The Keys for Developing the Toyota Production System

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Abstract

Just in Time System (JIT) based on the Toyota Production System (TPS) in Japan has been adopted by many of the leading firms worldwide. Unfortunately, the key elements essential to further developing TPS remain undefined if not misunderstood.

The paper looks into the rationalizations of TPS and identifies the key elements for developing TPS based on the discussions with the late Taiichi Ohno of Toyota Motor Corporation and observations on visits to "Class A" JIT practitioners in Japan, North America, and the Asia Pacific Region.

1. Introduction

In 1955, Japan joined the General Agreement on Tariffs and Trade (GATT), returned to the International economic stage and advances towards liberalizing its trade. There were concerns that liberalization would compel Japanese manufacturers to fight desperately to compete with the resulting influx of superior foreign goods. It was perceived that liberalization would particularly affect the automotive industry and that no more than two Japanese Automakers would be able to survive following the liberalization of imports of completely built-up foreign vehicles. All automakers quickly began devising measures for coping with liberalization. By 1960 the government announced plans to liberalize trade and double the national income. Japan then had 13 local car assemblers.

TMC embarked to achieve an ambitious goal to catch-up with Ford, GM, and Chrysler (US Big 3). TMC needed to drastically lower costs, improve quality, and shorten lead-time. Comparatively, the US production volume reached 80,000-100,000/year, the Crown; Toyota's most popular passenger vehicle per production line was turning out 3,000 to 5000 units only. Toyota's number one concern then was increasing her production volume in order to lower her cost.

All efforts by TMC at the initiative of Ohno have resulted to a new production system put into operation in all plants. The system subsequently introduced to parts maker and materials suppliers. Finally by the early 1970's, the entire system came to be called the Toyota Production System.

2. Mixed Production

TMC had 7-8 production lines having a 3000-5000 capacity. Ohno theorized that if Toyota adopts mixed line in the entire production department, the production capacity increases eight-folds. The 8 mixed production lines will be able

to increase production capacity to a total of 40,000(5000 x 8) vehicles per year. Because the idea was thought to be too innovative, Ohno had a tough time convincing the TMC president to grant him approval to proceed with his plan.

Having the support from top management, Ohno together with his peers needed to find a solutions to the problems and issues of Economies of Scale, Production Volume, Right Things at the Right Time Production, Not sending Defect Goods (Parts), and Removing all of wastes.

Improving TMC's Economies of Scale was the first and biggest concern. Comparing TMC's performance to that of the big 3, TMC was doing relatively poorly. Ohno's solution was to increase the flexibility of the line by adopting mixed production. However, the following basic requirements must first be satisfied: Shape-up flexible mixed processes/operations, minimize set-up time, minimize lot size, promote mixed loading, promote multi-function workers, introduce working teams, promote streamed-lines, and change the way the manufacturing engineer thinks in terms of the engineers' over-value for precision over actual market demand.
The required production volume was achieved by implemented mixed production. Lot size and set-up time reduction was determined based on aggressive kaizen activities. Production volume is achieved by assembling a variety of model within a single production line.

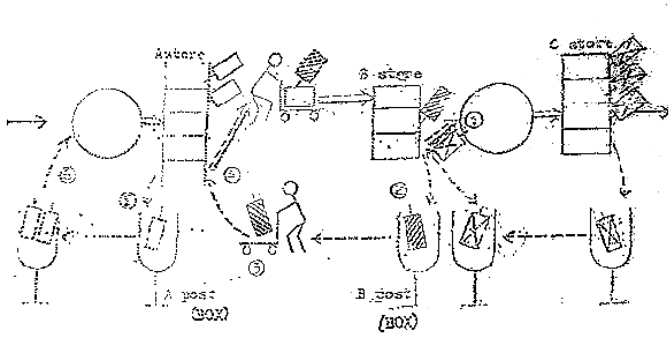
Three more problems need solutions before mixed production can be utilized. It was necessary to produce only the right things at the right time. An inventory pull-system (Kanban) was introduced to make it possible to produce the right things at the right time. Moreover, the problem of not sending Defect Goods (parts) to the subsequent process needed a solution. Ohno devised a system by which defects were immediately detected and remedied before the part reaches the next process (Jidoka). Finally, how to remove all wastes? Ohno felt that this might be achieved by adhering to the principle that systems are always a transient state to an ideal system. Because a system that immediately makes a product in response to the demand of customers is ideal, it is necessary that improvement activities be continuously implement on costly production activities in order to decrease the gap between required products and actual production output in terms of required volume and right timing.

3. Supermarket Method

The just-in-time (JIT) philosophy of production is one where only the required parts are produced or received at the rime they are needed in a production process. One of the major elements of a JIT is the information control system that determines how to "pull" items in the production system. In most situations, this is accomplished by the use of kanban cards to signal the amount and timing of material flow. When using the kanban discipline, a workstation is assigned a fixed number of kanbans for a specified period used in requesting work from upstream sources. Once an item arrives, the requesting kanban is attached to the work unit until the work unit leaves the workstation. At that time, the workstation can use the kanban to request more items from upstream sources. The kanban constitutes a flexible system that promotes close co-ordination among workstations in repetitive manufacturing.

Ohno wondered whether parts could be supplied from the proceeding to a subsequent process the same way a supermarket shopper would pick up goods from the shelf at the required quantities. Ohno felt this to be more appropriate rather than sending parts on to the next stage as soon as they are completed. In turn, only enough parts would be produced to replenish what the later process had used similar to supermarkets restocking their shelf with items

that have been taken. The supermarket method was developed and became known as a kanban system as early as 1954 and later applied from downstream process (assembly, sub-assembly, parts, and materials). The following diagram shows a typical flow of kanban generally observable at Toyota.



The way to compute for the Total number of Kanban is by using the simplified equation but finally decided by each supervisor is as follows:

$$\frac{\textit{Average Daily Demand x Lead Time x (1 + Safety Coefficient)}}{\textit{Container Capacity}}$$

Today, having at least 300,000 components in her car database, the numbers of kanbans are computed with the help of sophisticated Software. However in practice, each supervisor, based on the supervisors' experience with the workers, and desire to promote Kaizen, decides upon the actual number of kanbans. Electronic kanban was adopted for long distance and rationalization of the workers.

The requirements for installing the supermarket method are as follows: Standardized Item (repetitive specific item), preceding process must have the capacity to supply the demand of the subsequent process, Leveled Production (note: the ideal production rate is determined during the sales and production meetings that are held annually, monthly, and daily), and the standard capacity of the containers/pallets are equal to the demand.

4. Visibility Control System

In 1949 the multi-machine handling was developed considerably. By 1950 Andon board that indicates how the line operations was proceeding, and when and where problems occurred. Cords were also installed to stop the line if the line operators cannot immediately solve the problem.

Moreover, the installation of 5S is fundamental to shop floor management. 5S stands for seiri, seiton, seiso, seiketsu, and shitsuke. Like many Japanese Manufacturing firms, 5S forms part of the visibility control system.

Seiri (straightening-up) involves Classifying the necessary and unnecessary items such as: work-in-process, unnecessary tools, unused machinery, defective products, and unnecessary papers and documents then discarding the unnecessary. Seiton (putting things in order) requires identifying items necessary then arranging the items for use. Seiso

(clean-up), seiketsu (personal cleanliness) maintaining high standards of cleanliness for good house keeping, and shitsuke (discipline) requires shop floor people to routines the process.

5. Jidoka

The main purpose of Ohno in introducing Jidoka into the production system is to respond to the problem of having defective units from a preceding process flow into the following process. Jidoka provides the assurance that all parts flowing in the production line are all good parts. Quality improvement is the fundamental advantage achieved and purpose of implementing Jidoka rather than cost reduction, and the most important thing of Jidoka is to promote kaizen activities.

Jidoka is defined as Autonomous Defects Control. Many believe that Jidoka together with the Just in Time are the main pillars of Toyota Production System. Jidoka compliments JIT by never allowing defective units from a preceding process to flow into and disrupt a subsequent process. At TMC, Jidoka is done through human and mechanical intervention especially more observable in parts production lines and less observable in final assembly lines.

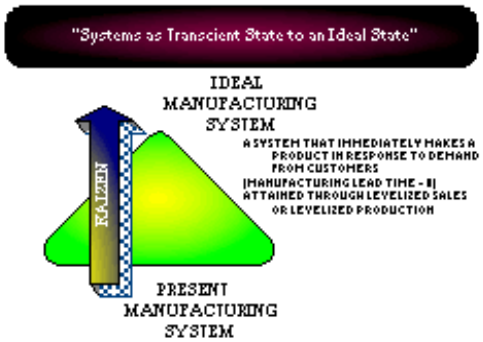
To introduce Jidoka, four basic requirements need to be satisfied, namely: operations and quality standards, fast feedback of defects, aggressive kaizen/Link with kaizen activities, and strict use of the kanban process.

Operations and Quality Standards define the concept of quality and improvement. Likewise, the workers have to be trained to think about how quality and improvement can be achieved at higher levels.

Fast Feedback of Defects is achieved only when shop floor workers recognize product defect as a very serious problem. Although a defective car in a million is statistically insignificant, this way of thinking is not tolerated at TMC because nothing less than the total satisfaction of each of the million customers is TMC's main goal in terms of improving on quality.

6. Kaizen

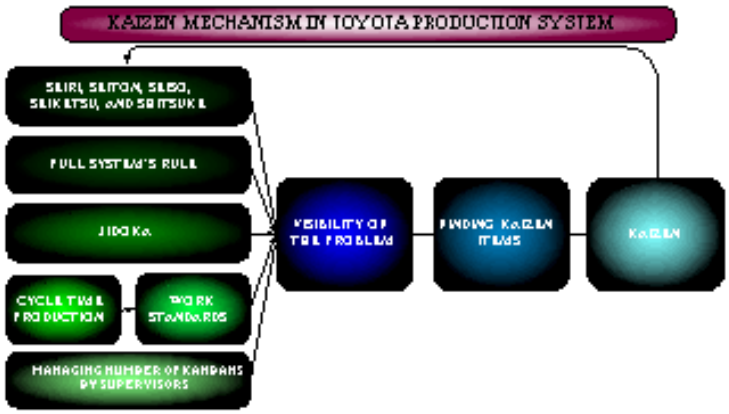
Mr. Ohno believes that although an ideal system (manufacturing lead-time = 0) is desirable, it will never be achieved since systems are always at a transient state to an ideal system. The diagram best describes Mr. Ohno's concept of Ideal State.



The Ideal Manufacturing System is immediately able to make a product at the demand of the customer. The Manufacturing System reaches the ideal state when lead-time equals zero. Having this in mind, Mr. Ohno aimed for the removal of all wastes as top priority and main concern of TMC to improve the Manufacturing lead-time. The following diagram to explain the concept of Manufacturing Lead Time

In the ordinary situation, queue time is significantly greater than operating time. The non-value added and cost generating queue time is composed of waiting time, moving time. Operating Time is composed of time spent only in production including the preparation for production.

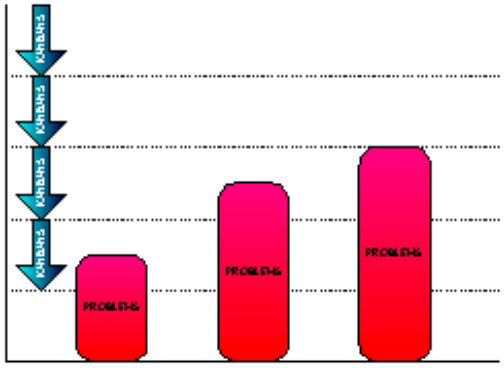
To be able to realize a manufacturing lead-time closer to zero, one should aim to decrease both queue time and operation time. Eliminating all wastes decreases the manufacturing lead-time. The wastes' needed to be eliminated are as follows: overproduction waste (do not produce 20 if you only need 10), wait waste, transportation and material handling waste (transportation is moving from point A to point B while materials handling is changing the position of a product within a given point.), stock/inventory waste, waste of making defects, and waste from process or operation itself. Kaizen (continuous improvement) is built into the system. This can be briefly explained through the following diagram:



The 5s provides an infrastructure base for kaizen. The pull system's rule enhances the control of the processes and operations. Jidoka acts as the trigger for kaizen and guarantees the quality of each process. Cycle Time defines the production rate (speed) to meet the demands of each workstation. Work standards are set in order to achieve the cycle time production without defects.

Control (Management of Inventory Level) is achieved through the control of the number of Kanbans. For example: 1. A supervisor watches the kanban containers. 2. Reduces unused kanban. 3. The decrease in inventory makes problems more visible. 4. Problem solving (kaizen).

All employees at TMC are responsible for both operations and kaizen. This is especially true with regards to the shop floor and staff personnel. Kaizen is good for the employees' morale since it breaks the monotony of doing the same thing over and over. Kaizen likewise enhances the individuals' creativity, promotes teamwork, and makes closer the relationship between workers and managers. The diagram illustrates the impact of decreasing the number of kanbans.



Decreasing the number of kanban make the real problems of a manufacturing system more visible. In TPS, kaizen is a major job for people, and the visibility of the problem triggers kaizen activities. Kaizen is practiced as follows:

1. Kaizen is a tool for enhancing the competitive advantage.
2. Kaizen is part of the Corporate Culture.
3. Kaizen activities are part of the Job.
4. Toyota production System uses the mechanism integrated into her system.

The introduction of kanban, jidoka, work standards, and 5S to the shop floor to increase the visibility of the problems is considered by many as Mr. Ohno's unique form of management style. He believes that the discovery of these problems alone will automatically encourage Kaizen within the shop floor.

Kaizen or Continuous Improvement is essential to assuring the achievement of greater positive results from implementing Jidoka and the other key elements. Continuous improvement activities are essential to achieving greater flexibility in the production line. However, in order to install Kaizen into the Toyota Production System, it is necessary to implement by the book the pull system rule, Jidoka, cycle time production, work standards, and reduction of inventory level by kaizen. By faithfully implementing these systems, the problems of the present production system become more visible. Hence, the process itself serves as the launching pad for identifying items for possible kaizen activities. After which, the results of kaizen would have its greatest impact on the improved way other key elements of TPS are installed/operated.

The diagram best describes the basic mechanism of kaizen in the Toyota Production System and shows how other key elements are inter-twined with Kaizen and exist in a form of co-prosperity relationship. The keys for developing TPS are as follows:

1. The major aim of TPS is developing people's ability and work lively.
2. For TPS, the strong weapon is the kaizen system.
3. Kaizen activities are a main job carrying the same weight as working operations.

4. Kaizen is a habit or custom and supported by corporate culture at Toyota.
5. Toyota created kaizen as a formal activity.
6. TPS is a system with high transparency.
7. In order to introduce TPS, companies need a fundamental infrastructure and ability for manufacturing need to emphasize people-ware.

7. Conclusion

Based on the discussions presented, the researchers wish to reiterate that the development of the Toyota Production found its way initially through a systematic trial and error approach in finding a resolution to the problems experienced as early as November 3, 1938 the date marking the founding of Toyota Motor Corporation.

The Toyota Production System evolved from four key elements namely: Mixed Production, Supermarket Method, Jidoka, and Kaizen. The Researchers believe that it is essential to continue to re-assess and determine the inadequacies of the system to flexibly match the requirements of a mature market before revolutionary changes may be made to the basic elements of the Toyota Production System.

Although we believing that all systems are always at a transient state toward the ideal system; Perhaps one day TPS will evolve to a superior production system that can deliver the customized products mature markets requires, just-on-time. This is the common dream shared by Kiichiro Toyoda, Taiichi Ohno, and the researchers as well.

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