Revisiting Lean Manufacturing Process with Vendor Managed Inventory System

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Abstract - Due to global competitive, countries striving for economic growth and competitive advantage are focusing on manufacturing process and supply chain with vendor managed inventory policy. The aims are to reduce costs, eliminate waste, shorten lead time and enhance competitiveness. This study applies lean manufacturing with VMI (Vendor Managed Inventory) to shorten lead time and reduce inventories. The study also applies TOC (theory of constraints), 5W1H (who, when, where, which, what, how much) techniques to identify bottleneck and suggest continuous improvements in production, sales and supply chain management. The objective is to develop a framework to improve overall efficiency and ensure profitable business performance.

Keywords - Lean production, supply chain management, theory of constraints, vendor managed inventory

I. INTRODUCTION

Due to the application of Toyota Production Systems and lean manufacturing, Toyota has overtaken General Motors (GM) to become the world's top car manufacturers [5]. However, while many companies have implemented lean production, many of them cannot achieve the same result as Toyota [15], [4]. The study seeks to look into the factors that affect the successful implementation of lean manufacturing. We investigate the cause using theory of constraints and problem-solving processes and techniques.

Theory of Constraints (TOC) was proposed by Goldratt who suggested the idea of bottleneck. He said that the strength of a system depends on the weakest link. Therefore, we must start with the weakest link in order to improve the efficiency of the entire chain. In the process, five questions are asked. They are: What to Change? Which direction? How to Cause the Change? What is the execution plan of action? How much resource should be allocated? Goldratt stated that the ultimate goal of business is to make profit, reduce inventory and operational costs while improving the throughput. Effective assessment should be based on customer demand to reflect the overall business indicators, enterprise value and market acceptance. However, the core in the problem solving process is solving the bottlenecks to find out the real problem that affect the overall goal of the company. Consolidated thinking process framework is suggested to maximize capacity, develop effective strategies monitor implementation to assessment the performance and problem-solving abilities. In this study, consolidated new problem-solving flowchart sorting is summarized in Fig.1.

![Fig.1. Consolidated new problem-solving flowchart](image)

To ensure maximum output, holistic transformation and evaluation are helpful in achieving the business objectives. TPS (Toyota Production System) is a tool to eliminate waste and improve efficiency. The 5W1H (who, when, where, which, what, how much) is used to find the root cause and minimize lead time. Banerjee [2] proposed the concept of economic batch size in pursuit of minimum inventory as the ultimate goal. Liao and Shyu [19] proposed lead time as decision variables in the stochastic stock model. Logistics should comply with VMI (Vendor Managed Inventory) operation mechanism. Electronic information platform and efficiency IT will share the information immediately to the central plant and suppliers. The flow of information must be disclosed immediately, so that
suppliers and central plant can establish quick response mechanism with VMI. The e-commerce framework is shown in Fig.2.

![VMI e-commerce framework](image)

**Fig.2. VMI e-commerce framework**

### II. RESEARCH REVIEW

#### A. Lean Production & Supply Chain

The term “lean” means a series of activities or solutions to eliminate waste, reduce non-value added (NVA) operations, and improve the value added (VA). The word “Lean” was first used in the Future Car Investigation by MIT professors; it represents Japan’s new production system different from mass production [8], [20]. “Waste” is defined as anything that interferes with the smooth production flow and does not add value [3], [22]. The eight wastes highlighted in TPS are overproduction, waiting, conveyance, over processing, excess inventory, movement, defects and unused employee creativity, and the biggest one being overproduction [27], [13].

The VSM is a lean supply chain tool used by TPS to identify wasteful and necessary value-adding activities. The “lean supply chain” identifies all types of waste in the value stream chain and tries to eliminate them; this is a major contribution of the lean production system [3]. Different from the conventional thinking, Toyota uses VSM to focus mainly on avoiding over production [27] VSM begins by listing all operations, and classifies them into VA and NVA (including waste). The VA activities are those that customers are willing to pay money for, either tangible goods or intangible functions. The NVA work includes the eight wastes of TPS [3].

The application of VSM in the TPS identifies VA/NVA activities for waste elimination, and the status of their lead time in the supply chain [20], [13].

#### B. Theory of Constraints:

The TOC is a problem solving model developed by Eliyahu M. Goldratt [7], [29], [21]. Since mid-1970s, Goldratt has used scientific methods to develop management concept which have great value to industry. Goldratt also presented the structured TOC thinking processes using common sense. The problem solving process applies the Theory of Constraints thinking process and five Theory of Constraints logic tree diagrams [7], [25].

The TOC is a set of management principles that helps to identify obstacles to one’s goal(s) and influence the changes essential to eliminate them [25], [26]. In essence, the Theory of Constraints is about change and how best to influence change.

In order to induce effective output from TOC thinking processes, Goldratt used three basic questions namely (1) What to Change? (2) What to change to? (3) How to cause the change? They are linked with five logic trees [7], [25], [26]. The detailed linkage is shown in Table I below:

<table>
<thead>
<tr>
<th>Key Quest</th>
<th>Intermediate Objectives</th>
<th>Logic Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>What to change?</td>
<td>Identify core problems and find out root causes.</td>
<td>1. Current Reality Tree (CRT)</td>
</tr>
<tr>
<td>What to change to?</td>
<td>Eliminate the core problem starting with an objective to search for solution.</td>
<td>2. Evaporating Cloud Tree (for use with conflicts)</td>
</tr>
<tr>
<td>How to cause the change?</td>
<td>Identify obstacles to implement and devise detailed plans for overcoming these obstacles.</td>
<td>3. Future Reality Tree (FRT)</td>
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<td></td>
<td></td>
<td>4. Prerequisites Tree (PRT)</td>
</tr>
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<td></td>
<td></td>
<td>5. Transition Tree (TT)</td>
</tr>
</tbody>
</table>

#### C. Vendor Managed Inventory (VMI)

VMI is an effective way of mitigating the bullwhip effect. Potentially VMI offers two possible sources of bullwhip reduction. Firstly, there is a reduction in decision-making level due to direct contact. Secondly, we reduce lead time by reducing information flow time delays [11]. VMI has become very popular in supermarkets since 15 years ago due to the success of retailers such as Wal-Mart [11].

The VMI was popularized by the successful partnership between Wal-Mart and Proctor & Gamble in 1985. Since then, other companies such as Shell Chemicals, HP, Campbell Soup, and Johnson & Johnson have adopted the same approach [9]. The advantages of implementing VMI program are very significant and can be summarized as reduced inventory costs, better response to market changes, reduction in demand uncertainty, and more flexibility in production planning and distribution [9].

### III. DISCUSSION

VMI enables suppliers to better control the inventory in the supply chains, reduces bullwhip effect and provides risk sharing. In order to focus on their core competencies, businesses should engage third-party logistics providers (3PL). Many 3PLs provide a range of services, including warehousing,