%.
36	Putri & Anwar, 2020	Injection molding industry (Plastic)	This study aims to increase the value of the engine OEE (MH-C 700), the biggest losses are idling minor stoppages losses which have a percentage of 28% and 16% in March and April 2019.

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
37	Rahayu & Herdiani, 2018	Textile Industry (Fabric)	This study aims to improve the pallet machine OEE with the current average OEE achievement of 71.8%. The dominant types of Six Big Losses on pallet machines are defect losses and reduced speed losses. defect losses has a value of 11.49% and the percentage of other losses is 84.29%. Meanwhile, reduce speed losses has a value of 13.79% and a percentage of other losses of 45.97%.
38	Rahman, 2019	Printing Industry	This study aims to increase availability on offset printing machines with availability values in the range of 90.8% - 93.2%. From the analysis of the causes of low availability problems due to breakdowns that occur in the feeder, printing and compressor
39	Riadi & Anwar, 2019	Ceramic industry	This study aims to measure the OEE value to provide recommendations for improvement, which currently has an OEE value of 47%. From the Pareto diagram, it is found that 62% of the problems are caused by the reduce speed losses factor.
40	Rufaidah & Abdillah, 2019	Palm processing industry	This study aims to determine the cause of low expeller engine OEE occurring in December with a value of 65.96%. From the Pareto diagram, it is found that the highest cause is the reduced speed losses factor with a contribution of 50.79%. From this, it can be given input that to minimize six big losses, the factors affecting it can be improved from materials, machines, humans and methods.
41	Ruslan & Prasmoro, 2018	Stationery industry	This study aims to provide recommendations for improvements to increase the OEE value on kneader machines, currently having an OEE value of 81.62%. The biggest factor that influences the low value of OEE is the performance rate with a percentage factor of six big losses in reduced spees losses of 42.66% and idling and minor stoppages of 31.27% of all time losses
42	Sahrupi & Juriantoro, 2018	Coal Industry	This study aims to provide recommendations for improvements to improve the OEE Transfer Conveyor 17A with the current OEE value of 82.98%. The proposed improvement is for heavy rain to be overcome by closing the roof of the conveyor belt area.
43	Sariyusda et al., 2016	Chemical industry (urea and ammonia fertilizer)	This study is to propose improvements to equipment in the process of making fertilizer and ammonia, which currently have an OEE value of 79.24%. The influential losses were breakdown losses of 29.64% and reduced speed losses of 10.70%.
44	Sulistiardi et al., 2019	Assembly automotive industry	This study aims to provide a proposal for improvement of the current OEE line assembly at 67.78%. From the analysis of six big losses, it is known that the value of equipment failure is 24.92%, set-up adjustment is 6.05%, idling & minor stoppage is 52.77%, reduced speed is 13.79%, rework is 2.48%, and yield / scrap is 0. %.
45	Sulistyo & Zakaria, 2019	Cement Industry	This study aims to increase the productivity of the Vertical Roller Mill (VRM) milling machine at the current OEE value of 64.52%. from the description of six big losses that the largest value of losses is in the equipment failure loss / breakdown factor in availability, namely 1684.02 hours (75%).

Table 1. Existing literature review of TPM implementation (continued)

No	Paper Identity	Research object	Result
46	Zohari, 2019	Tire Industry	This study aims to improve the current OEE of the steel calendar machine by an average of 47.3%. Based on the data, it was found that equipment failure losses of 3.32%, set up and adjustment of 22.37%, reduce speed losses by 2.35%, idling minor and stoppages by 2.01%, and defect losses by 0.45%.

3. RESULT AND DISCUSSION

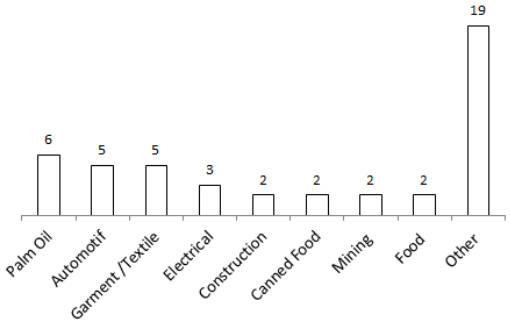

Fig. 2. Type of industry

Fig. 2 concludes that there are 27 types of industrial fields in Indonesia that have implemented TPM, this has become a very important priority in running this program because it is related to the effectiveness of the equipment used in company operations to make it more efficient. From the graph showing the palm oil industry, there are 6 journals that discuss TPM, this illustrates how important the application of TPM is to machine performance in order to increase their productivity so as to produce a larger volume of production. Based on data, these six palm oil companies industry (Diniaty & Susanto, 2017; Frima et al., 2019; Hairiyah et al., 2019; Hamdy & Pratiwi, 2015; Latif & Purnomo, 2020; Rufaidah & Abdillah, 2019) have an average OEE performance of around 75% so that they still have a difference of 10% from the world class target. By taking OEE measurements we can see which parameters are the cause of low machine OEE problems which are not only from engine factors or other factors, so that in making repairs we have the right decision in carrying out solutions to the causes of this problem.

Fig. 3 shows 6 big losses that cause low OEE performance. From the graph, it can be seen that the 3 biggest causes found in this literature are due to the main causes based on the highest percentage of each journal is the reduced speed with 20 journals (Anggraini et al., 2017; Anthony, 2019; Firman et al., 2018; Frima et al., 2019; Hafiz & Martianis, 2019; Hamid et al., 2018; Haryono & Susanty, 2015; Kholil et al., 2016; Latif & Purnomo, 2020; Livia & Fewidarto, 2016; Magdalena & Ginting, 2019; Mulyo & Hermansyah, 2018; Nurfaizah et al., 2014; Nursubiyantoro et al., 2016; Pratama et al., 2020; Rahayu & Herdiani, 2018; Riadi & Anwar, 2019; Rufaidah & Abdillah, 2019; Ruslan & Prasmoro, 2018; Sariyusda et al., 2016), equipment failure with 18 journals (Anthony, 2019; Bakti & Kartika, 2019; Bastanta et al., 2018; Diniaty & Susanto, 2017; Firman et al., 2018; Hafiz & Martianis, 2019; Hairiyah et al., 2019; Iftari, 2015; Kristono & Hudori, 2018; Livia & Fewidarto, 2016; Mulyo & Hermansyah, 2018; Nurprihatin et al., 2019; Pradana et al., 2013; Praharsi et al., 2015; Priyono et al., 2019; Rahman, 2019; Sahrupi & Juriantoro, 2018; Sariyusda et al., 2016; Sulistyo & Zakaria, 2019) and idling and minor stoppages with 13 journals (Aminah & Theresia, 2018; Frima et al., 2019; Hamdy & Pratiwi, 2015; Hamid et al., 2018; Haradito et al., 2019; Kholil et al., 2016; Latif & Purnomo, 2020; Magdalena & Ginting, 2019; Nurfaizah et al., 2014; Nursubiyantoro et al., 2016; Putri & Anwar, 2020; Ruslan & Prasmoro, 2018; Sulistiardi et al., 2019).

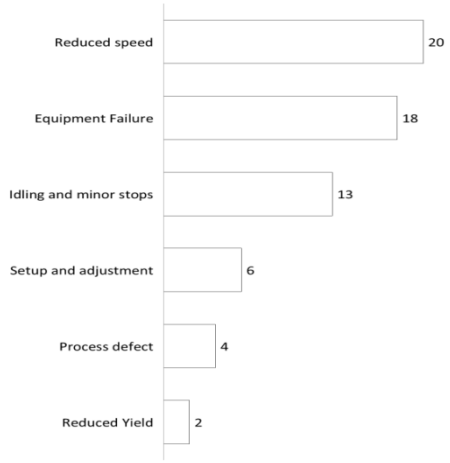

Fig. 3. Six big losses analysis

Based on the graph in Fig. 3, a conclusion analysis will be carried out with an indication of the common causes of the three previous causes of six big losses with the 4M + E analysis approach (man, machine, method, material, and environment) which is discussed in Table 2.

Table 2. 4M+E Analyze

Man:

CODE	Root Caused Low OEE
M1	Preparation when going to start work (Anggraini et al., 2017)
M2	Worker contract system (Anthony, 2019)(Apriatno, 2015)
M3	The spirit of innovation (Krisnaningsih, 2015)(Bakti & Kartika, 2019)
M4	Operator fatigue (Bastanta et al., 2018) (Frima et al., 2019)
A1	Management Mindset

Machine:

Code	Root Caused Low OEE
M5	Power failure (Anggraini et al., 2017)
M6	Spare Part is thirsty (Anthony, 2019)
M7	Non Original Spare Parts (Frima et al., 2019)(Bastanta et al., 2018)
M8	The provision of spare parts takes a long time (Iftari, 2015)
A2	Machines Modification

Method

CODE	Root Caused Low OEE
M9	Periodic Maintenance System (Anthony, 2019)
M10	Availability of work tools (Aminah & Theresia, 2018)
M11	Lacks SOP and WI (Apriatno, 2015)(Dewanti & Putra, 2019)
A3	Maintenance daily activities

Material:

CODE	Root Caused Low OEE
M12	Material specification(Anggraini et al., 2017)(Hamid et al., 2018)(Magdalena & Ginting, 2019)
A4	Product variation specifications

Environment

CODE	Root Caused Low OEE
L1	Hot Room Temperature (Anthony, 2019)
L2	Solid Areas (Frima et al., 2019)

In the preparation stage when starting work, there are still several multinational companies in Indonesia where an operator wears work equipment (shoes, glasses, masks, etc.) and the preparation of raw materials is done during working hours (M1), there is a lack of operator skills when using this machine This is also caused by short work contract regulations for operators, which causes operator changes which often results in a dynamic work system (M2). Lack of enthusiasm / operational improvement initiatives which often depend on mechanical parts so that operators are less responsive to machine abnormalities (M3). The operator fatigue factor is caused by the operator having a side job so that he does not focus on his job and the lack of accuracy and focus of the operator that occurs when going to rest and going home (M4).

Frequent blackouts that cause the engine to die and have to do the initial setup of the engine (M5), the engine is fully operational 24 hours and makes components thirsty (M6) and needs to be replaced, but the availability of spare parts is inadequate so that it forces to run the engine that is not optimal. The use of unoriginal spare parts also triggers engine failure and underperformance (M7). Provision of old spare parts (M8)

The method used is periodic maintenance, this is the case that there are still many engineering parts who do not understand the concept of TPM in carrying out the method to prevent engine damage (M9). The availability of work tools is not balanced with the number of machines that makes the operator change the model (M10). There is no SOP / WI as a working guide so that operators often have different methods (M11).

Differences in material specs, differences in a material formula can also cause the performance or speed used to be different from one material to another.

The hot temperature of the factory workroom causes the operator discomfort in working and also often makes the rubber seal break not last long which causes the hydraulic engine to leak (L1). The crowded environment due to the raw materials being placed but not yet being processed causes the operator's space to be limited (L2).

From the previous 4M + E analysis, the author also added several things that caused low OEE, among others,

• The middle management mindset that still thinks like an operator so that the lack of openness of the problems that occurs is produced creates a gap between machine performance capabilities and field actualization (A1).

- There are too many variations in product specifications, product specifications are usually made by the marketing division, which sometimes does not really understand the process being followed so that the large variety of specs causes many difficulties during the production process (A4).
- Conducting preventive checks which should be checked daily, weekly and monthly, not according to actual conditions, sometimes the auditors fill in the same as yesterday so that the data is incorrect and invalid (A3).
- Engine modification which causes reduced engine performance (A2).

Root cause versus the 8 Pillars of TPM
The root of the problem that occurs above is a problem that has often occurred in production activities so that the TPM method with 8 pillars is one solution to prevent problems that occur. In accordance with the 8 pillars of TPM, the root problems are classified into 8 pillars as described in Table 3.

Table 3. Matrix 8 pillar of TPM

TPM Pillar	Problem Code																	
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	L1	L2	A1	A2	A3	A4
Autonomous Maintenance			√															
Planned Maintenance					√	√		√					√					
Quality Maintenance							√					√						
Focus Improvement			√											√				√
Early Equipment Management	√									√								
Training and Education	√	√	√	√					√	√	√	√			√	√		√
Safety, Healty and Environment													√	√			√	
TPM in Administration																	√	

Autonomous Maintenance

The spirit of innovation (M3) for operators will be able to appear when they have carried out autonomous maintenance. The more they do it, it will provide stimulation and sensitivity to their daily activities and sensitivity to problems that occur in machines so that a creative idea will emerge that encourages innovation in their work.

Plan Maintenance

The problem of thirsty and damaged spare parts and the absence of spare parts (M5, M6, M8, L1) causes one of the engine's problems do not have good performance because the spare parts used should be replaced but forced due to the availability of spare parts that are not available and the possibility of frequent arrival is also late. The maintenance plan pillar is one that is used as a solution in preventing damage to spare parts on a machine. Periodic changes to spare parts will provide smooth operation for the engine.

Quality Maintenance

The use of unoriginal spare parts (M7) and material specifications (M12) is also one of the causes of engine performance not running optimally. This pillar prioritizes quality in making engine repairs by evaluating the spare parts used during replacement. And also related to the use of the material used, it is necessary to make a standard material that will be carried out in this process.

Focus Improvement

The lack of enthusiasm for innovation (M3) can occur because they do not understand what innovation is being done for this. This requires the involvement of upper to middle-level management to initiate innovation. Dense area (L2) can be reduced by making innovations in the production area

With the application of Lean TPM, it needs to be studied and implemented so that problems with lots of inventory can be minimized and the large variety of products (A4) that are usually provided by marketing needs to be improved so that the production process can run more flexibly.

Early Equipment Management

Production preparations such as the use of safety equipment, preparation of raw materials that are still being carried out during working hours (M1), and availability of work tools (M10), which not all machines have work tools, need to be improved in preparation for both operator and machine needs.

Training and education

Training and education will always be carried out for all production activities, not only for new operators but also when there are new

technologies, repair methods, and others. Activities (M1, M2, M3, M4, M9, M10, M11, M12, A1, A2, and A4) which result in low machine performance need to be re-learned and the results of improvements are made so that the knowledge and all the methods that were carried out were not standard, can be changed back through this pillar. Not only that, all the pillars that are implemented will also be disseminated to all employees. And it allows for changes in all aspects so that this education is needed in disseminating any changes made.

Safety, Health, and Environment

Problems related to density (L1), room temperature (L2), and daily checks (A3) related to safety also need to be done so that forms of work accidents can be avoided by workers.

TPM Administration

All forms of data collection, audit results, periodic checks (A3) need commitment and discipline. Supervision from management which also needs to verify every activity that provides a data collection needs to be done more carefully and seriously so that the data presented is more valid and used in making correct decisions.

Fig. 4 shows the importance of implementing TPM to competition in the industrial era 4.0. One of the important points in implementing TPM is related to the collection of OEE data, which currently still uses manual records, which with this method will provide a lot of recording errors and if you have a lot of equipment it will have a long input process. So that the process of making a quick decision will be hampered. It is necessary to compare a system in any industry to complement each other in administering integration into the system as learning in the industrial world which will be stronger in implementing the TPM program.

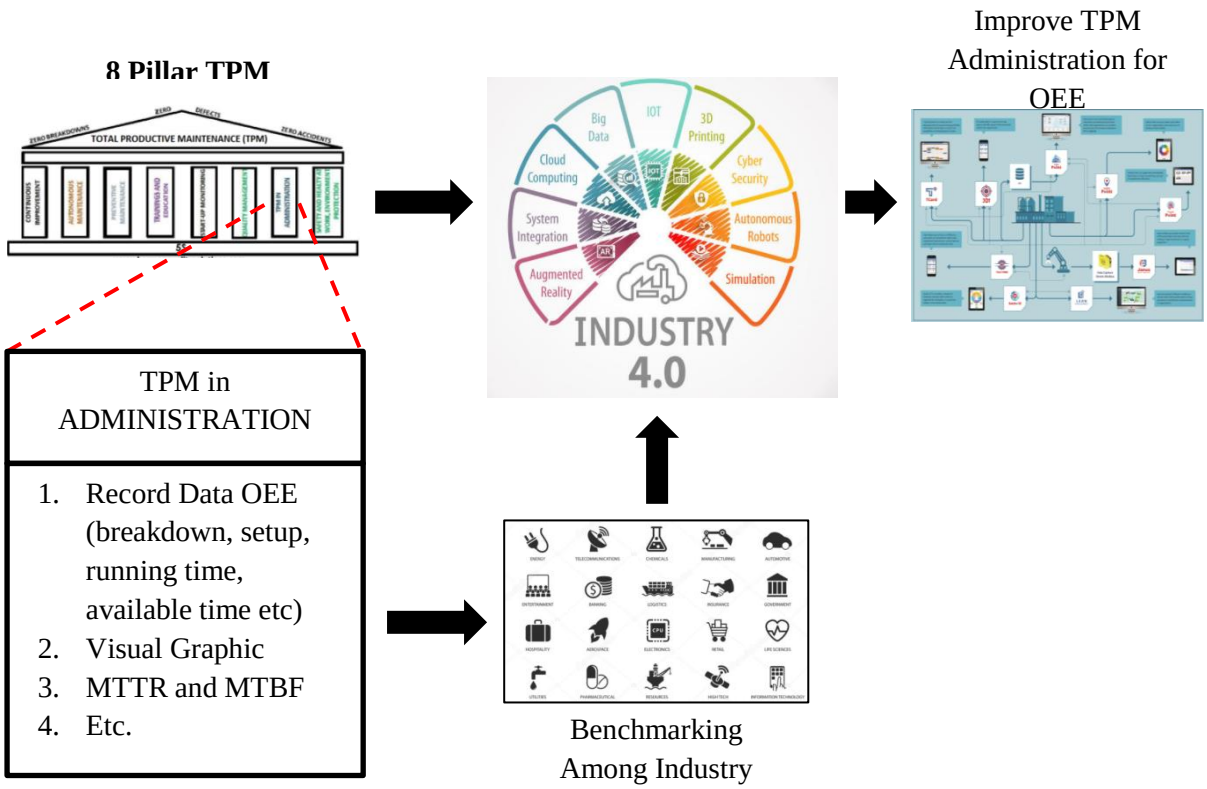

Fig. 4. Future research framework

4. CONCLUSION

In carrying out brainstorming activities, sometimes it is just a formal activity carried out to make it appear that the continuous improvement process is always being carried out. However, this kind of activity will not solve the problem because the solutions made do not reflect the problems that actually occur in the field. An interesting thing to get from this literature review is the low OEE:

- As a result of changes in operators associated with the contract system which causes this change to be properly prepared when a new operator works. The previous operator's method that has been good needs to be transferred to the operator that will enter. However, this is often a big gap with the preparation for this skill transfer.
- The operator fatigue factor who has a side job. With the proliferation of online-based applications, business operators are looking for additional income so that their main work is neglected.

The two points above are a case that most likely occurs in all industries, the factor of the desire of operators to look for companies that employ permanently and provide welfare is a very big homework for the company so that the morale of employees increases and can cause productivity to be high, but vice versa. making employees decrease also has an impact on the company's productivity decreasing.

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