ABSTRACT

In today’s global and highly competitive environment, it is essential for the survival of any firm to be adaptive, price competitive, responsive and proactive and needs to have the capability to deliver world class products according to diverse customer requirements. These challenges force companies to implement various Lean tools to meet the needs of the ever-changing market demand. In a great number of companies, in spite of huge improvements in productivity, there is still a bigger and better potential to utilize machine tools effectively and reach better productivity goals. One of the main methods to meet these challenges is to monitor and improve the overall effectiveness of the manufacturing system and benchmark it with the World class standard which will enable to continuously improve and become a World class organization. The literature supports the Overall Equipment Effectiveness (OEE), which consists of factors such as Availability, Performance efficiency and Quality rate, as a measure to improve the equipment performance. On the other hand, it lacks in addressing all the losses explicitly which are associated with manufacturing resources. In this context, a research work was undertaken to develop an improved methodology which can address the losses associated with manufacturing resources explicitly with a metric known as Overall Resource Effectiveness (ORE) and a methodology to enhance the ORE. In addition to that, the application of ORE on cost-time profile and cycle time of operations of an assembly cell was also explored.

In a manufacturing scenario, the desirable productivity, quality, cost, delivery, safety and morale, all depend on the effective functioning of the company’s facilities. Metrics for measuring and analyzing the productivity of manufacturing facilities have been studied for several decades.
Consequently, it is discovered that measurement is needed for identifying the problems in order to improve the productivity. To achieve this, it is necessary to establish appropriate metrics for measurement purposes. The metric OEE and its factors help to categorize the areas for initiating the equipment improvement. Based on the six losses, the Availability, Performance, Quality rate and thereby OEE can be calculated. Although OEE is seen to be the standard method for the measurement of equipment performance, it still requires further modification on classification of losses.

Availability, Performance and Quality rate are the factors for calculation of Overall Equipment Effectiveness (OEE). It is observed that OEE is often used as a driver for improving the performance of a business by concentrating on quality, productivity and machine utilization issues and, hence, it is aimed at reducing non-value adding activities often inherent in manufacturing processes. According to the classification of losses, equipment down time including set-up and adjustments is included within the availability of losses. The availability rate measures the total time that the system is not operating because of breakdowns, set-up and adjustment and other stoppages. This classification of losses includes all the down time events into one category and leads to the factor of availability, hampering the identification of losses explicitly. In addition to that, if planned down time is not taken into account in calculation of effectiveness then it leads to excessively long planned activities. The next problem in OEE calculation is that there is no separate metric to monitor the losses due to non-availability of manpower and material which are also critical for effectiveness of a manufacturing system. It was realized that the existing OEE factors are not sufficient for assessment of losses explicitly in a manufacturing system. Hence, an objective is set to develop the factors and a metric which can address all the losses associated with manufacturing resources with definite information which enable the engineers and managers to initiate the improvement actions on the specific
category of losses. The developed method of effectiveness calculation differs from the existing Overall Equipment Effectiveness (OEE). A new methodology is developed which can address the losses associated with manufacturing resources such as Man, Machine, Material, Method, etc., explicitly, with a metric known as Overall Resource Effectiveness (ORE) which includes factors such as Readiness, Availability of facility, Changeover efficiency, Availability of Material, Availability of Manpower, Performance efficiency and Quality rate.

The Japanese approach for continuous improvement promotes the team work and participation of all employees. The cross functional team (CFT) approach is adopted for enhancement of overall resource effectiveness (ORE) of a manufacturing system. ORE is applied to the bottleneck areas or poor performance equipments that affect the throughput or any other critical areas of a manufacturing. These areas are vital for company performance and ultimately fulfillment of customer requirements. But literature lacks in framework for enhancing the effectiveness of manufacturing system by integrating people, processes, tools and methods. Hence, an objective is set to develop a methodology known as Business Process Mapping (BPM) for enhancement of Overall Resource Effectiveness (ORE).

The developed BPM which integrates people, processes, tools and methods, was applied to a manufacturing line to enhance the ORE and it is evidenced that all the factors of ORE have been improved.

Traditional costing system considers the accumulation of costs, but does not consider the lead time. Value Stream Mapping (VSM) presents the time consumed and the operations performed, but not accumulation of costs. The cost-time profile (CTP) is a tool that follows the cost accumulation in manufacturing of a product through time. The cost-time investment (CTI) is an indicator of the use of resources in manufacturing of a product. Literature
shows the expected impact of Lean implementation on cost-time profile and cost-time investment. But it lacks in considering the losses associated with manufacturing resources. Hence, a methodology is developed which can apply ORE for cycle time/process time so as to get the true cost-time profile.

In practice, it is often desirable to balance and match the cycle time with respect to takt time, the widely used principle in lean manufacturing. Otherwise, it would not be possible to meet the customer demand. Predominantly assemblies being the major activity in industries, the losses/inefficiencies associated with manufacturing facilities would hamper the balancing of cycle time with the takt time even though the individual cycle times are well within the takt time. It was realized that the losses need to be accounted with cycle time to compute effective cycle time. Hence, a methodology is developed in this research to apply the ORE on cycle time to arrive at effective cycle time. The effective cycle time of the processes are compared with takt time. The operations whose effective cycle time is greater than the takt time are reduced below the takt time in order to meet the customer demand.

The methodologies developed in this research have been applied in manufacturing industries. The scope for future research is, the methodology developed in this research may be explored for application in process industries and service sectors.