ABSTRACT

Productivity is a buzzword in manufacturing as it satisfies the stakeholders from all domains of the supply chain whenever it is attained. There are a plethora of tool and techniques that are available for improving productivity in an organization. The implementation of those tools consumes a lot of time, effort and money. However, quite often, the results of these mammoth efforts will not be as expected due to various constraints. One important constraint is material flow. Material flow is an essential activity in transforming the raw materials into the finished products in manufacturing.

Materials flow through several stages of manufacturing processes to reach the final shape of a product. While flowing through its path, the materials witness the five factors, namely place, man, machine, process and materials. These are the factors which contribute to the stream of flow by making the product out of a material as per the customers' requirement. Any variation in material flow leads to lean wastes, which captivates huge amount of time in doing unnecessary activities. Unless those factors are controlled, reducing lean wastes and improving material flow would not be possible. In order to control those factors, it is required to continuously monitor and document the current state of the production line before making any changes.

In the present work, a framework for the material flow was constructed to show how a material would flow through those factors and the effects of those factors on the material flow. The framework has five different levels in the form of a pyramidal shape to define each factor one by one with respect to material flow. Controlling these factors poses a real challenge to the managers, so they anticipate a world-class technique to curb

them. One such technique is lean manufacturing. The present work is all about enhancing productivity by effectively controlling the material flow factors with the help of lean tools and techniques. Implementing lean manufacturing is a long term process and it involves several phases. The researchers and lean practitioners proposed different strategies for effective implementation of lean in an industry. One such method is the development of framework. The framework can regulate the way in which each and every activity leads to lean application. It is worthy to develop a model which encapsulates all the activities with respect to lean.

The present work suggested a framework called lean model for applying lean tools to improve the productivity by controlling the material flow factors. This model consisted of a material flow framework at the centre and five outer stages; they were lean readiness, lean diagnosis, lean tools selection, lean implementation and lean assessment. These outer stages were cyclic in nature as lean is a continuous improvement process. The developed model was implemented in a machining line of an auto component manufacturing company in Tiruppur, Tamil Nadu. The results showed that the productivity of the machining line was increased by 9.86%.

The first stage of lean model was lean readiness. Lean readiness was evaluated in the case study company by taking into account of the conflicting factors; critical success factors, and the barriers. Using force field analysis, the conflicting nature of these factors was portrayed. With the help of MATLAB, two stages of fuzzy logic were executed to find the lean readiness. Lean readiness of the case study company was found to be 7 out of 10, indicating more likely to be ready for its implementation.

The next stage was lean diagnosis; the quantitative approach was used in this stage to collect different lean wastes which hindered the production process. After a discussion with the management on lean implementation, a machining line was chosen for study to do analyse its current state.

In lean tools selection stage, a funnel methodology approach was used in selecting the appropriate lean tools. It consisted of two steps. In the first step, 25 lean tools were chosen by taking 5 tools under each material flow factor. These tools were ranked using a multi criteria decision making (MCDM) technique, fuzzy TOPSIS against the criteria such as value creation, sustain flow and waste elimination. Out of 25 lean tools, 15 were shortlisted by considering top three tools under each factor. In the second step, the shortlisted lean tools were again subjected to ranking against five lean wastes criteria using an MCDM technique, weighted sum model (WSM). Using WSM, the selected lean tools were 5S, ergonomics and safety, total productive maintenance, standard operation and just in time.

Lean implementation was the foremost activity of the lean model in an organization. Upon implementation, the target productivity was achieved. The total number of defects was reduced from 41 to 10. The overall availability of machines was increased by 7%. The percentage of overall lean waste was minimized by 32.45%.

Further a simulation model replicating the works of the machining line was developed using Technomatix software. By simulating the model, the percentage of difference between the simulation data and the real data of the machining line before and after lean implementation were 6% and 3.64%

respectively. Moreover, it also helped to justify the work of lean implementation.

Lean assessment was the final stage of lean model. The effect of lean implementation on the performance measures was assessed in this stage. It was carried out by conducting an empirical study by taking the opinion of the employees before and after lean implementation. The assessment results showed that the level of leanness within the machining line was transformed from high to very high. By and large, the lean model proved to be a better model in improving the productivity of machining line by influencing the key factors of material flow. Hence, this model can be adopted in any other production line to validate its worthiness further.