Implementation of Overall Equipment Effectiveness (OEE) in Maintenance Management

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Abstract

This research paper discussed the implementations of Overall Equipment Effectiveness (OEE) in maintenance management. This narrative research is based on the review of previous studies. Literature review is summarized, discussed and presented in tables. Since, the efficient & smooth flow of production system has been the severe concern in maintenance management due to its association with cost; thus it has been the focus of academicians and practitioners to study and implement effective maintenance management philosophy. Since, OEE is an effective technique for the efficient & smooth flow of production system and its techniques have captured the immense attention of academicians and practitioners for maintenance management. Therefore, there is an extreme need to conduct such studies about the usefulness and drawbacks of OEE implementation. In future, other maintenance management philosophies can be discussed in depth to put clearer and broader picture and to draw more comprehensive conclusions. Moreover, existing studies lack to investigate the implementation in various sectors. Studies related to OEE are significantly important in the development of maintenance knowledge due to variations in industrial sectors. In this regard, present review is conducted to put the open and broader picture of Overall Equipment Effectiveness (OEE) implementations in maintenance management comprehensively.

Keywords:

overall equipment effectiveness (OEE); lean manufacturing; maintenance management; Total Productive Maintenance (TPM); lean tools.

1. Introduction

Currently around the globe, companies based on manufacturing require to keep their production level sustainable as per customer demand. When they appears any capacity related problem, instantly they look ahead to increment in number of shifts, increases overtimes and purchase new equipment or machines(NALLUSAMY et al., 2018). During manufacturing process, the machines plays a pivotal role to keep the production smooth in other case production can confront several inhibits(Nurprihatin et al., 2019). On the other hand, the focus should remain on harnessing better resources and surging in performance of the machines that already exists which could pursue in reducing bottlenecks, improvising performance of equipment, curb overall downtime, turn operator performance efficient and reduce setup time and other loses, hence enabling in any decision on the investment of purchase of new machines (NALLUSAMY et al., 2018). In order to stay competitive and confront market pressures, companies requires to bring efficiency and productivity. Since very long, several companies are utilizing lean manufacturing

systems pursuing Toyota model to curb wastage in-process and expand their added value(Lugert et al., 2018). Lean manufacturing has resulted in recent time as a resilient substitute that, if adopted at balance level by various actor through supply chain, deduce satisfactory results in making significant profits (Romero & Arce, 2017).Toyota in the 1940-50s developed it, since then, lean has proven to be one of the significant managerial paradigms in business environments as empirical and theoretical evidence has highlighted its efficiency to expand the organizations' competitiveness(Garza-Reyes et al., 2018). The commencement of lean manufacturing was developed to reduce down waste in the automobile sector, (De Steur et al., 2016) defined at as "a system that utilizes fewer inputs and creates the same out- puts while contributing more value to customers".

Rajput et. al. (2020) conducted the case study at the automobile assembling plant to improve the productivity. The authors applied the lean tools and techniques to identify the causes of low productivity and proposed the lean manufacturing practices for the expected productivity improvement at the automobile assembling plant. The authors have also compared the the pre and post productivity measures. Khan et. al. (2020) conducted the comprehensive review of lean manufacturing in Pakistan. The authors have identified the potential, benefits and applications of lean manufacturing in the various manufacturing sectors of Pakistan. The authors have mentioned the case studies to support the growing awareness and increasing scope of lean manufacturing in the major industrial sectors of Pakistan. Sahito et. al. (2020) conducted the case study at the pharmaceutical plant to Identify, analyses and elimination the Lean Manufacturing Wastes through Lean Manufacturing Practices. The authors have identified the lean manufacturing wastes in pharmaceutical plant by lean standards and then analysis is performed by using the statistical tools and techniques. The authors, then suggested the most suitable lean practices for eliminating/reducing the most significant wastes at the pharmaceutical plant and compared the pre and post scenario.

In between the process and quality, there is the greater and important role of machine and equipment. In this regard, companies take good care of their machines by the help of maintenance staff. The lean tool that presents an interlink between maintenance and performance is 0EE, for improvement of product quality in continuity, the capacity of machinery, operational efficiency(S. Singh et al., 2020). In the current changing business environment maintenance is more challenging. Which is considered to be fundamental for strategic decisions in operations management(Kumar Gupta & Garg, 2012).OEE includes three pronged measuring metrics such as performance availability and quality. This is instrumental in gauging the plant's efficiency by highlighting categories of key losses that has an impact on manufacturing process. The reduction in downtime can be secured by availing OEE to achieve efficiency into machine status and to carry out analysis of root-cause of problems(NALLUSAMY et al., 2018). In the present research paper, literature review of one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) has been conducted in the context of different industries.

2. Research gap

Since, lean is waste elimination technique and its tools have captured the immense attention of businessmen and the academicians. It has been reported that studies lack which examine the lean tools implementation in various sectors. Such studies are significant and need of the hour for the development of lean knowledge because individual sectors have fundamental variance in their construction, production or service processes (Shou et al., 2017). In this regard, present review was conducted so as to put the open and broader picture of one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) comprehensively.

3. Aim and objectives

This research aimed to present the applications of one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) in the various industrial sectors along with its effectiveness, impacts and its useful outcomes after implementation.

- To discuss the applications of Overall Equipment Effectiveness (OEE) in various types of industries in detail
- To highlight the effectiveness of mentioned tools in industrial productivity

4. Research methodology

A narrative literature review was conducted to put the detailed and broader picture of one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) in terms of its implementation in industrial world. For the analysis of

literature, narrative review is used and it enables an extensive understanding of problems and controversies associated with the use of technology and at the same time, it helps to take out the key success factors of adopting and using technologies (Frennert & Östlund, 2018) . By this method, researchers conduct analysis of debates and outcomes of already conducted research; moreover, it helps in figuring out the research gap and future implications (Ferrari, 2015). Present research paper, summarizes the data and evidences as collected from the previously conducted research on the implementation of one of the major lean tool i.e. Overall Equipment Effectiveness (OEE).

4.1 Data Collection

This narrative research was based on the secondary data which was collected from the previously conducted empirical studies, case studies and literature reviews. Research papers on the implementation of mentioned lean tools were downloaded and most suitable research papers on the one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) were considered for the literature review. The data was extracted from those papers and was organized into the tables.

4.2 Data Analysis

Literature review was presented and summarized in the form of tables and graphs. For the data analysis of the collected data, MS excel was used for data organization in tables and plotting graphs.

5. Literature review

Literature review has been carried out on one of the major lean tool i.e. Overall Equipment Effectiveness (OEE). The literature review is produced under multiple headings and summary.

5.1 Overall Equipment Effectiveness

Issue related to the effectiveness/performance of the equipment and machinery cannot be separated from the company. It is visible from the engine that works every day without any impediment results in no quality of products related to quality standards fix by the company(Siregar et al., 2018). It was indicated by Nallusamy et al., 2018 that, the only influencing parameter is not downtime losses, but machines' idle time is another factor that adds to the variation in overall equipment effectiveness (OEE). Which is a process to minimize impediments operations of a specific process to certain extent(M. Singh & Narwal, 2017).A method that is used to gauge the efficiency of machine with three pronged measurement factors such as performance rate, availability rate and quality rate is Overall Equipment Effectiveness (OEE) (Tobe et al., 2017). Kumar et. al. (2020) conducted the case study at the automobile assembling plant for the performance evaluation by Lean Manufacturing tools and techniques. The authors have evaluated the performance of the machines and equiplments of the automobile assembling plant by lean tool of Overall Equipment Effectiveness (OEE). The authors, then comparednd OEE performance of the plant with world class OEE and suggested lean practices for improving the OEE performance of the automobile assembling plant. Moreover, percentage OEE can be turned into more effective substantially through implementation of total productive maintenance lean tools such as Kaizen, JishuHozen etc. in a manufacturing company(NALLUSAMY et al., 2018). In recent changing environment, the competition among organizations has assisted in maintenance activities to specify demands in manufacturing organizations(S. Singh et al., 2020).OEE can be incremented by reducing the changeovers losses and reducing the breakdowns which are related with availability and by reducing setup scraps losses and the defects that are linked with quality(M. Singh & Narwal, 2017). OEE, business performance and recent advancements in technology in this globalized work affect manufacturing system.Competition across the globe has made it essential for the formulation of both effective paradigms and efficient in response to the global economies for the purpose of improving the collective performance (Esmaeel et al., 2018). OEE has been a popular trend in managerial approaches across the globe. The collective equipment effectiveness (OEE) is a metrics to critically evaluate how successful a manufacturing operation is managed (Esa & Yusof, 2016). A few relevant researches are conducted on the subject of OEE which is presented below.It was focused by Nurprihatin et al., 2019 on the topmost downtime that happened in a specific product line and critical machine. The purpose of this research is to make the machine's performance and ability more efficient. We avail the use of Total Productive Maintenance (TPM), which initiates by gauging Overall Equipment Effectiveness (OEE) and Six Big Losses. This research depicts the impact of the low value of OEE, provided the performance maintenance policy according to MTTR and MTBF, and the implementation of proposed TPM.The value of Overall Equipment Effectiveness (OEE) value for WP-ATB 08 machine on line 7 in the packaging area was 71.27% with performance, availability and quality value are 82.56%, 90.83%, 95.04%. However, this OEE value has not achieved

the world class standard value (85%) and the least value is the availability factor in terms of percentage disparity from its individual world-class standard (7.44%).Thus, we dig deeper into the significance six major losses on the machine, such as breakdown losses (11.67%), pace losses on idle, setup and adjustment losses (5.76%), and miniature stoppage (4.11%), lessen speed losses (7.62%), re-work losses (0.67%), and scrap losses (2.87%). It was explored at the pinnacle contribution to the low OEE value is breakdown losses. In handling breakdown losses, we provide the information about the MTBF and MTTR are equal to 2313 minutes and 289 minutes. To add more, we suggest the company implement the 5S to increase the effectiveness and 8 pillars of TPM (Nurprihatin et al., 2019).

Khan, Marri & Khatri (2020) conducted the exploratory study to explore the major lean manufacturing practices in the textile industry and highlighted the applications of popular lean practices for the textile industry. The authors mentioned the substantial benefits of the applications of highlighted lean practices including Overall Equipment Effectiveness (OEE) in the specific segments of the textile industry.

It was carried out by Siregar et al., 2018 at a fertilizer company in Sumatra, where in order to meet customer needs produce fertilizers in the unit Plant Urea-1 as a whole then utilize method of Overall Equipment Effectiveness (OEE), that is a significant element in the Total Productive Maintenance (TPM) to gauge the machine's effectiveness so that it can take measure to keep that level.

Especially, In July, August and September OEE values above the standard set at 85%. Moreover, in October, November and December have not met the OEE values standard. To include further, the least value of OEE due to lack of time availability of machines for the production shut down due to the occurrence of the engine long enough so that the availability of reduced production time. 1. The value of OEE obtained during July, August and September 2016 has reached the expected standard, highlighting that the machine is being used efficiently. 2. suggested in improving the effectiveness of the machine on the Urea-1 Plant Unit can be implemented with the increase of Preventive Maintenance that is to inquire the machine quarterly and perform on and off maintenance (Siregar et al., 2018).

In 2018 Nallusamy et al., carried out a research, in order to secure overall equipment effectiveness (OEE) – total productive maintenance was implemented in proximity to high class standards. During calculation of OEE, the influencing factors are identified and performance improvement measures are undertaken. From the derived results. As It was highlighted that, the percentage OEE can be alleviate from 55.45% to 68.04% by executing this technique in medium scale industries. From the past experiences, before the implementation of TPM and OEE is 55.45% only. After successful implementation of TPM it was found that OEE is argued to 68.04%. Thus, the OEE has been incremented about 13% by curbing out the rejection rate and overall cycle time to achieve the demand at high time (NALLUSAMY et al., 2018).

Singh and Narwal, 2017 undertaken their research in the product manufacturing industry and OEE concepts are examined in the different lines (housing, assembly, pinion etc.). The three pronged parameters such as performance, availability and quality of the process are highlighted for this objective. Due to these effects of factors affecting OEE are analyzed. Even quality is good and performance is maximum, but due to reduced availability, OEE get affected and its value ended nearly to the value of availability.It is found from the deduced results that performance is better than or equal to that of availability due to availability takes into account downtime loss. Whole plant OEE is 88.72% which is acceptable as per world class OEE it should be more than 85%.It is found from the data calculated that if we want to surge OEE from calculated value we need to improve quality and availability(M. Singh & Narwal, 2017).

Esa and Yusof, 2016 focusedon employees' implementation of OEE in HicomDiecastingsSdn Bhd. The implementation of OEE in HicomDiecastingsSdnBhd is intended to be a cornerstone of competitiveness in order to fulfill customers' satisfaction as well as to achieve sustainable competitive advantage. Importantly, employees are regarded as the most important entity in ensuring that OEE can be carried out successfully in an organization. Since this research involves the staff (executive and non- executive employees) of HicomDiecastings, the unit of analysis is the individual. Respondents were identified through convenient sampling. 300 questionnaires were administered, examined and analyzed using the Statistical Package for Social Sciences version 12.0. Prior to the survey, this paper is to provide a critical review with graphical or visualize information and understanding of the OEE implementation in the past, present and future undertaking. The design of this paper includes a brief introduction of OEE and its approaches, methods, survey, discussion and conclusion. Present survey of 2008 until 2015. The findings was again

highlighting the important of executing planned maintenance as a significant pillar towards obtaining a better result on OEE, followed by focus improvement and education or training provision (Esa & Yusof, 2016).

Singh et al., 2020 carried out their research to establish the assistance of OEE proposals for achieving core competencies in process industries. Though, sector-wise execution of the plan for all process industries can also be achieved to evaluate the contributions of OEE in the industrial sectors. The plan of the study is to spot the impact of key OEE proposals and dimensions on managerial performance. The paper emphasizes the need to bring disciplined organizational changes in launching maintenance improvement activities for approving the enhancements in the performance of the industry. The above-stated information depicts that the implementation of OEE has significantly increased the effectiveness of machinery of the four workstations as observed by the authors from 2 to 8 percent. The successful OEE implementation also helps to decrease the downtime of associated workstations from 7 to 22 minutes. The rejection rate of all workstations slightly reduces to 22 to 33 tons per day and the setup time of these workstations also came down to 2 to 6 minutes per day. From the above discussions, it is obvious that successful OEE execution in the sugar mills can bring positive changes in the processing sector. The development of industries is only possible when the management will space and honestly implement performance-enhancing strategies such as OEE (S. Singh et al., 2020).

Khan (2018) conducted the preliminary study on lean manufacturing practices about textile manufacturing industry. The author mentioned that he used the Gemba, Waste Relations Matrix, Cause & effect analysis, ranking and statistical techniques to identify and analyse the wastes of lean manufacturing. The seven deadly wastes of lean manufacturing are investigated and defect is identified as the most significant waste in the textile manufacturing industry. The author suggested most relevant lean practices to eliminate /reduce the most significant defect waste of lean manufacturing which include Overall Equipment Effectiveness (OEE) as well.

Prabowo et a., 2018 In this global era where the level of competition is higher, in addition to the influence of the suitable marketing strategy is also required strategy from the side of production/productivity. PT. XYZ is a company engaged in the manufacturing of snacks especially biscuits. The problem that often occurs in this company is the number of biscuits that are not in accordance with the standard and the production does not reach the target set because the machine suddenly breaks down frequently. To overcome the problems PT. XYZ then choose to implement the Total Productive Maintenance (TPM) strategy. This study aims to evaluate the implementation of 8 TPM Pillars and measure the effects on manufacturing performance in the form of Overall Equipment Effectiveness (OEE) and Waste. This study uses questionnaire-based survey method. The number of samples distributed is 40 units. Which returned and filled 33 questionnaires and which is worth to be processed as many as 30 samples. Then tested the validity and reliability of data using SPSS program. Validity critical value R = 0.361 for n = 30 and error rate 5%. For reliability test, R value = 0.60 was selected. From the validity test, there are 7 items of questions that are not valid so it is not included in the next process. For the reliability test of the questionnaire is quite reliable with the value of Cronbach's alpha of 0.811. From the CFA analysis, only 6 of 8 TPM pillars are significant while for manufacturing performance only OEE variable is significant. Correlation between 8 Pillars of TPM and manufacturing performance is Strong enough with a value of R = 0.862, which also means 74.3% (R2) variable manufacturing performance can be explained/influenced by variable 8 Pillar TPM and 26.7% the rest by other variables (Prabowo et al., 2018).

Tobe et al., 2018 High machine downtime and large number of rejected products is still become a big problem for company as a research object in this study. The integration of OEE measurement and lean manufacturing analysis method is employed to improve production system in company. The measurement result shows that the value of availability rate is 88.82%, performance rate 93.70%, and quality rate 98.20%; then the OEE values obtained 81.73%. The root cause is investigated by using FMEA (Failure Mode and Effect Analysis) method particularly from the RPN (Risk Priority Number). Types of activities that are at the root of the problem include: no lubrication periodically, delaying clean up the dirt on the machine, heating furnace is too long at the time of machine setup, material storage (animal compost) and fuel (coal) in the open space.(Tobe et al., 2017).

Esmaeel et al., 2018 conducted a literature review which was concluded as: mostly, manufacturer focused on the usage of manufacturing strategies namely; Agile Manufacturing, Lean Manufacturing and Sustainability known as Fit Manufacturing. Manufacturing sectors plan to enhance their performance by applying these strategies. Thus the integration of these three manufacturing strategies are crucial to survive in current market competitive environment. Besides, Overall Equipment Effectiveness is known as an approach to ensure the reliability of the production operations which enable firms to satisfy their customers and end users. This paper assessed the relationship between Business Performance and Fit Manufacturing as manufacturing strategy with mediation of Overall Equipment

Effectiveness in manufacturing firm(Esmaeel et al., 2018). Summary of the conducted literature review on OEE is presented in form of table 1 which is presented below.

Table 1. Summary of the papers coming in the scope of overall equipment effectiveness

Author	Industry	Findings/Outcome	Limitations / Implications
Nurprihatin et al., 2019	Manufacturing Industry	Six big losses associated with the machine were identified, such as breakdown losses (11.67%), setup and adjustment losses (5.76%), speed losses on idle and minor stoppage (4.11%), reduced speed losses (7.62%), rework losses (0.67%), and scrap losses (2.87%). We discover the highest contribution to the low OEE value is breakdown losses. In handling breakdown losses, we provide the information about the MTBF and MTTR are equal to 2313 minutes and 289 minutes, respectively.	All the aspects of OEE were not covered in the research i.e. predictive OEE. The bank was suggested to implement the eight pillars of TPM and 5S.
Siregar et al., 2018	Fertilizer Industry	In July, August and September OEE values above the standard set at 85%. Meanwhile, in October, November and December have not reached the standard OEE values. The low value of OEE due to lack of time availability of machines for the production shut down due to the occurrence of the engine long enough so that the availability of reduced production time. 1. The value of OEE obtained during July, August and September 2016 has reached the expected standard, indicating that the machine is being used effectively. 2. Proposed in improving the effectiveness of the machine on the Urea-1 Plant Unit can be done with the increase of Preventive Maintenance that is to inspect the machine periodically and perform timely maintenance	Not all the lean tools used for the increasing effectiveness of the machines and equipment were considered in the present research i.e. preventive maintenance. Effectiveness of machines was suggested to be increased at Urea Plant 1 by proper implementation of preventive maintenance.
Nallusamy et al., 2018	Manufacturing Industry	it was found that, the percentage OEE can be improved from 55.45% to 68.04% by implementing this technique in medium scale industries. From the previous records, before the implementation of TPM and OEE is 55.45% only. After successful implementation of TPM it was found that OEE is increased to 68.04%. Hence, the OEE has been increased about 13% by reducing the rejection rate and overall cycle time to meet the demand at right time.	Not all the lean tools used for the increasing effectiveness of the machines and equipment were considered in the present research i.e. TPM. It would be beneficial for future projects focused to improve the effectiveness of machines which have low OEE by implementing the TPM technique and setup time reduction by using different TPM metrics like MTBF, MTTR, etc
Singh and Narwal, 2017	Manufacturing Industry	It is observed from the result that performance is always higher than or equal to that of availability because availability takes into account downtime loss. Whole plant OEE is 88.72% which is acceptable as per world class OEE it should be more than 85%.	Only three factors were calculated i.e. availability and performance but there is many more in the scope of OEE which is not part of this research. It is observed from the calculated data that if we want to increase OEE from calculated value we need to improve availability and quality
Esa and Yusof, 2016	Manufacturing Industry	Present survey of 2008 until 2015. The findings was again highlighting the important of executing planned maintenance as a significant pillar towards obtaining a better result on OEE, followed by focus improvement and education or training provision	The research covers the good quality survey and it can be used for further in depth study about the OEE.
Singh et al., 2020	Process Industry (Sugar Mill)	The implementation of OEE has significantly increased the effectiveness of machinery of the four workstations as observed by the authors from 2 to 8 percent. The successful OEE implementation also helps to decrease the downtime of associated workstations from 7 to 22 minutes. The rejection rate of all workstations slightly reduces to 22 to 33 tons per day and the setup time of these workstations also came down to 2 to 6 minutes per day.	Employees should be trained enough to avoid mistakes during operation and take part in fault finding task of their routine work.
Prabowo et a., 2018	Food Industry	It was indicated by confirmatory analysis that, only 6 of 8 TPM pillars are significant while for manufacturing performance only OEE variable is significant. Correlation between 8 Pillars of TPM and manufacturing performance is Strong enough with a value of R = 0.862, which also means 74.3% (R2) variable manufacturing performance can be explained/influenced by variable 8 Pillar TPM and 26.7% the rest by other variables	The waste indicator is not Significant to measure TPM performance because it is more suitable/appropriate to measure the implementation of Lean manufacturing strategy.
Tobe et al., 2018	Fertilizer Company	Based on data analysis shows that the value of availability rate is 88.82%, performance rate 93.70%, and quality rate	The company was suggested to revise the machine maintenance schedule to be

		98.20%; then the OEE values obtained 81.73%. The dominant factor of losses is high downtime due to mechanical motor breakdown that is 24% or 1160 minutes, and duration of setup time is 19.4% or 935 minutes	more frequently, improving more practical hygiene procedures and adding aids, making a special storage place closed for materials and fuel, as well as conducting training to employees at all levels
Esmaeel et al., 2018	Manufacturing Industry	This paper assessed the relationship between Business Performance and Fit Manufacturing as manufacturing strategy with mediation of Overall Equipment Effectiveness in manufacturing firm	The research highlighted the unique relationship which can be applied and analysed in multiple sectors.

6. Discussion

On the advent of new technology, the companies are needed to modify their practices for the sake of their survival in the market (Arain et al., 2020; Kalwar & Khan, 2020b, 2020a). In the manufacturing process, the machine is very important because downtime can inhibit and even stop production. Nurprihatin et al., 2019 focused on the highest downtime that occurred in a particular product line and critical machine. This research contributes to overcoming and making the machine's performance and ability better. We make use the Total Productive Maintenance (TPM), which started by calculating Overall Equipment Effectiveness (OEE) and Six Big Losses. This study also provides the maintenance attempt to increase the effectiveness and to eliminate losses incurred by calculating Mean Time between Failure (MTBF) and Mean Time to Repair (MTTR).Primary data were obtained by interviewing, observing the production process and monitoring the machine or equipment. The interview process was done by asking directly to the related stakeholders at the company. We observed the production process on the production line and found that a particular machine or equipment was interrupted during the production process. Secondary data i.e. MTBF and MTTR were obtained through historical data for one year (January-December 2017), such as downtime, the amount of production, the number of defects, non-productive time, the amount of damage to the machine, the standard repair time, product prices, component costs, and labor costs.Availability, performance, quality, MTBF and MTTR were calculated by the help of below given formulae i.e. (1), (2), (3), (4) and (5) respectively.

$$Availability = \left(1 - \frac{Down\ Time}{Loading\ Time}\right) X100 \tag{1}$$

$$Performance = \left(\frac{Theoritical\ Cycle\ Time\ X\ Process\ Amount}{Operating\ Time}\right) X100 \tag{2}$$

$$Quality = \left(1 - \frac{Defect\ Amount}{Processed\ Amount}\right) X100 \tag{3}$$

$$MTBF = \frac{Sum\ of\ equipment\ uptime\ of\ all\ machines}{of\ failure\ of\ all\ machines} \tag{4}$$

$$MTBF = \frac{Sum\ of\ repair\ time\ of\ all\ machines}{of\ failure\ of\ all\ machines} \tag{5}$$

Before the proper calculation of OEE value, it was necessary to list down the errors occurring in the machine while production. There were give different types of errors used to be showed by the machine i.e. 1) Pitch too short, 2) Pitch too long, 3) Cutter not protruded, 4) Alarm for Pusher Lock and 5) Alarm for Warning. Figure 1 shows the work process of WP-ATB 08 machine.

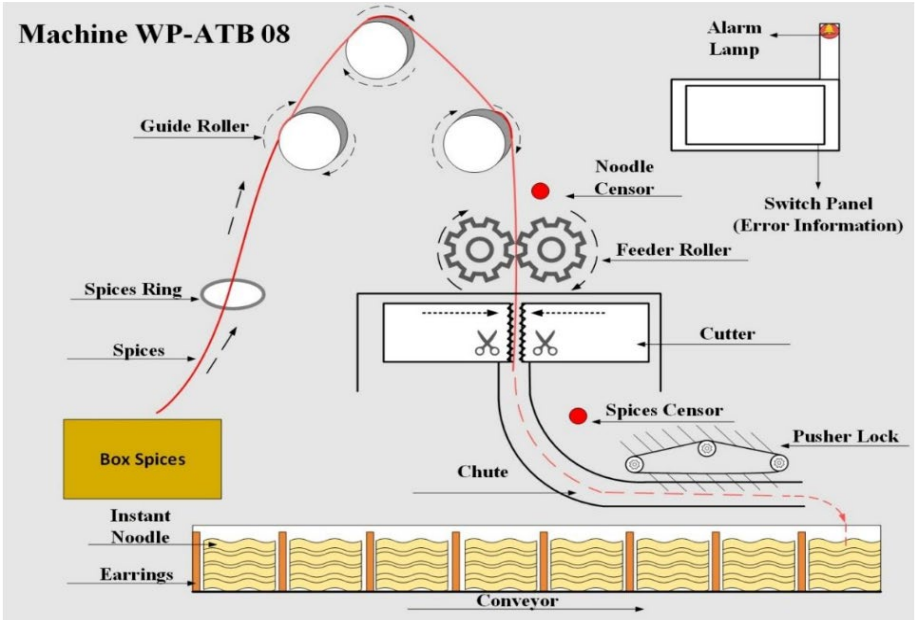

Figure 1. work process of WP-ATB 08 machine
(Nurprihatin et al., 2019)

After the data collection and analysis, overall Equipment Effectiveness (OEE) value for WP-ATB 08 machine on line 7 in the packaging area was 71.27%, with availability, performance, and quality value are 82.56%, 90.83%, and 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%). Therefore we go deeper into the particular six big losses on the machine, such as breakdown losses (11.67%), setup and adjustment losses (5.76%), and speed losses on idle and minor stoppage (4.11%), reduced speed losses (7.62%), rework losses (0.67%), and scrap losses (2.87%). We discover the highest contribution to the low OEE value is breakdown losses. In handling breakdown losses, we provide the information about the MTBF and MTTR are equal to 2313 minutes and 289 minutes, respectively. Furthermore, we also propose the company apply the 8 pillars of TPM and 5S to increase the effectiveness(Nurprihatin et al., 2019).

Singh and Narwal, 2017 calculated the various parameters and OEE for the various assembly lines at the company. Calculations included availability, quality performance and OEE value (see table 2). The company works on different lines such as assembly line, pinion line, housing line etc. Here production for different products on different lines is executed. For this to improve the productivity of different lines company needs to efficient use of resources, manpower as well as equipment. In aid to increase productivity overall equipment effectiveness approach applied and cause and effect analyzed.

Table 2. Calculation for the OEE
Source: (M. Singh & Narwal, 2017)

Line	ASSY-1	PINION-1	HSG-1	RACK/BAR-1	ASSY-2	PINION-2	HSG-2	HSG-3A	HSG-3B	HSG-3C	RACK/BAR-2	ASSY-3	PINION-3	RACK/BAR-3
Availability	9.31%	66.63%	96.38%	78.85%	80.74%	92.25%	89.27%	97.05%	97.91%	99.33%	91.19%	68.45%	91.55%	83.14%
Quality	99.48%	99.97%	94.33%	99.78%	99.76%	99.79%	98.99%	99.9%	100%	99.74%	99.9%	99.46%	99.85%	99.85%
Performance	99.88%	99.85%	92.71%	99.46%	99.99%	99.85%	98.01%	99.96%	99.96%	99.93%	99.88%	99.81%	93.78%	99.66%
OEE	99.88%	90.9%	78.56%	78.94%	91.94%	99.96%	88.33%	96.91%	97.87%	98.99%	90.99%	68.18%	85.68%	82.72%

Even performance is maximum and quality is good but due to less availability OEE get affected and its value ended nearly to the value of availability. It is observed from the result that performance is always higher than or equal to that of availability because availability takes into account downtime loss. Whole plant OEE is 88.72% which is

acceptable as per world class OEE it should be more than 85%. It is observed from the calculated data that if we want to increase OEE from calculated value we need to improve availability and quality. OEE can be increased by minimizing the breakdowns and changeovers losses which are associated with availability and by minimizing the defects and setup scraps losses which are associated with quality(M. Singh & Narwal, 2017).

7. Conclusion

Literature review was conducted on one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) in the context of its application and implementation in various industrial sectors. Most of the manufacturing and automotive companies, some of SMEs, food and construction companies have implemented mentioned lean tool i.e. Overall Equipment Effectiveness (OEE). Due to the lack of awareness about the effectiveness and impact of lean tools, the companies are reluctant to adopt this approach. At the other hand, resistance from employees and top management are also the main hindrances in the way to this change. In this regard, one of the researcher have suggested that the employees must be taught for proper OEE implementation from the bottom to the top in the execution of an autonomous flow of maintenance as machine operators are the main linkage to perform simple maintenance and fault finding tasks(S. Singh et al., 2020).

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9. Future implications

In the present paper, one of the major lean tool i.e. Overall Equipment Effectiveness (OEE) is discussed but in the future research, other lean tools can be discussed in depth in order to put more clear and broad picture of effectiveness and loopholes. More research papers can be considered in order to draw better and effective conclusion.

10. Conflict of interest

There were no conflict of interest among the authors of the present research paper.

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