Performa: Media Ilmiah Teknik Industri
ISSN 1412-8624 (cetak) | ISSN 2620-6412 (online)
Vol. 20, No. 2, 2021, Hal. 97-108 doi.org/10.20961/performa.20.2.50087

A Systematic Literature Review of Total Productive Maintenance on Industries

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Abstract

Attempts to achieve optimization of machine and equipment maintenance at manufacturing companies over the years have encountered a multitude of problems. Due to equipment losses such as setup and adjustment, minor stops and delays, defective products due to equipment, reduced engine speed, and reduced output has influenced their desire to reach world class manufacturing levels. This paper discusses a large part of the TPM approach in manufacturing companies and provides an overview of the various TPM implementation practices demonstrated by manufacturing companies in the world. Based on review results of the 50 journals about TPM in industries It was found that most of the TPM implementations used the OEE parameter to see the success rate of implementing this TPM. This paper also highlights the variable approach that is most widely used by various practitioners and researchers and evaluates in detail the success factors of implementing TPM and the reasons behind the failure of implementing TPM are also discussed so as to ensure the implementation of TPM can run smoothly and effectively in manufacturing companies.

Key words: *Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE), 8 pillar*

Abstrak

Upaya untuk mencapai optimalisasi perawatan mesin dan peralatan di perusahaan manufaktur selama bertahun-tahun telah menemui banyak masalah. Karena kehilangan peralatan seperti penyetelan dan penyesuaian, penghentian dan penundaan kecil, produk cacat karena peralatan, kecepatan engine yang berkurang, dan output yang berkurang telah memengaruhi keinginan mereka untuk mencapai tingkat manufaktur kelas dunia. Makalah ini membahas sebagian besar pendekatan TPM di perusahaan manufaktur dan memberikan gambaran tentang berbagai praktik implementasi TPM yang ditunjukkan oleh perusahaan manufaktur di dunia. Berdasarkan hasil review dari 50 jurnal tentang TPM di industri Ditemukan bahwa sebagian besar dari Implementasi TPM menggunakan parameter OEE untuk melihat tingkat keberhasilan implementasi TPM ini. Makalah ini juga menyoroti pendekatan variabel yang paling banyak digunakan oleh berbagai praktisi dan peneliti serta mengevaluasi secara rinci faktor-faktor keberhasilan penerapan TPM dan juga dibahas alasan dibalik kegagalan penerapan TPM sehingga untuk memastikan pelaksanaan TPM dapat berjalan dengan lancar. dan efektif di perusahaan manufaktur.

Kata Kunci*: Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE), 8 pillar*

1. Introduction

In Japan, the implementation of Total Productive Maintenance (TPM) can build teamwork that involves all workers from various functions as a culture and a continuous improvement system to achieve zero breakdowns, zero waste and zero accidents (Anh, 2012). Total Productive Maintenance is an effective program and is a new concept established in the equipment maintenance plan (Sethia et al., 2016).

TPM approach allows the manufacturing system to change for the better and has an impact on the company's business. This is a technique that continues to evolve and is applied in all organizations and is able to improve the key business processes used to identify key performance indicators (Nishal et al., 2018). Total Productive Maintenance (TPM) focuses on maximizing equipment performance, establishing a productive maintenance system that optimizes its life cycle, contributing for the continuous improvement and availability, avoiding early equipment wear, being necessary that the maintenance works on preventing with managerial focus (Meca Vital & Camello Lima, 2020).

Since 50 years ago, the development of the manufactucturing industry was established in Malaysia, the problems of waste, work safety, equipment maintenance, product quality, high costs and performance efficiency are still the spotlight and criticism of many researchers. Various approaches are suggested to obtain good operations management in order to achieve customer satisfaction. The Malaysian government continues to encourage industrial manufacturing activities to improve quality with total solutions in improving safety, quality, low-cost operation management and productive maintenance (Habidin et al., 2017). The Total Productive Maintenance approach is one of the effective operating strategies to reduce production losses caused by breakdowns of equipment and various other types of downtime. Competitive

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advantage in a growing market, cost and quality are things that continue to be considered so that we can run the production process at a low cost by increasing the efficiency of their equipment (Nasurdin et al., 2005).

Many studies have been carried out in various countries in order to find the best method for increasing the productivity and quality of a product from the results of the manufacturing process. TPM is one of the approaches used by researchers to achieve the desired results in overcoming zero breakdown and zero defects. In Japan, the TPM philosophy is used to maintain equipment during use in the production process. TPM involves all employees from various work functions in the organization and integrates all worker activities into teamwork to achieve world-class overall equipment effectiveness (OEE). OEE pays attention to the level of availability of machines and equipment, the level of performance at which it operates and the level of production quality as a result of the production process. TPM has 8 pillars which are used as a guide in overcoming organizational problems so that TPM implementation runs more effectively and overall manufacturing performance can improve (Parikh & Mahamuni, 2015). One of the aims of this paper is to highlight the major problems in equipment maintenance in a manufacturing environment and seek benefits related to the framework, overall equipment effectiveness and implementation of TPM program.

In TPM, we know the term "pillar" in the basic practice of TPM, TPM house stands on eight pillars as the building of a house. These eight pillars are also a system used by companies to maximize production efficiency and effectiveness (Erry Yulian Triblas Adesta & Prabowo, 2018). JIPM as the originator of TPM suggests that this eight pillar methodology can be used to increase labor productivity, reduce downtime and minor stopped and reduce overall maintenance costs (Fam et al., 2018). The JIPM eight pillar TPM is depicted in Figure 1.

The foundation of TPM house is 5S, this is a systemic concept to manage an orderly and comfortable workplace by involving all employees to commit to running 5S and making it a work culture. With 5S being awake, abnormality in the workplace can be clearly seen. Several studies have shown that the level of success of organizations in implementing TPM varies. Overall Equipment Effectiveness (OEE) is one of the most widely used methods to measure the parameters of the success of implementing TPM (Herry et al., 2018). The steps taken are measuring OEE and knowing the biggest factors that influence it by calculating the six big losses (Fahmi et al., 2013). Every manufacturer must decide the right policy in increasing the productivity of machines and equipment, for example in the case of a company in Indonesia (PT Inti Arca Corpora) with ring frame products. In the manufacturing process the product has to go through 124 machines which must always be prime, if there is frequent down time on the machine and unpredictable breakdown, it will damage the planned production schedule. then research is carried out on those 124 machines. The research conducted was to measure the level of effectiveness in the use of machines and equipment, to find the root of the problems that occurred and to provide suggestions for improvements to the company's top management. The first thing the researcher did was to measure the value of the OEE condition before the repair, then identify the six major losses that occurred. The results showed that the value obtained was still below the ideal standard value of world-class OEE, namely 79.9%, where the ideal standard was 85%. The biggest problem that causes the low OEE value is the performance rate factor, namely there is still a speed loss of 17.30% of the total time lost (Martono, 2014).

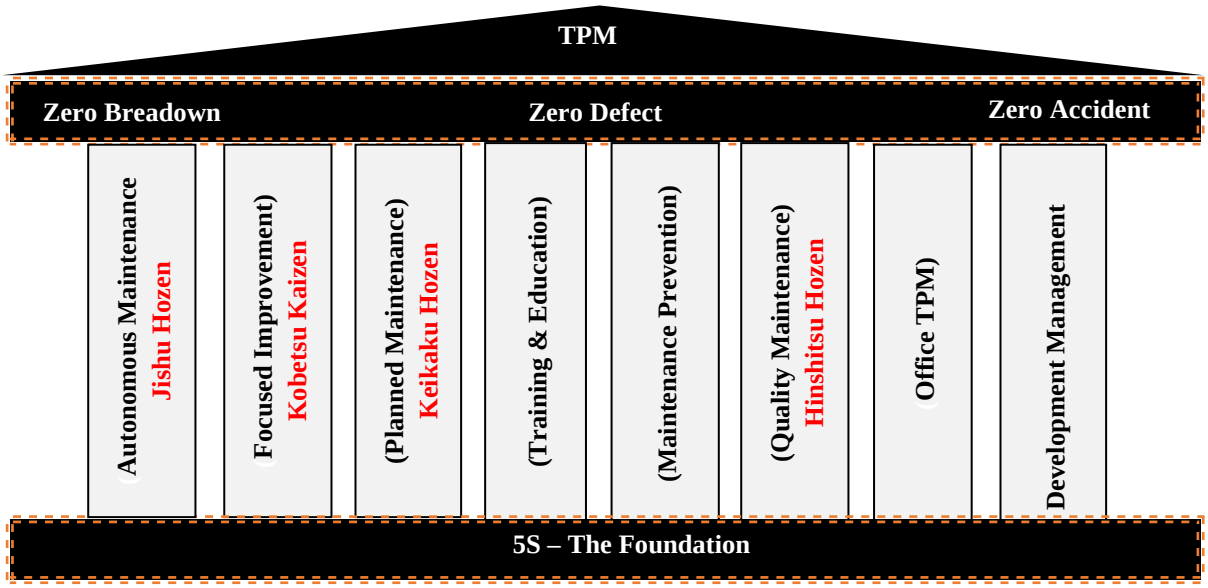

Figure 1. Eight pillars of TPM (suggested by JIPM)

2. Research Method

For decades, TPM Technique has existed as an advanced manufacturing technique in helping each production process maximize organizational assets, equipment and produce quality products. But only a few companies succeeded to implement TPM well as a strategy for a comprehensive improvement process. they only apply part of the TPM component and have not realized the benefits that can be achieved through TPM (Ireland & Dale, 2001).

This paper will show the importance of implementing TPM in organizations, starting from the study framework, the most widely used methods, Overall Equipment Effectiveness, and various TPM implementation practices from various types of manufacturing as well as the obstacles found and what factors support the successful implementation of TPM (Ahuja & Khamba, 2008). The contribution of TPM program to engaging employees in its implementation is also highlighted here.

The literature on classification of Total Productive Maintenance has so far been very limited. We took 50 random samples of journals discussing TPM for review. This paper reviews and presents an overview of various kinds of TPM implementation practices from various types of manufacturing globally. as well as practical approaches and ways of implementation suggested by various researchers in order to find the maximum success rate and some of the obstacles that need to be avoided in practice. Then compare from various perspectives, then make a summary. For more details can be seen in Figure 2.

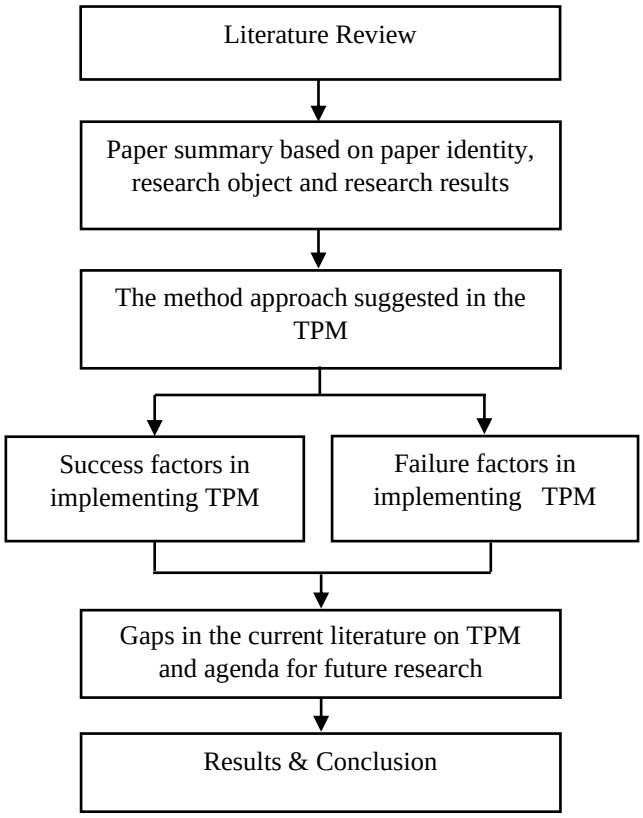

Figure 2. Study Framework

3. Results & Discussion

3.1 Paper Summary

The 50 articles showing implementation TPM in the industrial of manufacturing is selected for review. The selected articles analyzed from the aspect of TPM methodologies, consist of TPM basic concepts and TPM enhancement, then also analyzed by research object and the result. We took a sample of 50 national and international journals with a time span from 1999 to 2020 to determine the use of TPM in organizations. The following is a review of selected articles.

Tabel 1. Paper Summary

No	Paper Identity	Research Object	Result
1	(Gallesi-Torres et al., 2020)	Case Study Maintenance TPM at Manufacturing	After the implementation of TPM there was a decrease of 35% from total downtime that occurred in the plant, a decrease in maintenance costs by 16% and time available in the machine by 784 tons per year.
2	(Meca Vital & Camello Lima, 2020)	Verify the use of the productive system capacity at Industrial Company with TPM.	In the analysis of the evolution results of the TPM pillars, it was verified the importance of the Specific Improvement and Planned Maintenance pillars, which, after its implementation, led to an increase in the OEE metric, with improvements between 12.5 and 33.3%, showing the performance improvement that these pillars provide.
3	(Palomino-Valles et al., 2020)	TPM Maintenance at Construction Sector	The proposed maintenance process simulation can reduce the average waiting time between failures which can be reduced by 7 hours from 13 hours, meaning that there is a decrease in downtime by 15%. and an increase in available time by 90%.
4	(Lukmandono et al., 2020)	TPM & FMEA approach at Manufacturing	The dropped/exited IMC from the operation line was repaired day at expense of IDR 5,6 MIDR, and rollung slip damage 10 day at cost of 34 MIDR.

No	Paper Identity	Research Object	Result
5	(Hairiyah et al., 2019)	Analysis of TPM in the Oil Palm Processing Industry	The OEE value for the first press machine at KCP station is 68.26%, with a significant difference from the international standard value of 85%.
6	(Azid et al., 2019)	Analysis TPM at Plant	In practice TPM can be applied to large industries and small or medium sized factories can be combined with the application of RCM.
7	(Irwansyah et al., 2019)	Improvement TPM at Manufacturing Beverage Production.	The average OEE is 81.13% and it is still far below the standards of world class industries. It was found that the cause of the low OEE was influenced by Equipment Failure Losses of 11.42%
8	(Nurprihatin et al., 2019)	Study Case TPM at Manufacture	OEE value for WP-ATB 08 machine on line 7 was 71.27%, with availability, performance, and quality value are 82.56%, 90.83%, 95.04% respectively. This OEE value does not yet reach the world-class standard value (85%) and the lowest value is the availability factor in terms of percentage disparity from its individual world-class standard (7.44%).
9	(Anthony, 2019)	Application of TPM in Steel Companies	The biggest factor that caused the low machine effectiveness was reduced speed losses by 11.59% and equipment failure losses by 6.04%.
10	(Priyono et al., 2019)	TPM at Refined Sugar Factory	The results of the study illustrate that the implementation of 5S as the basic foundation of TPM in organizations has reached 65% of the total area.
11	(Ali, 2019)	Application TPM in Copy Center at Woldia University	The OEE value for WU copy center was 35% which indicated that the center needs urgent improvement in equipment maintenance management program.
12	(Sutoni et al., 2019)	TPM Analysis at Manufacturing Motorcycle Parts	The results show that the lowest OEE occurred in October 2017 where a factor of 6 major losses occurred in lathes such as set up or adjustment time (40.3%), decreased speed losses (19.9%), breakdown machine (18.5%), Minor stoppage (17.6%), Rework loss (3.8%), and scrap (0%).
13	(Martomo & Laksono, 2018)	Case study at Manufacturing	Obtained an average OEE value of 79.96%, still below the standards of world class industries (85%).
14	(Nishal et al., 2018)	Case study TPM Implementing at Small And Medium-Sized Enterprises	The results showed that by involving employees in the implementation of TPM, create awareness and a sense of shared responsibility in maintaining the equipment. and this will have a positive effect on increasing productivity.
15	(Reyes et al., 2018)	Implementation TPM at Ecuadorian Footwear Industry	4 phases of the project model such as preparation, introduction, implementation, and consolidation can be proposed in carrying out a detailed analysis of failures that occur on critical machines and have a positive effect on the application of TPM.
16	(Fam et al., 2018)	TPM at Manufacture Electronic	The results showed that 91.2% of the total variation of OEE was influenced by the 3 pillars of TPM, namely planned maintenance, autonomous maintenance, and focused improvement.
17	(E. Y.T. Adesta et al., 2018)	Evaluating 8 Pillars Of TPM Implementation to Manufacturing Performance	There is a strong and positive relationship between the TPM and MP pillar models. where the pillar of TPM can explain MP variability of 62.6% and 37.4% influenced by other factors.
18	(Herry et al., 2018)	Case Study analysis TPM Implementation at Manufacturing	The OEE value of the stamping machine is still low due to reduced speed loss (53%) as the biggest factor affecting overall downtime.
19	(Erry Yulian Triblas Adesta & Prabowo, 2018)	TPM Implementation at Manufacturing Industries	The results of the study provide a reliable CFA model from TPM, LM and MP and the researchers propose that this model can be applied to various types of manufacturing industries.
20	(Prashanth Pai et al., 2018)	A Study on Usage of Total Productive Maintenance (TPM) in Selected SMEs	It was found that around 52% of SMEs have implemented TPM in their organizations and 48% have not benefited from implementing TPM.

No	Paper Identity	Research Object	Result
21	(Manik, 2018)	OEE approach and identification of 6 big lossess in manufacturing	OEE on the kneader machine is 81.62% with a percentage factor of six big losses in reduce speeds losses of 42.66% and idling and minor stoppages of 31.27% of all time losses.
22	(Habidin et al., 2017)	A Proposed TPM Tool for Lean Dashboard, Statistics and Performance at Manufacturing	The researchers propose a TPM tool that can be used as an important catalyst for finding maintenance performance that has an impact on company productivity and competitiveness.
23	(Brodny & Tutak, 2017)	Case Study Application TPM at Manufacturing	The study concluded that the use of coal mining machines in Poland was still ineffective, and this was a major problem to be solved.
24	(Venkateswaran, 2017)	Case Study TPM Practices Adopted at Manufacturing	The results showed that the increase in OEE was due to proper machine utilization and reduced scrap in the process.
25	(Amrussalam et al., 2016)	Measurement and Repair of TPM in the Garment Industry	The factor greatly affects poor OEE, and reliability is downtime loss in the machine, which is 2394,8 sec / process / day or 88,07%.
26	(Sethia et al., 2016)	Study Case TPM at Contemporary Manufacturing Scenario	The results of OEE calculations show that the availability rate reaches 93.48%, the quality rate reaches 70.90% and the process performance reaches 90.03%. and these results are still below the world class OEE standards.
27	(Nursubiyantoro et al., 2016)	Implementation of TPM in the Leather Gloves Industry	The OEE value achievement on the hydraulic atom press machine averaged 55.24%. The focus of improvement that causes loss factors for the Hydraulic Atom engine is the low average performance ratio of 62.11% because it is influenced by idle and minor stoppages and speed losses in the engine.
28	(Sariyusda et al., 2016)	Implementation of TPM in the Leather Gloves Industry	OEE average value in 2015 was 79.24%. Influential losses are breakdown losses of 29.64% and reduced speed losses of 10.70%.
29	(Krisnaningsih, 2015)	OEE approach to manufacturing	OEE in this study was 65.43%. The dominant analysis of Six big losses using Pareto diagram is setup and adjustment losses of 62.84% and reduced speed losses of 29.18%.
30	(Parikh & Mahamuni, 2015)	Case Study TPM at Manufacturing	This study highlights the importance of machine and equipment maintenance efficiency to achieve optimal equipment performance.
31	(Haryono & Susanty, 2015)	Application of TPM in Textile Manufacturing	From the calculations that have been done, the largest reduced speed loss defect is 12.952%.
32	(Arya Wiguna, 2015)	Implementation of the TPM Program in Manufacturing	Measurement of the effectiveness level of the CJ4 PT machine. KCI was carried out using the OEE method, its value is still low compared to the JIPM standard value, which is <85%.
33	(Jain et al., 2014)	Case Study TPM Implementation Practice at Manufacturing Organizations	The research results illustrate that most of the large-scale industries in the world have expected TPM to increase the performance of their companies, but the application of TPM in SMEs is still rare in India. This fact shows that SMEs in India need a TPM approach in improving performance, productivity, product quality, preventing equipment failures, reducing production costs, OEE and others.
34	(Nurfaizah et al., 2014)	The application of TPM in electrical equipment production companies	The results of the research on the Dobby 50 No.4, ISIS 40 No.1, use a maintenance schedule to minimize downtime.
35	(Dyah Ika Rinawati, 2014)	TPM Implementation at Manufacturing company	The biggest factor that affects the low OEE value is the performance rate with a percentage factor of six big losses at idling and minor stoppages loss of 41.08% of all time loss.
36	(Tondato & Gonçalves, 2013)	Case Study TPM in Manufacturing Industry	Overall productivity of industry increased. OEE value is encouraging and with the passage of time results will be quite good and may reach a world class OEE value of 85%-90%.
37	(Fahmi et al., 2013)	TPM Implementation at Manufacturing	The biggest factor that affects the low OEE value is the performance rate with a percentage factor of six big losses at the speed loss of 71.205% of the total time loss.
38	(Lazim et al., 2013)	TPM Performance at Manufacturing	The results indicated that TPM strategy and planned maintenance found to be related to cost.

No	Paper Identity	Research Object	Result
39	(Singh et al., 2013)	Case Study TPM Implementation at Manufacturing	There was an increase in product quality and productivity which resulted in an increase in equipment effectiveness from 63% to 79%.
40	(Anh, 2012)	Contribution TPM at Japanese Manufacturing Plants	TPM approach can facilitate organizations, especially manufacturers, to achieve good product quality and be able to compete with competitor manufacturers.
41	(Almeanazel, 2010)	Case Study TPM Review and OEE Measurement at Manufacturing	Calculation results obtained Quality rate (99%), Availability rate (76%) and performance rate (72%).
42	(Didikwahjudi & Soejonotjitro, 2009)	OEE approach and 6 big losses in manufacturing	Through the application of TPM the value of OEE in P.T. X can be increased from 67.76% to 81.88%.
43	(Ahuja & Khamba, 2008)	Case Study TPM Literature Review and Directions At Manufacturing	TPM has been proven to be an effective corporate strategy and has been implemented in various manufacturing industries in the world which provide consistency in achieving company performance.
44	(Wang, 2006)	Evaluating the Efficiency of Implementing TPM at Manufacturing	The efficiency score from the Data Envelopment Analysis (DEA) evaluation can be combined with the OEE score and the results can be used to classify factories from four categories.
45	(Liu & Rubert, 2005)	Mapping surface properties of sinusoidal roughness standards by TPM at Warwick University	In conclusion have demonstrated that the TPM is capable of measuring the geometrical and mechanical behaviours of the chosen roughness standard specimens under a controlled condition.
46	(Chan et al., 2005)	Case Study TPM in an Electronics Manufacturing	The productivity of the model machine increased by 83%.
47	(Nasurdin et al., 2005)	TPM on *Job Characteristics*	The results showed that employee involvement in the application of TPM had a positive effect on the five dimensions of work, namely: job identity, type of skills, special tasks, autonomous maintenance, and feedback.
48	(One Yoon Seng, Muhamad Jantan, 2004)	Case study at Manufacturing	It can be concluded that the extent of both the human and process-oriented strategies would lead to higher TPM implementation in the organization.
49	(Brah & Chong, 2004)	Impact of TPM on the Performance of the Organization.	The study finds significant support for positive correlation between TPM and business performance. It finds business performance of TPM firms to be significantly superior to the non-TPM firms.
50	(McKone et al., 1999)	Case Study TPM Contextual View at Manufacturing	The results showed that the managerial contextual factors from the direction of the factory manager to the workers greatly influenced the implementation of the TPM program.

Provides an overview of TPM practices in various manufacturing industries in the world globally. The table also suggests variables and methods suggested by researchers based on the problems faced with regard to equipment maintenance and the results achieved from each organization so that they can be used as benchmarking of the achievement of their application based on the type of similar business. Furthermore, it can be seen also the relationship between TPM and managerial practices in involving employees.

Total Productive Maintenance is a simple tool with many amazing benefits. The widely circulated literature from academics and practitioners has failed to identify contextual problems that affect the success and failure of TPM implementation(McKone et al., 1999). This paper will provide a complete description of the methods commonly used in each country in implementing TPM.

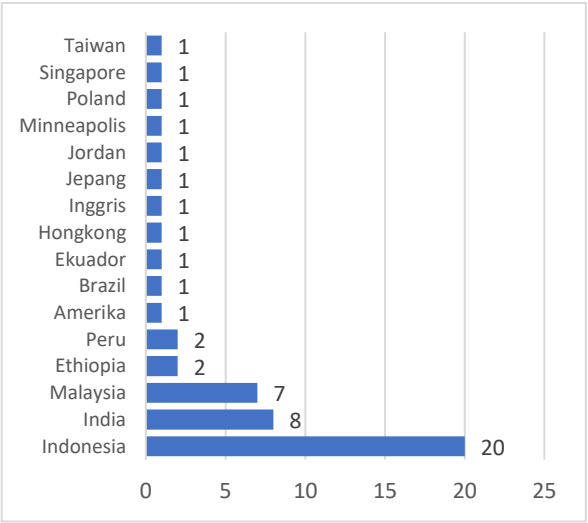

Figure 3. Country of Authors.

Performa: Media Ilmiah Teknik Industri
ISSN 1412-8624 (cetak) | ISSN 2620-6412 (online)
Vol. 20, No. 2, 2021, Hal. 97-108 doi.org/10.20961/performa.20.2.50087

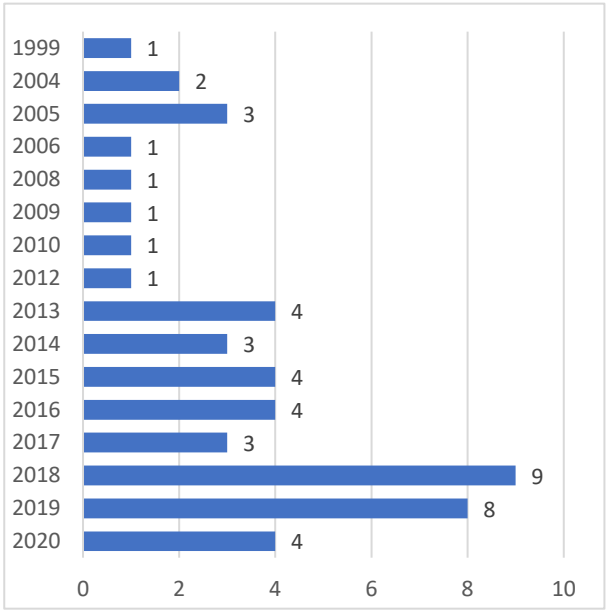

Figure 4. Years of publications.

Figure 3 stated that Indonesia is one of the countries that does a lot of research with the theme of TPM, namely as much as 40% of the sample taken, followed by India (16%), Malaysia (14%), Peru (4%), Ethiopia (4 %) and others each reaching 2%.

Figure 4 are years of publications are selected by five years range and not longer than 1999, and distribution of the year lead by the year 2018 (9 paper), 2019 (8 paper), In 2013, 2015, 2016 and 2020 there were 4 papers. In 2005, 2014, 2017 there were 3 paper, and the rest of the other years are around 2 and 1 papers

By understanding the contents of this sample of 50 journals, we can sort out what variables are best applied to our organization and can figure out the methods and results to be achieved later. Due to every country has a different work culture, this can affect the work ethic of each employee in receiving the TPM program. This literature will provide detailed information on the variables that are widely used by country. for detailed information can be seen in the following discussion

Tabel 2: Research variable base on country

Country	Research Variable											
	OEE	Six Big losses	JIT	TPM	SEM	RCM	TQM	FMEA	FUZZY FMEA	5S	RCFA	Lean
Amerika			1		1							
Brazil	1											
Ekuador	1											
Ethiopia	2											
Hongkong	1											
India	7			1								
Indonesia	20	7							1	1	1	
Inggris				1								
Jepang			1	1								
Jordan	1											
Malaysia	4			1	1	1		1				1
Minneapolis			1				1					
Peru	1					1		1				
Poland	1											
Singapore			1				1					
Taiwan	1		1									
Grand Total	40	7	5	4	2	2	2	2	1	1	1	1

Method Approach of Total Productive Maintenance dominated by OEE 60%, then Six Big Losses 10%, JIT 7%, TPM 6%, in this calculation one research paper can use more than one tools of Total Productive Maintenance (tabel 2)

3.2 The TPM method approach (OEE)

TPM focuses on zero breakdowns and zero defects. The target to be achieved is to eliminate 6 big losses consisting of breakdown machines, setup of equipment or adjustment losses, minor stopage or idling, reduced speed, defects and rework, and reduced production output due to less than optimal equipment conditions (Vigneshwaranp et al., 2015). TPM techniques that can be applied and provide benefits include 5S as the company's foundation, One Point Lesson as an indication of conditions before and after improvement, continuous improvement (kaizen), Autonomous maintenance, Pokayoke as an early detection of abnormalities that occur and others (Okpala et al., 2018). OEE methodology helps factory managers see the condition of their production systems by identifying and measuring the

results of OEE calculations and finding factors that cause problems and prioritizing improvements so that equipment performance can increase and reduce Cost Of Ownership (COO) (Ahuja & Khamba, 2008), OEE is used as a parameter of equipment performance in the factory and identifies problems in the production process for improvement (Muchiri & Pintelon, 2008). The most effective way to identify six big losses is to take the OEE approach (Okpala et al., 2018). Every manufacturing industry always tries to provide added value to the products produced, both goods and services. through OEE calculations we can measure the performance of the manufacturer and continuously provide added value to the customer. The OEE model that comprises of equipment timing, six big losses, and perspectives are shown below in figure 5.

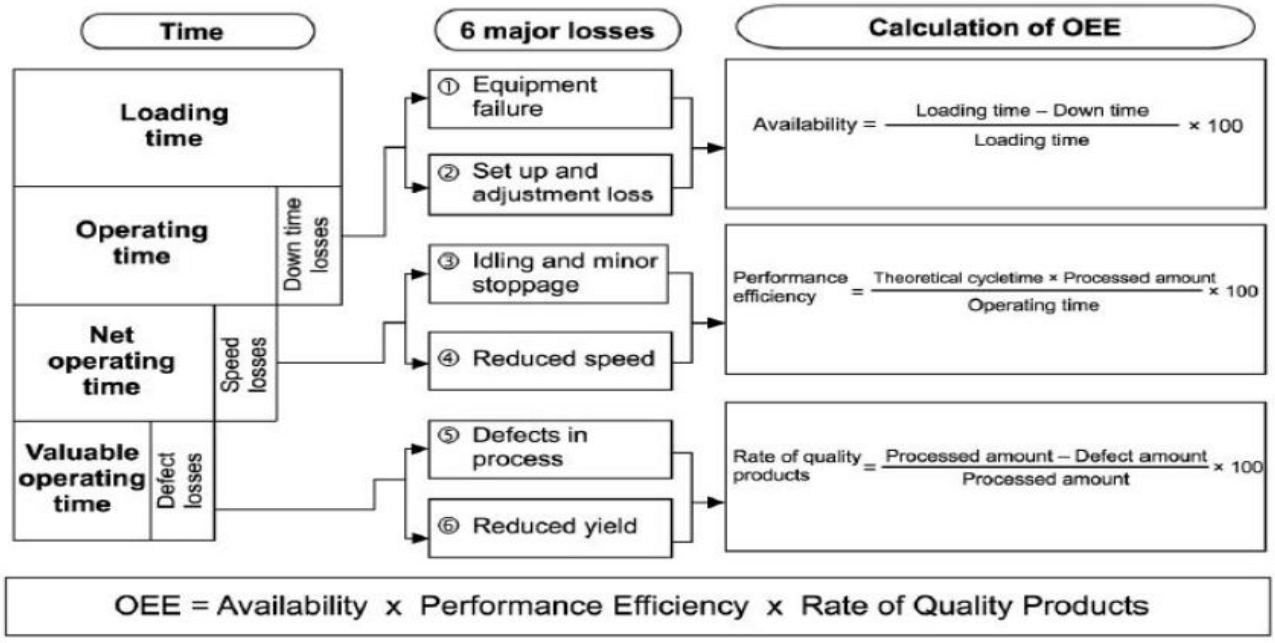

Figure 5. The OEE Model and the Six Big Losses
(Source: Ahuja & Khamba, 2008)

3.3 Success factors for TPM implementation

TPM literature presented in this paper summarizes some of the success criteria in implementing TPM in various manufacturing industries. The first key to success is that we need to combine strategic plans and targets to be achieved. Top management commitment in supporting TPM activities is needed. Because TPM involves many workers, the second key to success is the commitment of all workers in the organization, so that teamwork from various functions is also one of the keys to organizational success, without realizing it this teamwork turns into a positive work culture. Third, it is necessary to change the attitude and point of view of production personnel regarding equipment maintenance so that there is a need for training to workers about the goals and philosophy of TPM. Fourth is the application of the eight pillars of TPM to overcome abnormalities in equipment such as autonomous maintenance, planned maintenance, focus of improvement, preventive maintenance, quality maintenance and others. this activity is to improve the performance of existing equipment in our organization. An overview of the key model for success can be seen how to maintain facilities as shown in Figure 6

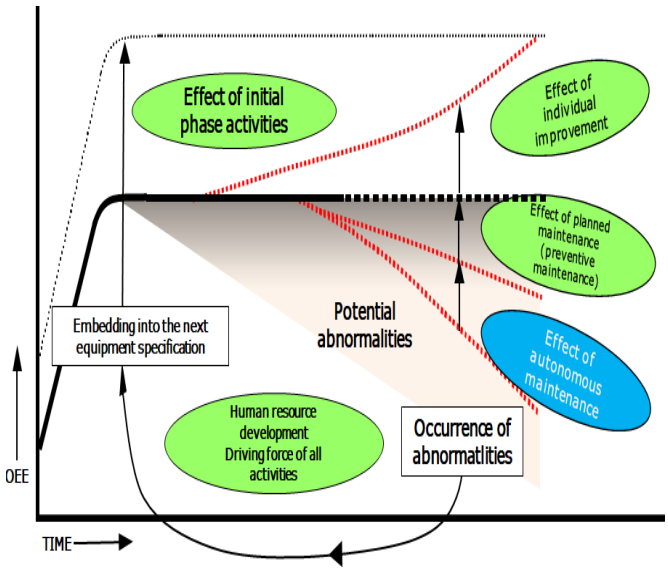

Figure 6. Main activity model of facility maintenance
(Source: Motors, 2018)

3.4 Failure factors in implementing TPM

The literature on the application of TPM obtained the calculation results of equipment performance without discussing the obstacles in its application. TPM Implementation is not an easy task, manufacturers that have successfully implemented TPM are still relatively small and there are still many failures in its application. This failure can be caused by the commitment and consistency of management that changes in its application, which makes employees confused about the direction and goals to be achieved. a company culture that is not ready to accept changes is also one of the obstacles in implementing TPM, implementing some TPM and excessive expectations of the results to be achieved are also part of the constraints. Employees need the same point of view in its application, the lack of training and education makes employees not aware of the goals and philosophy of TPM itself. The implementation of TPM is not a prestige in itself but a tool by which the organization can achieve its goals.

3.5 Gaps in the current literature on TPM and agenda for future research

The literature that we discuss about TPM is how we improve the performance of equipment in the manufacturing industry with various methods offered in order to get organizational efficiency and effectiveness. The discussion of this paper does not discuss the data collection techniques from the equipment that we use. Along with the development of our times, it is easier for us to collect data on equipment that is more efficient and real time by using IoT, where the equipment is connected to the internet network and convey information in real time. This IoT is one of the tools in industry 4.0

Industrial Revolution 4.0 is a term that is familiar to society. Industry 4.0 is a big leap in the manufacturing sector through the maximum use of information and communication technology. Not only in terms of production, but also the entire value chain to achieve optimal efficiency so as to give birth to a new digital-based business model. The industrial revolution 4.0 is believed to bring many changes with all the consequences.

In future research we need to improve equipment efficiency by combining 3 components such as Lean, TPM and Industry 4.0 to maximize organizational performance and eliminate waste. equipment needs to be installed with sensors and build automation of processes that are connected via the internet network, so that any abnormality in the production process can be known in real time so that we can quickly take corrective action. Future reasearch frame work shown in figure 7.

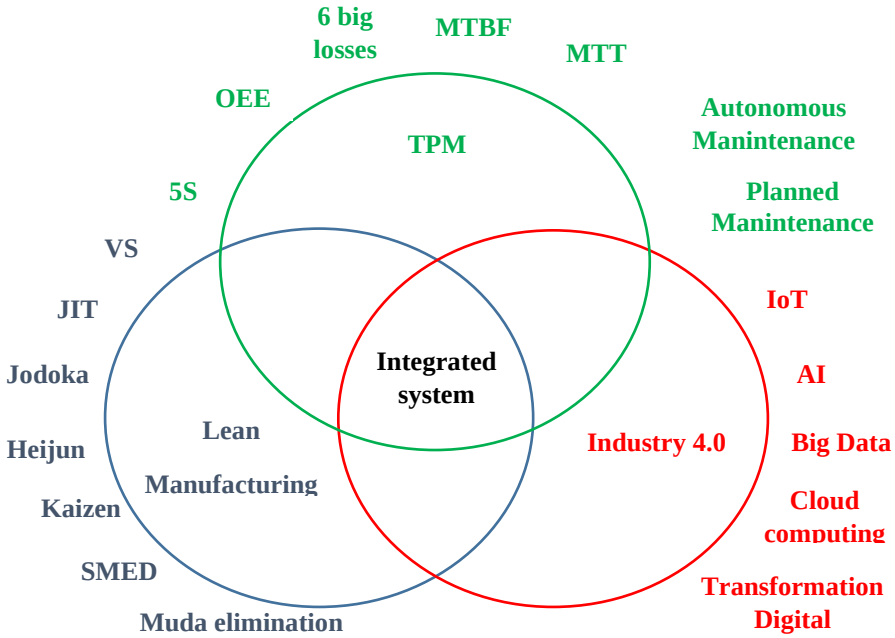

Figure 7. Future Reasearch Framework

4. Conclusion

The literature highlights various problems faced by manufacturing that can be resolved by implementing TPM as an organizational strategic in facing global competition. This TPM is here to provide solutions to improve equipment performance in organizational environment. Based on review results of the 50 journals about TPM in industries It was found that most of the TPM implementations used the OEE parameter to see the success rate of implementing this TPM.

TPM techniques must be understood through training and education, if employees understand the philosophy of TPM and combined with commitment from top management and the involvement of all employees in implementing TPM is the key to the successful implementation of TPM in realizing zero breakdowns, sero defects and zero accidents.. In the

future research can be developed TPM of basic concepts and enhancement by further develop the scientific basis for basic concept; extends the capabilities of TPM and determines whether it is necessary to develop new tools to strengthen the methodology which is provide highest potential contribution for TPM knowledge. As well as combining TPM with existing tools in Industry 4.0 to get real time information from equipment and also integrate with lean manufacturing to identify and eliminate wastes that occur in organizations. The combination of these 3 tools (TPM, Industry 4.0 and lean manufacturing) is expected to achieve the overall organizational goals, namely profitability and competitiveness.

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