Lean supply chain: learning from the Toyota Production System

The three big motor companies (the Big 3) – General Motors (GM), Ford & Chrysler almost dominated the global market in early twentieth century. In 1994, Toyota replaced Chrysler, and it became the global No. 2 motor manufacturer by squeezing out Ford in 2003. Since 2008, Toyota has replaced GM to be the largest automaker globally.

How did Toyota achieve its success? It all started with the first President of Toyota Motor Corporation, Kiichiro Toyoda, who set up the company's objective “to use small lot size with cheaper vehicles to compete with the cost of American motor companies by continuously reducing cost through waste elimination”. The second president, Eiji Toyoda, went further to improve Toyota's manufacturing process. In 1950, after the Second World War, Toyota learnt the concepts of continuous material flow, process standardization and waste elimination from Henry Ford's book, Today and Tomorrow. Moreover, Toyota developed one-piece flow and the concept of “Pull System” which was inspired by American supermarkets. After decades of practice and refinement, the above principles and the concepts form the core of judoka and just-in-time (JIT), making the Toyota Production System (TPS) more functional.

The traditional thinking in the US and Europe was that only mass production could reduce manufacturing costs. However, Japan's auto makers have managed to achieve low cost manufacturing with smaller volume and higher complexity and shorter lead times. Toyota products have the reputation of fuel efficient and durable or having good resell value.

However, if the implementation of TPS is the key to Toyota's success, why have its competitors struggled despite adopting similar principles? It seems that there are special ingredients within Toyota, which are not easily learnt by their competitors.

Lean 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).

This VA and NVA concept was derived mainly from TPS. However, the word "Lean" was first used in the Future Car Investigation by MIT professors to interpret Japan's new production system which does away with mass production due to it producing much waste. "Waste" is defined as anything that interferes with the smooth flow of production. The eight wastes highlighted in TPS are:

1. *Overproduction*: Producing too much or too soon, resulting in poor information flow and excess inventory.
2. *Waiting (time on hand)*: The item/work in the process has stopped, such as machine downtime, bottlenecked operations, equipment changeover, system downtime, system response time, approvals from others, information from customers.
3. *Unnecessary transport or conveyance*: Movement of work or paperwork from one step to the next step in the process.
4. *Over processing, or incorrect processing*: Applying too much technology or using the wrong tools or procedures in a work process when a simpler and less costly approach may be more effective.
5. Excess inventory: Any supply that is in excess, any form of batch processing, producing more than customer demand.

6. Motion: Movement of people. Reaching for, looking for, or stacking parts, tools, etc. Walking to/from copier, central filing, fax machine, other offices.

7. Defects: Frequent errors in paperwork, product quality, or delivery performance, leading to excessive cost and decreased customer satisfaction.

8. Unused employee creativity: People’s creativity, ideas, and abilities are not fully tapped. This results in losing ideas, skills, and improvements by not listening to employees.

Value stream mapping

Value stream mapping (VSM) is a lean supply chain tool used by TPS to identify between wasteful and necessary value-adding activities. The “lean supply chain” identifies all types of waste in the value stream chain and seeks to eliminate them, and this is a major strength of the lean production system.

The way Toyota uses VSM is different from the conventional thinking; they focus mainly on avoiding overproduction. 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 tangible goods or intangible functions. The NVA work includes the eight wastes of TPS.

The application of VSM in the TPS not only identifies VA/NVA activities for waste elimination, but also the status of their lead time in the supply chain from incoming parts to finished goods delivery.

VSM is all the activities in the product process, which includes:

1. production flow – from raw material input to finished good delivery;
2. design flow – from concept to launch; and
3. material and information flow – the combination of production and design flow.

It uses different but simple visual icons to express all activities, which expose problems and waste, and highlight improvements quickly. Accordingly, VSM has the following benefits:

1. Provides a complete visual flow (material and information) to support decision making.
2. Highlights and exposes the wastes.
3. Demonstrates the close linkage between information and material flow.
4. Develops a plan to eliminate waste and continuous improvement.

The lean VSM links all processes from raw material to final consumer smoothly. This results in a shorter lead time, higher quality and lower cost.

The VSM process

The first step of VSM is to conduct an on site study of the current process, including 5M – Man, Machine, Material, Method, and Message (or Information) – followed by VA as well as NVA operations in order to draw a visual Current State Map (CSM). Then the eight wastes and the bottleneck for further lean improvement can be identified.

After data collection and analysis, the CSM will become a visual improvement tool for work groups to set up challenging targets with measurable indicators. Furthermore, work groups can use continuously improved ideas with measurable targets using brainstorming to draw their future state map (FSM).

Through gap analysis between CSM and FSM, one can discover problems, and countermeasures to implement, evaluate and follow-up problems. After each improvement
session, the FSM changes back to the CSM. This creates a continuous improvement cycle.

Implementing VSM

So why has Toyota Motor achieved such dramatically high-performance while GM, Ford and Chrysler (the Big 3 of US) still show decreasing market share despite applying TPS or Lean related production for over ten years?

Most companies aim at short-term strategies, which achieve piece-meal improvements and short-term financial goals. For short-term financial goals, most companies – including the Big 3 – build more products than demand through mass production. This traditional approach always results in over production at a tremendous extra cost, such as warehousing cost for vehicles and the storage of CKD (completed knock down) parts. Moreover, the Big 3 approach conceals many quality issues in the supply chain. Through continuous waste elimination with LSC, the VSM application aims at no overproduction. The needed fundamental changes are built into the enterprise’s system and working culture with a long term philosophy.

The Lean supply chain concept has been applied to industries for several decades. The reason it has remained an open issue is because the whole supply chain system is very complicated with a long lead-time, making it difficult to make improvements throughout the system. Due to the dynamic market; there is the bullwhip effect with lots of changing measurable indexes.

The VSM is the main tool used to identify the opportunities with various lean techniques and aims at the core business process, starting from lean stations to lean processes. It enables supply chains to become more efficient and effective in sustaining continuous improvement. Moreover, VSM uses the pull system and one piece flow concepts to effectively eliminate wastes and remove the bullwhip effect through lead time reduction and inventory cost control.

Basic principles to implement VSM include:

- Standardized operations – set up the standard operation process (SOP) for different operators or different shifts, the standard which is the basis for continuous improvement must be unique.

- Level production – if the volume and model mix are changed, then the operators and stations are changed simultaneously. That means that the operation time including VA and NVA are also changing. Changing too frequently will disturb or even stop further improvement due to the lack of stable data.

- Model mix control – in order to enable fast and efficient improvement for line re-balance, it is suggested in Toyota's assembly line.

- Operations division – all operations must be divided into VA and NVA (including waste) for improving priority.

- Manpower focused – use VSM to calculate direct-manpower and do continuous improvement.

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