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# Lean Manufacturing, Just in Time and Kanban of Toyota Production System (TPS)

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**Abstract:** In this paper, describes about "Lean Manufacturing, Just In Time and Kanban System of Toyota Production System (TPS)". Today, many manufacturing companies must follow the all new technology and tools for efficiently and effectively to present themselves a good competitor in the global economy Lean manufacturing is a efficiency based system on optimizing flow to minimizing the wastage and using advance methods to improve manufacturing system by modified or change pre-existing ideas. This manufacturing approach makes an organization able to sustain market competition by improving its competence for better quality; on time delivery with lower cost. This paper shows lean manufacturing system case study of the Toyota Production System ('TPS') how the specific tools of just-in-time manufacturing and kanban systems. Just-In-Time (JIT) manufacturing is a Japanese management philosophy applied in manufacturing. "Just-in-Time" (JIT) production system is to reduce product costs through the elimination of waste.

**Keywords:** Toyota, Lean Manufacturing, Efficiency Based System, Just In Time, Kanban System.

## I. INTRODUCTION

Lean Manufacturing is a philosophy that aims to maintain smooth production flow by continuously identifying and eliminating waste resulting in increasing value of activities in the production process. Lean manufacturing is the basic techniques for improve the production rate with the minimum available resources. This concept is comes out after the World War 2. This manufacturing, an approach that depends greatly on flexibility and workplace organization, is an excellent starting point for companies wanting to take a fresh look at their current manufacturing methods. Lean techniques are also worthy of investigation because they eliminate large capital outlays for dedicated machinery until automation becomes absolutely necessary. Indeed, the concept of lean manufacturing represents a significant departure from the automated factory so popular in recent years. The "less is better" approach to manufacturing leads to a vastly simplified, remarkably uncluttered environment that is carefully tuned to the manufacturer's demands. Products are manufactured one at a time in response to the customer's requirements rather than batch manufactured for stock. The goal is to produce only the quantity required and no more[13].

## II. JUST IN TIME SYSTEM

Just-In-Time (JIT) manufacturing is a Japanese management philosophy applied in manufacturing. Essentially it involves having the right items with the right quality and quantity in the right place at the right time. The manufacturing philosophy of JIT is well defined by the following analogy. This paper will detail the history of the "Just-in-Time" production system. The JIT system will be followed from its conception in 1940 to its success today. The characteristics and advantages of the JIT production system will be further outlined. The idea of producing the necessary units in the necessary quantities at the necessary time is described by the short term Just-in-time. Just-in-time means, for example, that in the process of assembling the parts to build a car, the necessary kind of sub-assemblies of the preceding processes should arrive at the product line at the time needed in the necessary quantities. If Just-in-time is realized in the entire firm, then unnecessary inventories in the factory will be completely eliminated, making stores or warehouses unnecessary. The inventory carrying costs will be diminished, and the ratio of capital turnover will be increased. However, to rely solely on the central planning approach, which instructs the production schedules to all processes simultaneously, it is very difficult to realize Just-in-time in all the processes for a product like an automobile, which consists of thousands of parts. Therefore, in Toyota system, it is necessary to look at the production flow conversely; in other words, the people of a certain process go to the preceding process to withdraw the necessary units in the necessary quantities at the necessary time. Then what the preceding process has to do is produce only enough quantities of units to replace those that have been withdrawn. JIT Manufacturing tries to smooth the flow of materials from the suppliers to the customers, thereby increasing the speed of the manufacturing process.

The objectives of JIT is to change the manufacturing system gradually rather than drastically:

1. To be more responsive to customers,
2. To have better communication among departments and suppliers,
3. To be more flexible
4. To achieve better quality,
5. To reduce product cost.

**A. Big JIT**

It is the philosophy of operation management that seeks to eliminate waste in all aspects of a firm's productions activities. Examples are Human relations, Vendor relations, management of materials and inventories.

**B. Little JIT**

It focuses more narrowly on scheduling goods inventory and providing service resources where and when needed. Examples are companies such as manpower temporary services.

**C. Just In Time Concept**

The operations planning and control system is an information system running throughout the manufacturing environment. Dedicated production lines can be designed in a balanced way with minimal setups in order to maximize the flow rate of the materials, while a general purpose machine must be set up before producing a specific item. In setup operations, the material flow is interrupted. Manufacturing environments can be changed to make planning and control systems simpler and more effective. Products are designed to have high similarity in processing and are mixed in a dedicated production line with negligible setups. JIT control systems are only effective in JIT environments. JIT Control can be incorporated into an ERP system as a control part with a condition that the system has to be in a JIT environment. The JIT philosophy guides the development of the JIT environment. The JIT environment provides the foundation for implementing the JIT control techniques. The JIT philosophy, JIT environment, and the JIT technique can be expressed in Figure 1. [12]

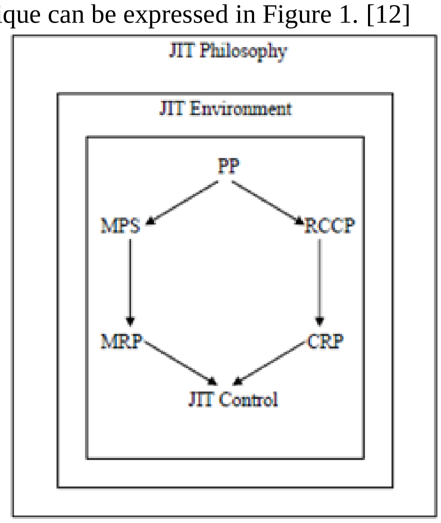


**Figure1. JIT Technique [12].**

**D. Just In Time Philosophy**

Any activity that does not add value to the product or service in the eyes of the customer is a waste. Poor product design such as the inclusion of fancy functions not required by the customer is a waste. A product design causing difficulty in manufacturing is a waste. Standardization reduces the planning and control efforts, the number of parts, and the inventory required. A poor product design without enough standardization leads to waste. In addition to waste resulting from poor design, Toyota identifies seven examples of waste resulting from poor manufacturing methods.

**E. Waste of Overproduction**

Overproduction is the production of goods more than what are immediately needed. Overproduction causes extra material handling, quality problems, and unnecessary inventories. Consuming materials for unnecessary products may cause a shortage of material for other products that are needed. Never overproduce products to keep men and machines busy. If the required loading is less than the capacity, leave it alone. The labor can be switched to other departments, cleaning or maintaining the machines, accepting training and education, etc.

**F. Waste of Waiting**

A material waiting in queue is a waste. An operator waiting for material or instruction and having no productive work to do is a waste.

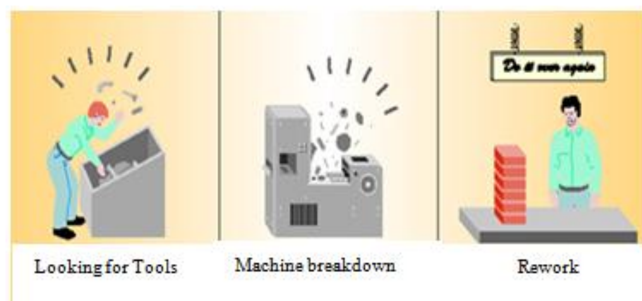


**Figure 2. Wait in Operations for Waiting Parts**

**G. Waste of Movement**

Poor plant layout results in materials having to be moved extra distances and cause unnecessary material handling costs. Work centers should be close to each other in order to reduce the move distance. Someone may say that close work centers provide no room for WIP inventories.

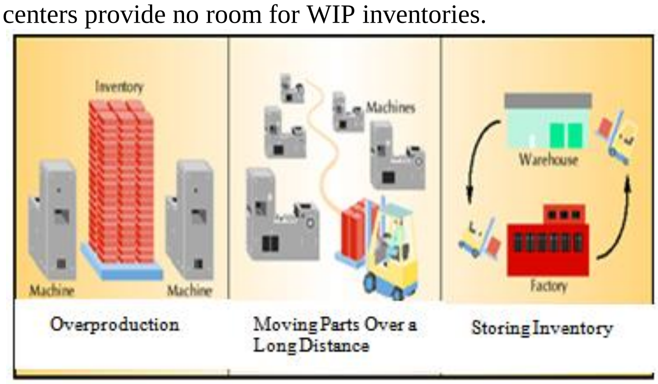


**Figure3. Wait in Operations of Over Production [12].**

### H. Waste of Inventories

Inventory causes costs of interest, space, record keeping, and obsolescence. Moreover, inventory can mask problems which could cause more inventory buildup. For example, WIP inventory between work centers can hide the symptoms of an unbalanced production rate. Finished goods inventory can mask poor forecasting, poor quality, and poor production control. Inventory is not an asset; it is a waste.

### I. Waste of Motion

Improper methods of performing tasks by the operators cause wasted motions. Reaching far for materials or machine buttons is a waste of motion. Searching for tools is a waste of motion. Any activity that does not add value to the products should be eliminated. Bad layout or training causes waste of motion.

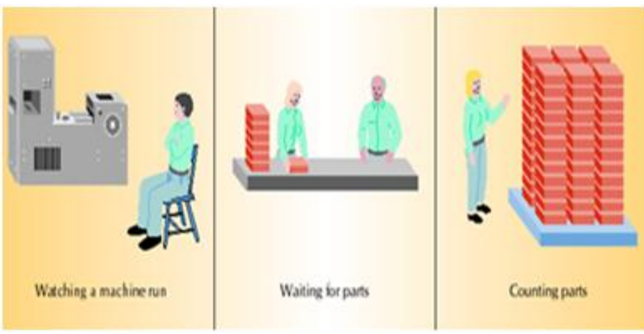


**Figure 4. Wait in Operations for Waiting Parts[12].**

### J. Waste of Making Defects

The cost of scraps is a waste. But it is the least important compared with other wastes caused by making defects. Defects interrupt the smooth flow of materials in the production line. If the scrap is not identified, next workstation will try using it to produce more wastes, or waste time waiting for good materials.

### K. Waste of Process Itself

Bad process design is a waste. For example, wrong type or size of machines, wrong tools, and wrong fixtures are wastes.

## III. JIT ENVIRONMENT

In addition to philosophical concepts, JIT also provides an environment in which products are manufactured in a simpler way.

### A. Repetitive Manufacturing

Repetitive manufacturing is the production of discrete items in a production line with fixed routings. The items can be a product or a family of products. The product is standard or made from standard modules. The manufacturing environment is make-to-order (MTO) or assemble-to-order (ATO). The production line consists of workstations located close together and in sequence. Materials flow from a workstation to the next at a relatively constant rate. Material handling systems are normally used to move the materials from process to process in the production line. Normally, the capacity of the production line is kept sufficient. The repetitive manufacturing is based on an uninterrupted flow of materials. [15]

### B. Total Quality Management (TQM)

Total quality management is a management approach used to achieve quality improvement and long-term success through customer satisfaction. TQM involves all members of the organization, and is meant to improve the quality of all processes, products, services, operations, and corporate culture. TQM activities follow a plan-do-check-action (PDCA) cycle to improve the quality. In the "plan" step, the problem is defined, the symptoms are explained, and the key performance measures are determined. In the "do" step, the cause of the symptoms is identified. The causes of the causes are also investigated until the root cause is uncovered. Then, an approach to solve the problem is developed and implemented. The performance measures can be changed in this step. In the "check" step, the effectiveness of the proposed approach is observed by using the performance measures. In the "action" step, the results are studied to determine what was learned and what can be predicted. The improvement process is standardized to apply to similar problems. [4]

### C. Total Productive Maintenance (TPM)

Preventive maintenance is a restrictive term which mentally prohibits us from thinking more broadly. TPM means preventive maintenance and continuing efforts to adapt, modify, and refine equipment in order to increase flexibility, reduce material handling, and promote continuous flows. It is operator-oriented maintenance involving all qualified employees in all maintenance activities. [4]

### D. Total Employee Involvement (TEI)

Elimination of waste and continuous improvement are the central ideas of the JIT philosophy. They can be accomplished only when employees are cooperative. A successful JIT environment should have the cooperation and involvement of everyone in the organization. Traditionally, operators take orders from management and do what they are asked to do, while management is in charge of planning, supervising, inspecting, etc. In a JIT environment, operators take responsibility for controlling the equipment, inspecting for quality, correcting the deviations, maintaining the machines, and improving the processes. Many of the tasks traditionally done by the management become the duties of the line workers under JIT. Managers are not playing the game; they are coaches and the line workers are the players. The mission of a coach is to train the players.

### E. Supplier Partnership

In order to establish a smooth flow of materials into the factory, a close and reliable relationship with the suppliers is very important. Supplier partnership is the establishment of a working relationship with a supplier whereby the two organizations act as one. Relationships with the suppliers should be based on mutual trust, cooperation, and long-term commitment.

## IV. JIT AS A CONTROL TECHNIQUE

In daily operations, JIT provides useful control methods. The characteristics of a JIT control technique include uniform loading, repetitive processes, pull system, using production cards, and synchronized production.

### A. Pull System

JIT control pulls materials from the previous workstation. The workstation replenishes any materials consumed by its following workstation. Since only the consumed materials are produced, the inventories between workstations never accumulate. For the first workstation of the factory, the supplier is its preceding workstation. For the last workstation in a factory, the customer is its following workstation. Customers pull the products from the factory, and factory pulls the materials from the suppliers.

### B. Uniform Loading

The loads for jobs in every workstation are equal. This makes the pull system possible. If uneven loading exists, the following workstation may have to wait for the materials from the preceding workstation. Uniform loading allows the materials to flow through the production line smoothly. Every workstation runs at a constant rate. If the demand increases, the production rates in all workstation increase together. If the demand drops, all workstations may have the same level of idleness. [14]

### C. Production Card

JIT control uses various cards to transmit production signals. During the production, these cards are attached to and detached from the materials. Production signals are transmitted from the following workstation back to the preceding workstation. The cards have various shapes and colors to indicate different purposes. Sometimes material containers or the material itself are themselves the signals.

### D. Synchronized Production

Synchronized production is a manufacturing practice in which production activities in each workstation are synchronized with certain control signals. The production rates of workstations are related to each other, and the work-in-process inventories are limited to a predetermined level. Synchronized production can be seen in JIT environments or theory-of-constraints (TOC) environments. The control signals are carried by kanbans in a JIT environment. In the TOC environment, drum-buffer-rope (DBR) is used to synchronize the workstations. [14]

## V. KANBAN SYSTEM

Kanban (kahn-bahn) is Japanese word that when translated literally means “visible record” or “visible part”. The kanban system is based on a customer of a part pulling the part from the supplier of that part. The customer of the part can be an actual consumer of a finished product (external) or the production personnel at the succeeding station in a manufacturing facility (internal). The premise of kanbans is that material will not be produced or moved until a customer sends the signal to do so. The typical kanban signal is an empty container designed to hold a standard quantity of material or parts. When the container is empty, the customer sends it back to the supplier. The container has attached to it instructions for refilling the container such as the part number, description, quantity, customer, supplier, and purchase or work order number. Some other common forms of kanban signals are supplier replaceable cards for cardboard boxed designed to hold a standard quantity, standard container enclosed by a painting of the outline of the container on the floor, and color coded striped golf balls sent via pneumatic tubes from station to station. Kanbans serve many purposes. They act as communication devices from the point of use to the previous operation and as visual communication tools. They act as purchase orders for your suppliers and work orders for the production departments, thereby eliminating much of the paperwork that would otherwise be required. In addition, kanbans reinforce other manufacturing objectives such as increasing responsibility of the machine operator and allowing for proactive action on quality defects. However, kanbans should not be used when lot production or safety stock is required because the kanban system will not account for these requirements. [6]

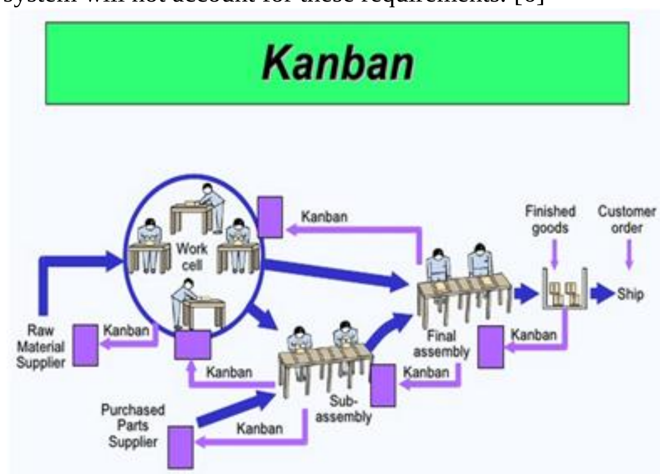


**Figure5. Kanban System [6]**

### A. Push VS. Pull System

The kanban system described is a pull system. Traditionally, a push system is and has been employed. The push system is also more commonly known as the Materials Requirements Planning (MRP) system. This system is based on the Planning Department setting up a long-term production schedule, which is then dissected to give a detailed schedule for making or buying parts. This detailed schedule then pushes the production people to make a part and push it forward to the next station. The major weakness of this system is that it relies on guessing the future customer demand to develop the schedule that production is based on and guessing the time it takes to produce each part. Overestimation and under-estimation may lead to excess inventory or part shortages, respectively. One of the major reasons kanbans are used is to eliminate or reduce the above mentioned wastes throughout an organization due to the pull system that is employed. Waste can come from over-production (inventory) and therefore, the need for a stockroom. This waste is eliminated. Part shortages (under-production) are also eliminated. Costs are reduced by eliminating the need for many of the purchasing personnel and the paperwork associated with purchasing. The planning department's workload is also reduced, as they no longer need to produce work orders. Many people think the Toyota production system a Kanban system: this is incorrect. The Toyota production system is a way to make products, whereas the Kanban system is the way to manage the Just-in-time production method. In short, the kanban system is an information system to harmoniously control the production quantities in every process. It is a tool to achieve just-in-time production. In this system what kind of units and how many units needed are written on a tag-like card called Kanban. [6]

**Figure 6. Push Vs Pull System[6]**

This connecting of processes in a factory allows for better control of necessary quantities for various products.

## VI. CONCLUSION

Traditionally, a manufacturing business competes on price, quality, variety, after service, etc. Now, these conditions are merely prerequisites. Few businesses exist today without offering low prices, high quality, and good service. The key competitive factor has become speed. All else being equal, the faster a business responds to its customers, the more profitable it is. The shorter the lead-time in which a manufacturer can supply its products, the higher the probability that it will survive. High velocity manufacturing is a common goal for all manufacturing businesses. In high velocity manufacturing, everything is moving. Machines, people, funds and materials are constantly moving. Therefore, inventories in storage or on the shop floor are moving inventories rather than sitting inventories. Inventories are stocked only for a very short time, and will move to other locations only moments after being stocked. The conditions of high velocity manufacturing include flow manufacturing, line balancing, level schedule, and linearity.

## VII. REFERENCES

[1] Adler, Paul S. and Robert E. Cole, 'Designed for Learning: A Tale of Two Auto Plants.'Sloan Management Review, Vol. 34, No. 3 (Fall), pp. 85-94, 1993a.

[2] Adler, Paul S., Barbara Goldoftas, and David I. Levine, 'Ergonomics, employeeinvolvement, and the Toyota production system: A case study of NUMMI's 1993 model introduction', Industrial & Labor Relations Review, 50(3): 416-437, Apr. 1997.

[3] Barnard, Chester, The Functions of the Executive, 1938. Barley, Stephen R., "Images of Imaging: Notes on Doing Longitudinal Field Work", Organization Science, Vol. 1 No. 3, August 1990.

[4] Boccard, Ronald R., Push vs. Pull: Is One Better than the Other?, Production & Inventory Management Review & APICS News. 10(2): 39-40, Feb.1990.

[5] Cusumano, Michael, The Japanese Automobile Industry: Technology and Management atNissan and Toyota, Harvard University Press, 1989.

[6] Deleersnyder, Jean-Luc, Thom J. Hodgson, Henri Muller, and Peter J. O'Grady, 'Kanban Controlled Pull Systems: An Analytic, Approach', Management Science. 35(9): 1079-1091. Sept. 1989.

[7] Hayes, Robert, and Gary Pisano, "Beyond World-Class: The New Manufacturing Strategy", Harvard Business Review, January-February 1994.

[8] Hirano, Hiroyuki, JIT Factory Revolution, Productivity Press, 1988. Hopp, Wallace and Mark L. Spearman, Factory Physics: 2nd Ed., McGraw-Hill, 2000.

[9] Jaikumar, Ramachandran and Roger E. Bohn, 'A dynamic approach to operations management: An alternative to static optimization', International Journal of Production Economics, 27 (1992) 265-282.

[10] Krafcik, John F., 'Triumph of the Lean Production System', Sloan Management Review, Fall 1988, page 41-52. Lawrence, Paul and Jay Lorsch, Organizations and Environment, 1967.

[11] Monden, Yasuhiro, Toyota Production System : An Integrated Approach To Just-In-Time 2nd Ed. Norcross, Ga. : Industrial Engineering and Management Press.

[12]Sarker, Bhaba R., "Simulating a Just-in-Time Production System", Computers & Industrial Engineering, 16(1): 127-137. 1989.

[13] Spear, Steven J. "Essence of Just-in-Time: Imbedding diagnostic tests in work-systems to achieve operational excellence, The," Production, Planning, and Control, (forthcoming) and HBS Working Paper 02-020.

[14] Fujimoto, T. (2011). Supply Chain Competitiveness and Robustness: A Lesson from the 2011 Tohoku Earthquake and Supply Chain "Virtual Dualization". Manufacturing Management Research Center.

[15] Just In Time(2016, September 29). Retrieved November 25, 2016,from Toyota Global: http://www.toyota-global.com/company/vision_philosophy/toyota_production_system/just-in-time.html

[16] Kubota, Y. (2016, April 19). Japan Earthquakes Rattle Toyota's Vulnerable Supply Chain. Retrieved September 10, 2016, from The Wall Street Journal: http://www.wsj.com/articles/japan-earthquakes-rattle-toyotas-supply-chain-14609 86805 57

[17] Lu, D. J. (1989). Kanban/Just-In-Time At Toyota: Management Begins at the Workplace. Productivity Press. Marksberry, P. (2013). The Modern theory of the Toyota production System: A Systems Enquiry of the World's Most Emulated and Profitable Management System. Taylor and Francis Group.

[18] Mclnnis, K. R., & Gross, J. M. (2003). Kanban Made Simple: Demystifying and Applying Toyota's Legendary manufacturing Process. American Managemnet Association. Monden,Y.(2012). Toyota Production System: An Integrated Approach to Just-In-Time. Taylor and Francis Group.

[19] Nishiguchi, T., & Beaudet, A. (1998, October 15). The Toyota Group and the Aisin Fire. Retrieved September 25, 2016, from MIT Sloan Managemnet Reviev: http://sloan review.mit.edu/article/the-toyota-group-and-the-aisin-fire/

Nishiguchi, T., & Beaudet, A. (1998). The Toyota Group and the Aisin Fire. Sloan Management Review.
[20] Tajitsu, N., & Yamazaki, M. (2016, April 17). Toyota and Other Major Japanese Firms Hit by Quake Damage, Supply Disruptions. Retrieved September 8, 2016, from Reuters:http://www.reuters.com/article/us-japan-quake-toyota-idUSKCN0XE08O.