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Development of Value Stream Mapping Framework With Fuzzy QFD

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Abstract - *The manufacturing systems have been witnessing a key transition from mass manufacturing to lean manufacturing. Mass manufacturing focuses on high volume production with limited product variety. Lean manufacturing is focused on elimination of wastes thereby stream-lining the processes and facilitating cost reduction is necessary.*

Lean manufacturing focuses on the elimination of seven wastes namely over production, over processing, waiting, transportation, defects, inventory and storage. Recently under utilization of creativity of work force is added as eighth waste and environmental waste, ninth waste. Some of the vital tools of lean manufacturing include Value Stream Mapping (VSM), Kaizen, Total Productive Maintenance (TPM), 5S etc.

VSM is one of the vital tools of lean manufacturing which needs to be implemented first for enabling lean practices. VSM involves construction of current state map, identification of improvement proposals and implementing in future state map. The improvement proposals need to be prioritized and a suitable mapping to be devised for relating the wastes and improvement proposals.

This article represents the integration of Quality Function Deployment (QFD) to prioritize the improvement proposals. In order to cope up with vagueness and impreciseness associated with data, fuzzy QFD has been used research work which focuses on the prioritization of wastes includes inventory & defects.

***Key Words*: Lean Manufacturing, QFD, Fuzzy Logic**

1. INTRODUCTION

Nowadays, manufacturing firms are in the position to redefine and redesign their manufacturing systems in order to meet the competitive demands raised by market challenges. The manufacturing systems exhibited a key transition from mass manufacturing to lean manufacturing. The Comparative aspects of lean production with that of mass production are presented as follows:

The focus of lean production is customer, whereas mass production focuses on product. Lean productions are characterized with synchronized flow and pull, whereas mass production is based on batch and queue operations [1]. The overall aim of lean Production is to eliminate waste and add value on contrary mass production focuses on cost reduction and efficiency improvement. Lean production focus on worker driven continuous improvement whereas mass production focuses on expert driven continuous improvement. Lean system is flexible and adaptable whereas mass system works on economies of scale. Quality is an inbuilt function in lean system. The features of lean system include waste elimination; limited flexibility to accommodate product complexities; non reconfigurable products and the system is not suitable for unstable market conditions.

The fundamentals of lean system include: Value defined by customer in terms of specific products and services identification of value stream which maps out all end-to-end linked actions, processes and functions for transformations of inputs to outputs. Making value flow continuously by means of waste elimination customers pull value enabling Just-In-Time (JIT) production pursuing continuous improvement process striving to achieve perfection [5].

Activities in the context of lean system need to be categorized into Value Added, Non Value Added and Necessary but Non Value Added. Value added activities include the transformation activities concerned with conversion of inputs into output. Done right for the first time and wanted by the customers. Non value added activities consumes resources, but creates no value from customer perspective. Necessary but non value added activities creates no value but cannot be eliminated based on the current practices.

Lean manufacturing include a comprehensive set of elements, rules and tools that focuses on the elimination of waste and creation of value. It focuses on elimination of all non-value added activities and brings about a philosophy of continuous incremental improvement.
Lean manufacture implies speedy, smooth and economical manufacture. Waste implies the entity that consumes resources and does not add value to the customer. Industries have identified the following forms of wastes namely high inventory, scrap, rework, repair, low productivity, downtime, poor yield, cycle time

inconsistency, over time, delay, excess labor etc.,

This research article represents the necessity of the adaptation of lean manufacturing principles which reduces the high cost of quality, delayed supply, high manufacturing cost and reduction in profit margin, high inventory of raw materials/finished goods, high inventory of raw materials/finished goods, on include improvement of all processes, increases productivity, enhances quality, improve inventory management.

2. LITERATURE REVIEW

Wei (2009) addressed the question, if banishing waste is the core value and mission of lean, what would be the opportunity cost of delayed diffusion of lean from manufacturing to services. By proposing ten lean principles of service process design. The ten principles to be followed to extend lean into service operations are:
1. Document the value stream with visual tools.
2. Identify wastes and ask, 5s why?
3. Be proactive via 'five S' and service inventory.
4. Error proofs the process.
5. Manage 'loop-back'.
6. Enable 1- price flow.
7. Standardize.
8. Buffer the bottle necks.
9. Ensure segment complexity
10. Promote transparency.

Deif(2010) studied the use of computer simulation to explore the impact of applying JIT, lean policy on a traditional inventory based production system. A system dynamic model is introduced to capture the different components of the production system [7]. The inventory dynamics of the modeled system is examined against different production scenarios under stochastic demand. The use of computer simulation in production system not able to fully transferred to lean and adapting lean principles are always not beneficial. It is required on dynamic analysis of lean policies to find more evident and calls to implement lean principles and tools among traditional manufacturers.
Diaz-Essayed identified a technique to incorporate both lean and green strategies into a manufacturing system. A case study was conducted in an automotive sector on past production, in which combination of lean and green strategies were implemented with simulation model [2]. The implementation of lean and green strategies in production system reduces the production cost. Future research efforts required on broader variety of quantifiable green strategies within the factory.

3. RESEARCH GAP

Based on the literature review, it has been found that there has been no concrete research reported on the integration of QFD with VSM framework for enabling leanness. Based on the literature review, the application of fuzzy QFD for identifying the improvement proposals in VSM framework towards enabling leanness forms the scope of this research study [3]. Based on the literature review, it has been found that lean manufacturing principles provide scope for ensuring sustainable benefits. Though researchers have contributed certain theoretical concepts behind this extension, concrete studies to illustrate the scope of lean principles for ensuring sustainable performance is not justified. This aspect forms the scope of this study.

4. RESEARCH METHODOLOGY

4.1 Value Stream Mapping

Lean production /lean manufacturing /lean is a manufacturing paradigm, minimizing wastes and maximizing the flow, continuously which is the primary goal of the Toyota production system. Lean continuously increases the awareness over the wastes and work for either eliminate or reduce it. This lean tool ensures the sustainable improvements [10]. In the book, the machine that changed the world authored by James Womack and Daniel Roos used the term 'Lean Production' during Value stream management is a technique to plan and link lean initiatives by systematic data capture and analysis. VSM is a management tool, proved that the company to become lean. It encompasses all functional and operational relationships that exist within the value stream. The value stream management has the following eight steps as the processes, followed sequentially:
1) Commit to lean
2) Choose the value stream
3) Learn about lean
4) Map the current state
5) Determine lean metrics
6) Map the future state
7) Create kaizen plans
8) Implement kaizen pans

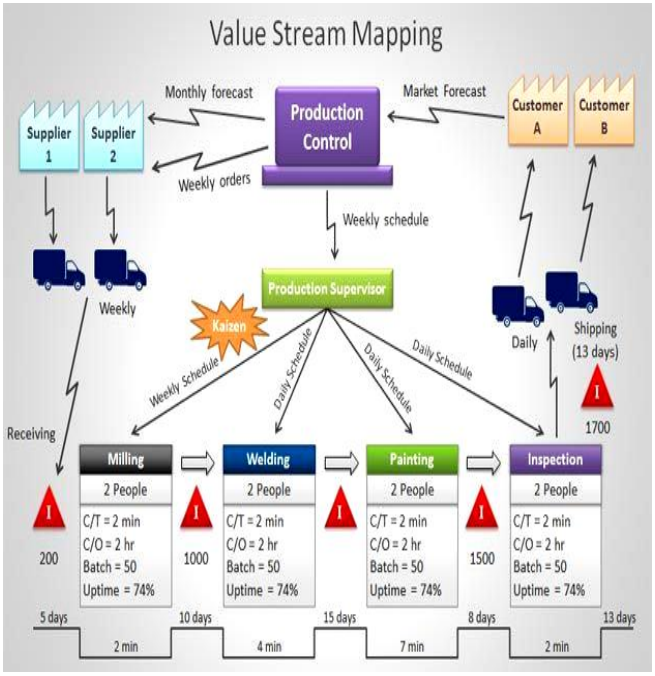

Fig -1: Value Stream Mapping

The successful implementation of lean manufacturing depends on committeemen from people, understanding customer demands and present working conditions and good communication[8].The following lean management principles are necessary while proceeding over eight VSM steps: Defining the value stream from customer's viewpoint, identifying suitable value stream, eliminating seven deadly wastes, making the work flow, pulling the work and pursuing perfection.

4.2 Fuzzy QFD

The proposed architecture of Fuzzy QFD integrated with VSM is shown in Fig 2.

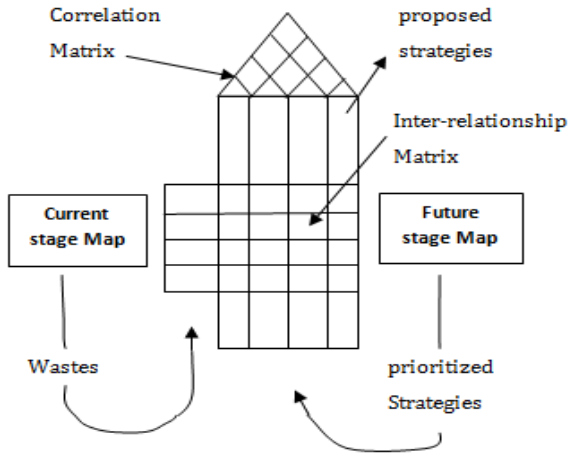

Fig- 2: Integration of VSM and Fuzzy QFD

As shown in Figure 2, the integrated VSM and Fuzzy QFD is created, after the construction of current state map, the wastes are categorized as over production, over processing, waiting, transportation, defects, inventory, and storage[4].

Then the proposals /improvements identified during brainstorming sessions are designated as design attributes. Then, Fuzzy QFD procedure was used for the construction of correlation matrix and interrelationship matrix. Then the wastes as well as the improvement proposals are prioritized. This prioritization will help to incorporate the improvement proposals in the future state map.

5. RESULT AND DISCUSSION

The integration of QFD in VSM framework enables the systematic identification of wastes and techniques for eliminating them. The prioritized wastes in our study include Inventory Waiting Defects and Transport [9] .The prioritized techniques for waste elimination include

1. Kanban
2. Single Piece Flow
3. Quick Change Over
4. Kaizen

The improvement techniques are being subjected to implementation in the case organization. In order to minimize the raw material and work in progress inventory, kanban system is under design stage to ensure streamlining of processes.

6. CONCLUSION

Lean manufacturing is mainly focused on elimination of seven deadly wastes using various tools/ techniques. Among various tools/techniques of lean manufacturing, VSM is one of the vital techniques to identify the opportunities for leanness improvement. In order to improve the framework of VSM, in the present work, a modified VSM approach is presented.

In VSM, the prioritization of improvement proposals gains importance. QFD could be used for prioritization; in order to overcome the impreciseness and vagueness associated with conventional QFD, fuzzy QFD was used. In this context, this research work represent a case studies that are focused on the development of Fuzzy QFD integrated VSM approach for manufacturing organizations. Case study was conducted considering traditional data whereas a study is incorporated with environmental data [6].

Various proposals from the perspective of leanness improvement were identified using Fuzzy QFD and implemented in future state map. After implementing the proposals, leanness performance measures like value added time, Total cycle time, Work in process inventory, on time delivery, Defect rate and Uptime were observed to be improved significantly. The managerial and industrial

implications as a result of the conduct of the studies are being presented. Besides, a roadmap for implementing the proposed approach was also being proposed.

The conduct of this research fulfills developing advanced frameworks of lean tools/techniques. Thus the effectiveness of the VSM tool has been practically validated in real time manufacturing environments.

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