

A SYSTEMATIC LITERATURE REVIEW OF OVERALL EQUIPMENT EFFECTIVENESS IMPLEMENTATION IN ASIA

Dias Irawati Sukma, Indra Setiawan, Humiras Hardi Purba

Master of Industrial Engineering Program at Mercu Buana University
Meruya Selatan Street No 1, Kembangan, Jakarta 11650, Indonesia
Email: diasirawati2005@gmail.com

ABSTRAK

Abstrak: Overall equipment effectiveness (OEE) adalah pendekatan yang digunakan untuk mengukur produktivitas peralatan ataupun mesin. Tujuan dari makalah ini adalah untuk mengidentifikasi, meninjau dan menganalisis pendekatan OEE. Pengetahuan yang lebih spesifik tentang OEE telah berkembang pesat. Banyak penelitian tentang OEE dilakukan di berbagai industri untuk mengukur produktivitas peralatan atau mesin. Makalah ini melibatkan studi review dari 30 makalah yang terkait dengan implementasi OEE di berbagai industry. Makalah ini memuat hasil dari berbagai aspek yang berbeda. Aspek itu meliputi fokus industri, fokus jumlah distribusi menurut negara dan fokus tahun publikasi. Makalah ini bermanfaat bagi semua jenis sektor industri untuk mendapatkan solusi permasalahan pada performa peralatan ataupun mesin. Makalah ini juga memberikan keuntungan bagi peneliti selanjutnya untuk menambah wawasan dan referensi untuk studi terkait OEE di berbagai industri.

Kata Kunci: OEE, performa mesin, industri 4.0, tinjauan literatur

ABSTRACT

Abstract: Overall equipment effectiveness (OEE) is an approach used to measure the productivity of equipment or machines. The aim of this paper is to identify, review and analyze the OEE approach. More specific knowledge about OEE has grown rapidly. Much research on OEE is carried out in various industries to measure the productivity of equipment or machines. This paper involves a review study of 30 papers related to OEE implementation in various industries. This paper contains the results of many different aspects. These aspects include focus of industry, focus number of distribution by country and focus year of publication. This paper is useful for all types of industrial sectors to find solutions to problems with equipment or machine performance. This paper also provides an advantage for future researchers to add insight and reference for OEE-related studies in various industries.

Keywords: OEE, performance machine, industry 4.0, literature review

1. Introduction

In competition in the international market a business strategy is needed to win the competition, because this is a competitive advantage. The business strategy to achieve competitive advantage is the success in maintaining or maintaining a machine so that engine performance remains reliable and maintained. OEE exists as an approach to make it happen. Today, OEE is one of the most popular engine performance enhancement innovations in various industrial sectors, including the

manufacturing industry. Within the Industry 4.0 framework, digitizing production processes in factories and collecting data are important to improve business efficiency. OEE is an approach introduced by Nakajima in 1988. This approach was developed as part of the TPM strategy to measure the productivity of equipment or machinery in various industrial sectors. OEE is the comparison of productivity between real production systems and ideal production capabilities. This indicator is widely accepted as a tool by some companies, for example when implementing lean manufacturing or maintenance and maintenance programs to monitor the performance of equipment or machines. In general, OEE can be calculated using the formula

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality} \quad (1)$$

OEE value is measured from 0-100% (the higher the percentage, the better)

According to Nakajima (1988), there are six equipment losses that cause the low performance of machines and equipment. The six losses are known as Six Big Losses, namely: 1) Planned engine downtime (Planned downtime). 2) Machine downtime is damaged/ unplanned (Unplanned Downtime). 3) Loss on short/ temporary stops (Minor Stops). 4) Loss of slow running time (Speed Loss). 5) Rework Loss. 6) Loss of time for defective goods (Reject Loss). In its implementation, OEE (Overall Equipment Effectiveness) provides benefits including: 1) Determining the starting point of the company or equipment/ machines. 2) Identifying bottleneck events in the equipment/ machine. 3) Identifying true productivity losses. 4) Determining priorities in an effort to increase OEE and increase productivity.

2. Method

This paper presents the best steps for studying and analyzing OEE for application in various industrial sectors. This paper is also to find solutions to improve the performance of machines or equipment. This study paper begins with the collection of various papers from 2012 to 2020. The keyword in the search for the paper used is "Overall equipment effectiveness".

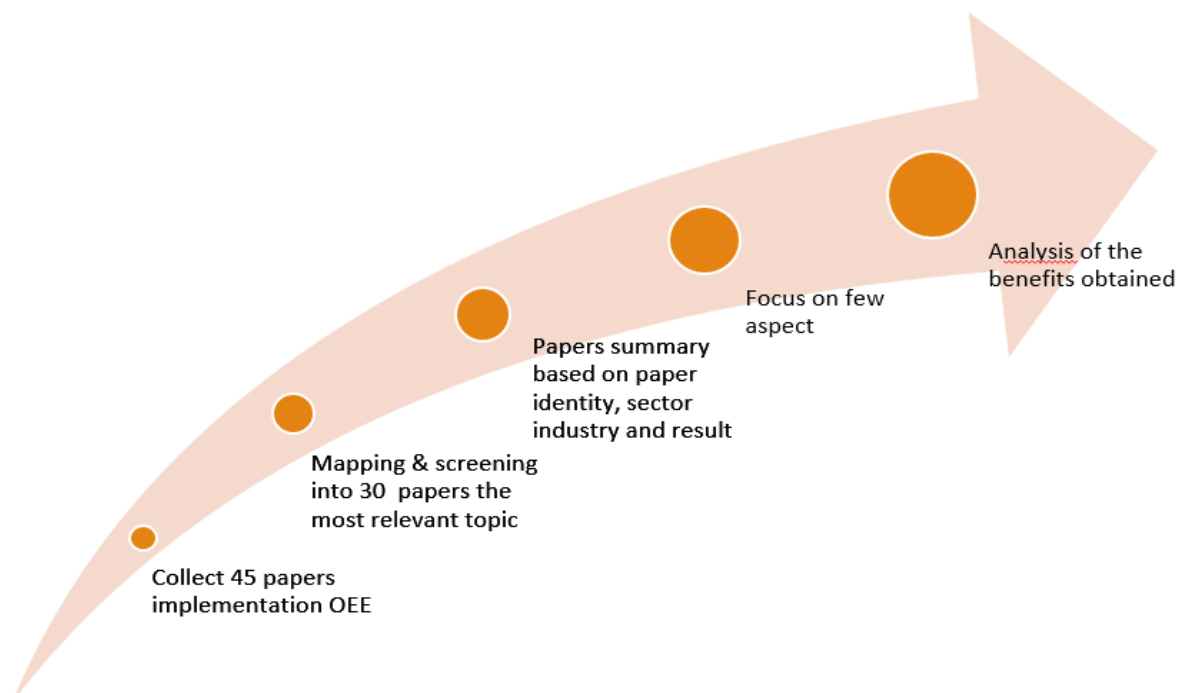


Figure 1. Literature Framework Study

In order for this paper to be structured specifically, clearly and directed, it is necessary to carry out the following stages:

- First step: Paper submission: 45 papers have been successfully submitted with the keyword Overall equipment effectiveness
- Second step: Screening: Screening and mapping several articles into 30 articles according to the relevant theme topics.
- Third step: Paper summary: Summarize all relevant articles based on paper identity, industrial sector and research results.
- Fourth step: Focus several Aspects: Group all articles into several aspects, namely, industry focus, focus area of publication, focus of publication year.
- Fifth step: Benefit analysis: Analyze the benefits of each article.
- For more details on the literature review steps in this paper, see Figure 1.

3. Result and Discussion

This paper resulted in a screening of 30 papers from a total of 45 papers collected. Before the analysis is carried out, the papers are grouped first so that they will be easy to analyze. The following is a summary of each of the selected papers, can be seen in Table 1.

Table 1. An existing literature review of Overall Equipment Effectiveness

No	Paper Identity	Research object	Result
1	[1]	Industry Transportation	The results of the OEE measurement show that machine failure is the main cause among the other 6 factors
3	[2]	Food and Beverage Industry	Reduce the damage rate from 74.6% to 69.7%
4	[3]	Automotive Industry	Increase the OEE value by 6.06%.
5	[4]	Automotive Industry	cylinder block engines, OEE increased from 87% to 92%.
6	[5]	Health Services	The OEE value of Dental Chair tools is 18.7%, still far below the 85% standard.
7	[6]	Electronic Industry	Reduced Speed Loss 39.12%. Loss of equipment cost Rp. 849,839,947.53
8	[7]	Food and Beverage Industry	The OEE value shows the effectiveness of the baking cone machine in the last three months of 82%.
9	[8]	Electronics Industry	Performance rate decreases by up to 63.5% due to speed losses
10	[9]	Electronics Industry	8 Pillar TPM has a high significance to production performance even though only from the high OEE value $R = 0.862$
2	[10]	Garment Industry	Successfully increasing the OEE value on semi-automatic cutting machines increases by 18%
11	[11]	Packaging Industry	Current OEE condition is 65.43% due to the dominant losses, namely 62.84% setup adjustment, and 29.18% reduced speed.
12	[12]	Sport Shoes Industry	OEE shows an average increase from 2017-2018 (average OEE 2017: 61.37%, average OEE 2018: 72.24%).

No	Paper Identity	Research object	Result
13	[13]	Health Service	The industry standard for OEE states that 40% effectiveness is low efficiency, 60% typical, and 85% world class efficiency for engines
14	[14]	Automotive Industry	OEE can analyze failure and repair data production and eliminates the root causes of damage and losses lost speed.
16	[15]	Steel Industry	Seen from the six factors of Six Big Losses, the greatest value is in the Equipment Failure factor
17	[16]	Electronics Industry	Drying Oven Machine succeeded in increasing the OEE value from 56.71% to 92.16%.
18	[17]	Food and Beverage Industry	The Performance Variable (OEE) of 73.4% of the performance characteristics can be explained and influenced by the TPM Pillars (6 pillars).
19	[18]	Electronic Industry	The result of quality assessment is 95.76% - 96.11%.
20	[19]	Electronic Industry	Increased value of OEE seven month
21	[20]	Service Industry	Value of the effectiveness of the three machines SOLNA WEB can be known through the OEE calculations has been done, until it gets results with a mean value on SOLNA WEB machine
22	[21]	Electronics Industry	OEE analysis large losses were obtained reduce the speed loss
23	[22]	Drug Industry	Increase productivity in blistering machines succeeded in increasing OEE from 49.05% to 64.05%
24	[23]	Services Industry	The value of painting services of availability is 95.33%, the performance value is 76.2%, the quality is 97.4%.
25	[24]	Food and Beverage Industry	Human error in maintenance has a significant positive relationship with OEE
26	[25]	Electronics Industry	OEE increased from 45.36% to 60.38%. Due to the increase in OEE, tire production increased from 2600 tires to 3800 tires
27	[26]	Automotive Industry	The application of maintenance has succeeded in reducing the defect rate. Reduced engine breakdown time and OEE is increasing
28	[27]	Food and Beverage Industry	The main factor causing the drop in OEE value is that the machine operator takes a long time to prepare the machine
29	[28]	Electronics Industry	Assessment of the appropriate OEE planning System for Performance implementation at an early stage in an OEE organization

No	Paper Identity	Research object	Result
29	[29]	Automotive Industry	This company achieves quick improvement in machine breakdown
30	[30]	Automotive Industry	The OEE analysis explains that OEE is 67% and the six major losses represent 35% of product time loss

Based on Table 1, it can be seen that this paper summarizes 30 articles related to the application of Overall Equipment Effectiveness in various industrial sectors and is summarized based on the identity of the paper, the industrial sector and the research results obtained.

3.1. Article Classification into Several Aspects

In this paper, the articles on which OEE are most predominantly implemented in the electronics industry (Figure 2) are traced from publications ranging from 2012 to 2020 (Figure 3). OEE is considered as a new innovation in improving the performance of machines or equipment. The success of OEE in various industrial sectors has received significant benefits for the related industrial sectors. When applied in the electronics industry, OEE can reduce speed loss by 39.12% and reduce equipment cost losses by Rp. 849,839,947.53 [6]. When applied in the food and beverage industry, OEE can analyze the main factors that cause machine setup failure, namely that machine operators need a long time to prepare the machine [27]. When implemented in health services, OEE can improve device performance so that the services provided increase [5]. When applied in the automotive industry, it can increase production productivity due to good engine performance [14].

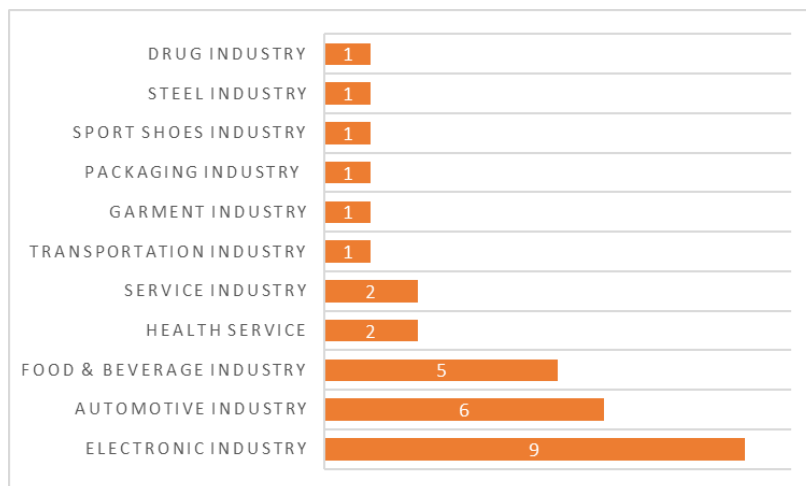


Figure 2. Industry sector focus

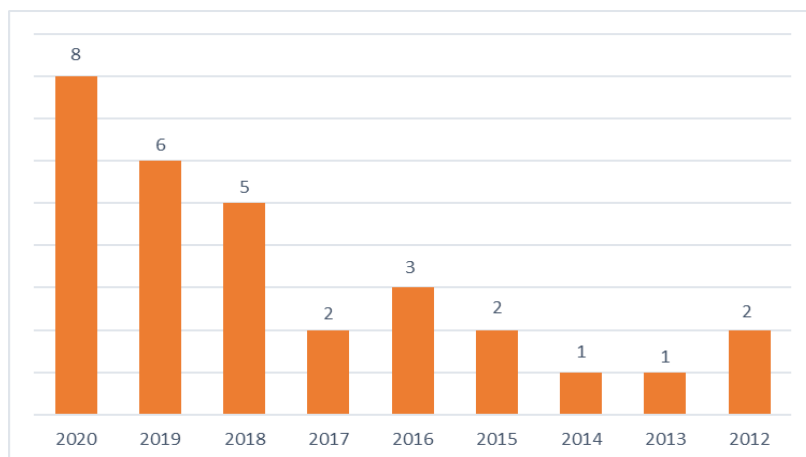


Figure 3. Focus year of publication

In its implementation, OEE is often integrated with various methods of measuring machine performance values such as Lean Manufacturing [3], Single-Minute Exchange of Die [10], Total Productive Maintenance [11]

This paper identifies the distribution of OEE implementation publications in various industrial sectors based on identified regions (Figure 4). In this paper, Indonesia is the largest supplier of publications with 67% followed by Malaysia with 14%, India 13% and Bangladesh and Vietnam with 3% each.

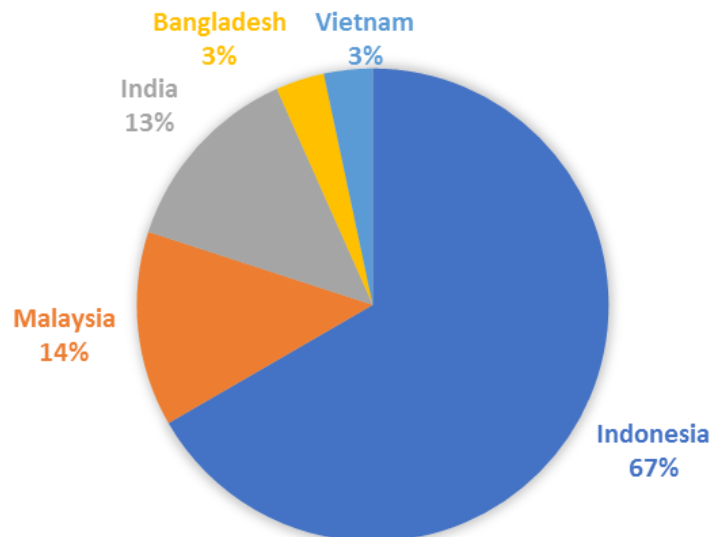


Figure 4. Focus area of publication

3.2. The Benefits of Implementing OEE

OEE brings significant benefits to various industrial sectors. This is because OEE can be the basis for improvement activities such as reducing downtime, reducing equipment and maintenance costs, a more efficient workforce, increasing productivity with fewer obstacles, and improving product quality and reducing waste. But OEE is an excellent calculation for a productivity benchmark

3.3. The Relationship Between OEE and Industry 4.0

In accordance with industry 4.0, this OEE concept needs to be redefined to suit the modern manufacturing world. Industry 4.0 is based on cyber physical systems and digitization of information, facilitating the accumulation and transformation of real-time information processing into decisions to reduce uncertainty in outcomes.

Industry 4.0 is characterized by the role of the IoT, Artificial Intelligence, Cloud computing, Real-time etc. In fact, in improving engine performance, a sensor is needed. The implementation of this sensor is to detect abnormalities such as vibration, temperature, running and others. This sensor will transfer normal conditions to the cloud via IoT. This sensor can inform about abnormalities in real time. If there is excessive vibration or high temperature, it means that the machine will breakdown. Then we can have a quick response to prevent a breakdown in the middle of production. If a breakdown occurs during production, it will hurt the company. The losses include operators stopping work, defective goods, stop lines during production hazards and others. With this, the importance of the role of IoT in its implementation in improving machine performance.

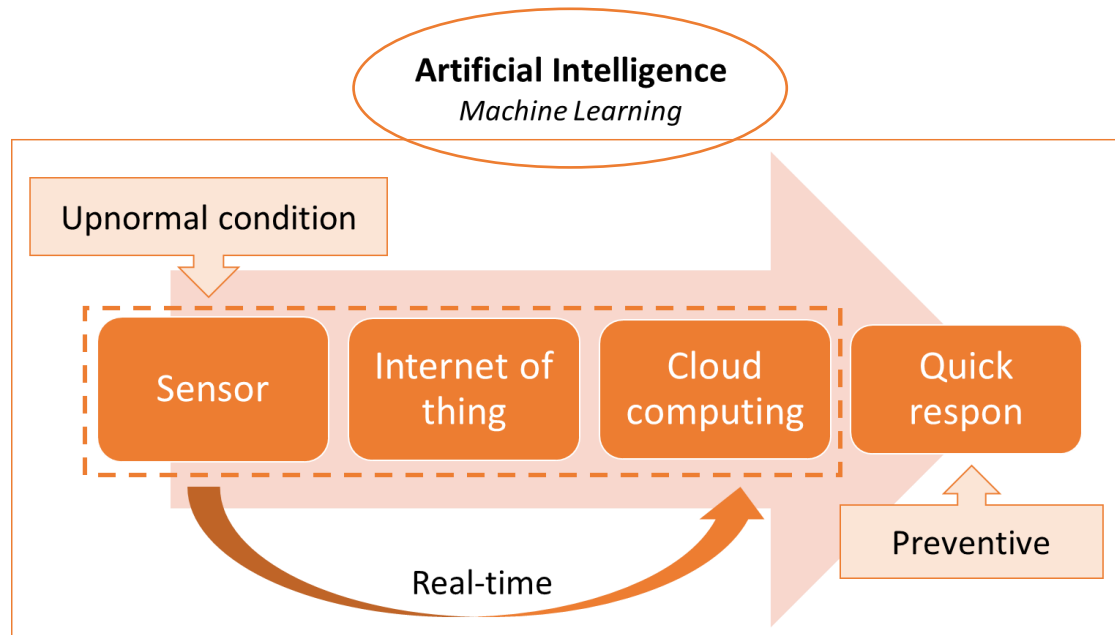


Figure 5. Machine Learning cycle in industry 4.0

3.4. Agenda for further research

Future research on OEE can be implemented in the transportation sector and can be included in the formulation of equipment or machine variables, such as modes of transportation. Meanwhile, in the service sector, OEE can be used to measure customer satisfaction in terms of availability, performance and quality of service received. In the supply chain, OEE can be used to measure the productivity of cargo moving equipment in the warehouse. In addition, the OEE-based model can be implemented in measuring employee performance. OEE is incorporated into the balanced orecard to visualize real-life business productivity. This measurement variable provides an overview of the business and in order to achieve the main objectives of production, namely increasing productivity and reducing waste.

4. Conclusion

The main focus of OEE as a method or approach used to measure the performance of equipment / machines, so that machines display reliable performance when used. The literature on this paper shows that studies focus on OEE to improve equipment or machine performance, improve service, increase production volume, create quality products, maintain operator safety while using machines and eliminate repair and setup times.

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