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To Increase Overall Equipment Effectiveness using Value Stream Mapping: Review and Analysis

Prateek Kalra[1], Rishab Bhardwaj[2], Shikha Kashyap[3] and Ravindra Ojha[4]

[1,2,3,4]Mechanical Engineering Department, NCU
E-mail: [1]prateek9268082126@gmail.com, [2]mudit390@gmail.com,
[3]shikhakashyap@ncuindia.edu, [4]ravindraojha@ncuindia.edu

Abstract—*Automotive industry has shown unprecedented growth in recent past. Competition in this industry has enhanced to considerable level. To map with never ending and ever increasing demands of the market, productivity enhancement with efficient and optimum utilization of resources has become dire necessity. This is becoming challenge with technically complex manufacturing systems implemented in this sector to escalate production levels. Present work reviews the suitability of Value Stream Mapping (VSM) and Overall Equipment Effectiveness (OEE) techniques for implementation in auto sector to identify non-productive activities involving huge investment and replace with productive ones finally to enhance overall efficiency of the critical equipment.*

Keywords*: OEE, VSM, Automobile industry*

1. INTRODUCTION

In an automobile industry productivity enhancement, increase in efficiency of plant and rejuvenation of new technologies to meet up the market demand and needs of people has become dire necessity. Socio technical complexity is affecting the operational efficiency which decreases the productivity which ultimately impacts the cost of product. With such scenario it is important to identify those activities which are not adding any value instead leading to over utilisation or non optimal utilisation of resources and eliminate those activities. Present work reviews the combined methodology of VSM and OEE which deals with reducing high lead time, eliminating bottlenecks and determining value added and non value added activities which consumes resources which ultimately impact the product price, and competency level. VSM is performed in three levels namely process (for specific assembly line), factory (within factory) and extended level (Beyond factory). VSM stands for value stream mapping, value can be defined as what customer is buying, and it can be a dairy product, a car which consumes resources, man power investments. If the resource used to manufacture the same is non optimal or the lead time is high it will directly affect the product price which is ultimately paid by the customer. If we simply draw the stream of these values in the form of activities or operations in an assembly line, we get to know that which activity takes up more time and about the bottleneck operations or critical activities. After determining the critical activity, OEE of the present state can be calculated contemplating parameters like availability, performance and quality of equipment to set a benchmark to reach the world class level of OEE. Combined methodology of application of VSM and OEE can referred to from Fig. 1.

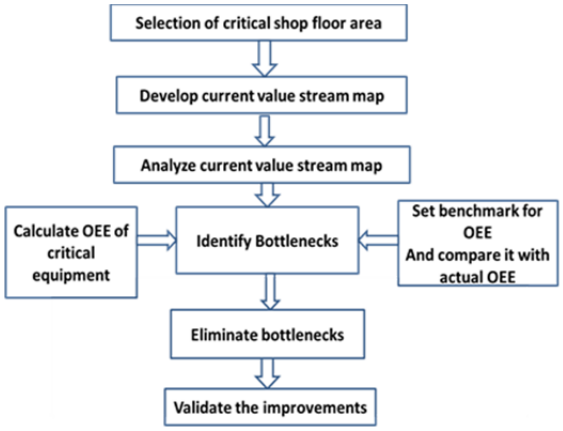

Fig. 1: Combined methodology for the application of OEE

2. LITERATURE REVIEW

This section contains the findings of the papers reviewed related to OEE and VSM. The aim is to simplify the idea and results obtained from the papers so that it could be used to support the findings and the final conclusion at the end.

2.1. Value Stream Mapping

Value Stream Mapping can be defined as a pictorial representation of the flow of all the processes in an enterprise which include both Value as well as Non Value adding processes [1]. Since, VSM is a visual tool it enables us to

interpret information in a faster and more comprehensive way thus, providing us a broader horizon for identifying area of improvements depending on users priorities. VSM helps in finding better approach for the implementation of various techniques in a manufacturing unit such as Lean Production systems etc. as it reveals hidden waste that affects the productivity of the entire unit [2]. VSM plays an important role for the development of green manufacturing where an energy value stream map is developed which consider the energy expenditures in the value stream, thus highlighting the area where efforts should be made for energy conservation in the manufacturing unit [3]. VSM is very useful when process improvements or addition of new processes are made in a system for example VSM was used by service providing industries as a performance measurement tool which not only helped in measuring the performance of their service delivery but also made basis on which performance management decision could be made thus, VSM successfully depicted manufacturing and service functions and included customer interaction with these functions [4]. VSM also helps in improvement of quality assurance of the product; VSM can be used to successfully integrate inspection processes within a process chain, thus resulting in better manufacturing quality and quality assurance [5]. With the help of VSM lead time and WIP inventory can be reduced significantly which results in reduction of overall inventory cost [6]. VSM is very useful in driving continuous improvement activities. It solidifies the vision of the future value stream layout and is useful in pin pointing wastages in the enterprise [7].

2.2 Overall Equipment Effectiveness

Overall Equipment effectiveness is a numerical approach which is used to calculate the effectiveness of an equipment in a given unit or plant. It takes into account Availability, Quality and performance. The improvement in OEE of any equipment depends on the 6 big losses which the affect the parameters taken into consideration while measuring OEE. These losses are categorized into downtime loss, speed loss and quality loss. Losses such as breakdown loss, setup and adjustment losses come under the downtime losses, they determine the value of availability of machine. Minor stoppage and reduced speed losses come under the category of speed loss, they give the idea of the performance of the equipment under scrutiny. Rework and yield losses come under the category of quality loss and help in determining the quality of the output of the machine [8]. Different categories of 6 critical losses can be referred to from Fig. 2.

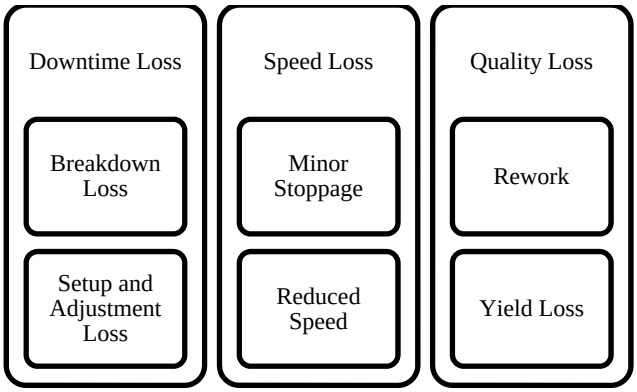

Fig. 2: Categorization of 6 critical losses

Quantification of parameters Performance, Quality and Speed in measurement of OEE are as follows [9]:-

OEE = Availability X Performance X Quality

1) Availability: (Run time of Machine)/(Total time of Machine).
   Importance: It signifies the amount of time machine was actually utilized while it was running.
2) Performance: (Total Count)/(Target Count)
   Importance: It signifies parts produced with respect to production rate of machine.
3) Quality: (Good Count)/ (Total Count) *Importance*: it signifies the difference between the good parts and bad parts produced by machine.

Only a fraction of Theoretical production time is utilized. It is due to the various losses discussed above and also because of planned shutdown periods. Various production times can be referred to from Fig. 3.

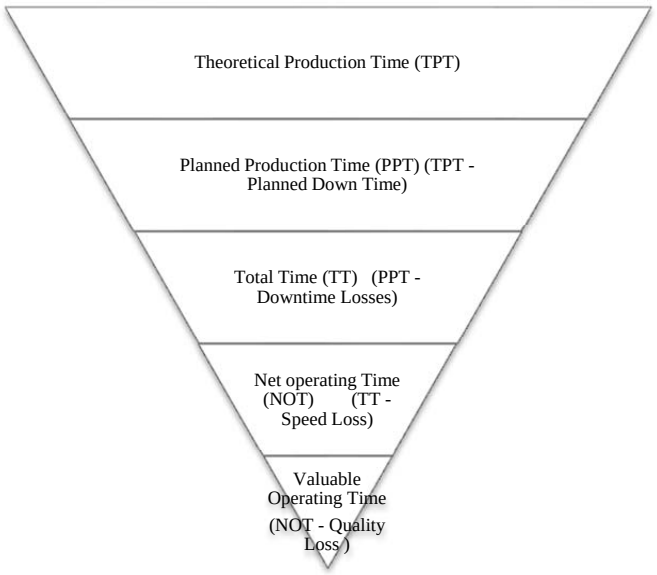

Fig. 3: Different time losses from Theoretical Production time

Parameters used in the calculation of OEE are dependent upon the industry and the process taken into consideration. New parameters such as operational efficiency (OR) or rate efficiency (ER) can also be taken into consideration while calculating OEE [10]. OEE score is used to validate the bottlenecks identified in the manufacture line, after the validation of the bottlenecks they are eliminated by using techniques such as SMED, grouping of orders etc. the validation of the improvements made or the affect of the techniques used on the equipment is also identified by the calculation of OEE [11]. A relation between demand rate of the customer and the OEE has also been established. High utilization of the machine without demand is an inventory handling wastage which in turn results in decrease in the OEE. While calculating OEE of equipment a parameter known as ideal cycle time is calculated but there are certain processes where there is no constant ideal cycle time such as curing because mix of products are cured together thus each one has a different cycle (curing time) which makes it difficult to calculate the Takt time and establish real time targets thus special techniques are required for the calculation of the Takt time of such processes such as calculating demand as aggregate unit. This is done by using importance factor which is calculated by dividing required cycle (curing) time by any particular product type over the total cycle time elapsed for 1 set of all product types [8]. A relation between OEE and TPM has also been established. Implementation of TPM results in a gradual increase in the OEE Score which indicates to the fact that overall line efficiency increases by the implementation of TPM [12]. OEE is also related to Failure Mode and Effect Analysis (FMEA) by a parameter known as Risk Priority Number (RPN). It has been proven that low RPN results in high OEE [13].

Setting up of benchmark OEE:-

Setting of bench mark OEE is necessary because it acts as a target. All the improvements are made to achieve the benchmark OEE. Most common way of establishing benchmark OEE is by using TAKT time which is computed by dividing Total Planned Production Time during the period with Customer demand during the period. Takt time tells us the rhythm with which production should take place. We relate Takt time with OEE by calculating Production Pace which is Target cycle time divided by OEE. Target should have production pace lower than and as close as possible to the Takt time [14].

3. RESULTS AND DISCUSSION

Review for the techniques VSM and OEE was performed and considerable outcome and findings as shown below were obtained for successful implementation of VSM and OEE in tier 2 and tier 3 automotive enterprises.

- VSM and OEE have still not been used effectively in tier 2 and tier 3 Vendors.
- VSM and OEE only help in identification of bottlenecks. To eliminate these bottlenecks further techniques have to be applied depending on the root cause of the bottleneck.
- Parameters used for calculation of OEE vary with the process under consideration.
- Setting benchmark OEE using Takt time is necessary to get robust outcome.
- Continuous supervision is necessary for maintaining OEE.
- Certain processes require use of special techniques for calculation of OEE. These techniques depend on the processes under consideration like calculating ideal cycle time in curing process in the form of aggregate units.

4. CONCLUSION

VSM & OEE are few of the popular tools that are implemented in industries, irrespective of its type to identify and screen non value added activities to save resources and enhance efficiency of equipments. Automobile industry is not an exception to this, but implementation of these techniques in tier 2 and tier 3 companies is not significantly witnessed. Present work proposes the methodology for the allocation of VSM combined OEE to improve overall efficiency and enhance productivity. Some of the key findings like "Establishing benchmark OEE using Takt time is necessary to get robust outcome" can be considered in future work for further analysis and successful implementation of proposed approach.

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