Inventory Control by Kanban Based Pull System Implementation

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ABSTRACT

Business organizations today are facing great competitions & challenges as the economy is growing. The growth & the downfall of the company depend upon how it uses its resources. There is need to control Inventory and Smooth Flow of Information.

In manufacturing industry, almost 60% of total cost is constituted by the inventory. Kanban system which is one of the tools to maintain inventory at optimum level is used in various man-ufacturing organizations. This system helps in fulfilling all the above mentioned characters, that is, it provides smooth flow of information, 'pull technology' in production (material movement) and hence helps in maintaining the inventory at optimum level.

Kanban system has been implemented and observed firstly for 8O43 piston line, which is re-lated to power steering product. Also after gaining positive results from the system at 8O43 piston line as well as positive feedback from top management, there was a time to give training to other cell leaders and operators related to different part's cells to implement the system suc-cessfully there and for achieving positive results in return.

Keywords : KANBAN, Pull system, Inventory Control, Kanban Cards]

CONCEPTS

Kanban is a scheduling system for lean and just-in-time(JIT) production. Kanban is a system to control the logistical chain from a production point of view, and is not an inventory control system.

Kanban was developed by 'Taiichi Ohno', at Toyota, as a system to improve and maintain a high level of production. Kanban is one method through which JIT is achieved.

Kanban became an effective tool in support of running a production system as a whole and it proved to be an excellent way for promoting improvement. Problem areas were highlighted by reducing the number of kanban in circulation. One of the main benefits of Kanban is to establish

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an upper limit to the work in progress inventory, avoiding overloading of the manufacturing system.

Kanban Origins

In the late 1940s, Toyota started studying supermarkets with the idea of applying shelf-stocking techniques to the factory floor. In a supermarket, customers obtain the required quantity of product at the required time; no more and no less. Furthermore, the supermarket stocks only what it expects to sell within a given time frame, and customers take only what they need, since future supply is assured.

Taiichi Ohno stated that to be effective, kanban must follow strict rules of use. Toyota, for example, has six simple rules, and close monitoring of these rules is a never-ending task, thereby ensuring that the Kanban does what is required.

Kanban Cards

Kanban cards are a key component of kanban and they signal the need to move materials within a production facility or to move materials from an outside supplier in to the production facility. The kanban card is, in effect, a message that signals depletion of product, parts or inventory that, when received, the kanban will trigger the replenishment of that product, part or inventory.

Consumption therefore drives demand for more production, and demand for more products is signaled by the kanban card. Kanban cards therefore help create a demand-driven system. Kan-ban cards, in keeping with the principles of kanban, simply convey the need for more materials. A red card lying in an empty parts cart conveys that more parts are needed.

The Contents of the Kanban

Kanban	Part Name	Part Number	Kanban Number
Work Station (From)	Work Station (To)	Quantity	Container Number

No. of Kanban cards = (Expected demand during lead time + Safety stock) / Size of the container.

The Kanban system is flexible system. This system can be easily adjusted to fit the current way. The system is operating because card sets can be easily added or removed from the system. If the workers find that are not able to consistently replenish the item on time, an additional con-tainer of material with the accompanying Kanban cards can be added. If it is found that excess containers of material accumulate, card sets can be easily removed thus reducing the amount of inventory.

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Advantages of Using the Kanban System

- Flexibility
- Focus on continuous delivery
- Reduction of wasted work / wasted time
- Increased productivity & efficiency
- Team members' ability to focus

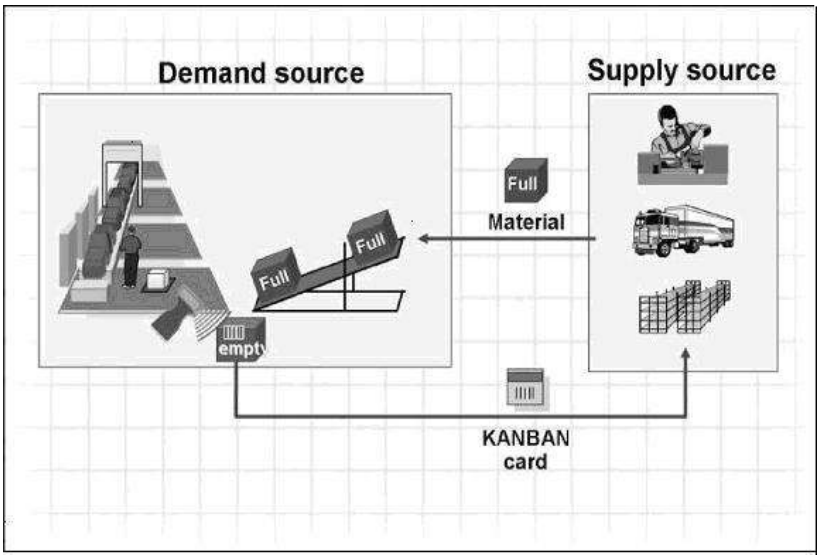

Figure: Operating principle of Kanban System

OBJECTIVES OF THE STUDY

1. To study the current inventory & production system.
2. To design the Kanban card for flow of information.
3. To implement Kanban card to convert present push system of material movement into pull system.

RESEARCH PROBLEM AREA

Economists and business analysts alike have long recognized the central role played by swings in inventory accumulation during cyclical contractions in the economy. The importance of understanding inventory behavior cannot be overstated when analyzing business cycles. Although it is easy to see how inventories are important in cyclical fluctuations, other aspects of inventory behavior remain poorly understood. For example, to what extent have firms lived up to much

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lauded "just-in-time" inventory management techniques? If inventory holdings truly have fall-en, what does this imply about the role of inventories in future cyclical fluctuations?

One such tool used to control the inventories is Kanban system. The Japanese refer to Kanban as a simple parts-movement system that depends on cards and boxes/containers to take parts from one work station to another on a production line.

The essence of the Kanban concept is that a preceding process should only deliver components to the succeeding process as and when they are needed, so that there is no storage in the produc-tion area. Within this system, workstations/store along production lines only produce/deliver desired components when they receive a card's signal and an empty container, indicating that more parts are needed in production. In case of line interruptions, each work-station will only produce enough components to fill the container and then stop. In addition, Kanban limits the amount of inventory in the process by acting as an authorization to produce more inventories.

Since Kanban is a chain process in which orders flow from one process to another, the produc-tion or deliveries of components are pulled to the production line, in contrast to the traditional forecast oriented method where parts are pushed to the line. An attempt has been made in this project to understand and implement the Kanban system in inventory control so as to make sure that components flow as well as information flow should be smooth to meet the requirements of the shop floor. So to overcome these problems, this topic was selected.

RESEARCH DESIGN

S N	Parameter	Description
1	Type of research	Analytical Research
2	Nature of Research	Quantitative
3	Sources of data collection	Primary and Secondary sources
4	Primary sources	Observation, interview and field survey
5	Secondary sources	Books, Journals, Articles, Magazines Company Data Sheets
6	Data interpretation	Mathematical Calculations using formulas.

DATA ANALYSIS & INTERPRETATION

Before implementing the Kanban system, study of their present manufacturing process, ma-chines, the types of parts they were manufacturing, the types of parts they were outsourcing etc was done. At initial stage, researchers concentrated on a product called power steering. For

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manufacturing power steering cellular manufacturing process was being used. Cellular Manufacturing is based on the principle of Group Technology.

By studying present scenario of production, researchers found that the technology they were using for movement of components or materials or parts was Push technology. It means that the moment parts were manufactured by the preceding process; they were got delivered to suc-ceeding process. Though there was no requirement of parts at succeeding process, it was got delivered by the preceding process.

The safety inventory they were maintaining at shop floor is quite less than that of heat treatment plant, because heat treatment plant was having operations like Hardening and Carburizing, which were having cycle time of 12hours and 36 hours respectively.

Due to such long cycle time they were keeping large amount of safety stock for heat treatment plant. As it has already said that the number of inventory they were maintaining was totally flexible quantity and it was varying according to the monthly predicted demand of product (e.g. 8O43 power steering) by customers.

To Design the Kanban Card for Smooth Flow of Information

Use of Pull technology principle and card mechanism of Kanban system will help in overcoming the above mentioned weaknesses of the production practices in the company. Hence, researchers started to implement Kanban system for power steering. As it has mentioned that power steering is a combination of various parts like, piston, nut, worm, end cover etc. research-ers took first piston part for implementation of Kanban system because of its complex nature of manufacturing.

Also, there were three types of piston which are 8O43 piston, MO33 piston and 8O33 piston. Because of the more demand, 8O43 piston was selected. Initial stage of implementing the Kan-ban system, is to design a Kanban card. With the help of discussion with respective cell leader, production manager, guide, etc. researchers designed Kanban cards. The type of Kanban system which was going to implement there, was Double Kanban system. In that, the Withdrawal Kan-ban card was denoted by yellow sheet while the Production Kanban card was denoted by green sheet. Two different colors were used to avoid the confusion of users of the cards. The contents which are shown in Kanban card was according to need and requirement of a cell leader, oper-ators and casuals.

Followings are the meaning of terms used in Kanban card.

1. Production Kanban card: This card should be at output side of process. (Items ready for Dispatch)
2. Withdrawal Kanban card: This card should be at input side of process. (Items to be received for Processing)

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3. Item Description and part number denotes the information about type of component which is to be kept in that particular trolley. e. g. Piston 8O43
4. One trolley should contain one card.
5. Subsequent process should pull material from preceding process with exchange of cards. e. g. Hardening process should pull trolley of piston from piston carburizing cell.
6. Trolley Capacity: This is the optimum number of quantity of component which should be kept in one particular trolley, to which that card is attached. Trolley should not contain less than or more than that particular trolley capacity. e. g. For 8O43 Piston, Trolley Capacity = 48
7. Location From: This is the location from where information is sent.
8. Location To: This is the location at which information is collected. e. g. Information (Kan-ban card) is sent from Heat Treatment Plant (Hardening) and is collected at Piston Carbu-rized Cell.
9. Issue Number: This is denoted by 'a/b'. Where 'a' is the number of that particular card and 'b' is the total number of cards. e. g. 1/3

The formula for calculating number of Kanban is as bellow:

$$K = DL (1+S) / C$$

Where, K = Number of Kanban

D = Demand per hour

L = Lead Time or Replenishment Time of Kanban in

hours S = Safety Requirement (10%)

C = Size of Container or Kanban (According to Thumb Rule, it is nearly 10% of Daily Demand)

As it has mentioned that according to Thumb Rule, the size of container is nearly 10% of daily demand, but by considering the material carrying cost and the holding cost, it was not possible to take it as 10% of daily demand so we took it as an optimum balancing figure. The size of container we had considered was depending on the size and weight of parts which had to trans-fer as well as the distance between two cells where the parts had to transfer. As hardening and carburizing operations were at heat treatment plant, also some cells related to power steering product were at plant-2 while some were at plant-3, so taking size of container as only 10% of daily demand for long distance movement of parts was quite uneconomical. Hence, after

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considering all these things, we found the final container sizes for each type of parts of power steering like, piston, sector shaft, worm, nut, etc.

As a sample example, the calculation of number of Kanban as well as inventory, according to formula given above, for 8O43 hard piston cell is shown bellow. e. g. Lead time for 8O43 hard piston = 3.55 hours

Demand per hour = 10

Size of container = 48

Safety requirement = 10%

Number of Kanban = [10 * 3.55 * (1 + 0.1)] / 48

= 0.79 / hour

= 0.79 * 16 / day

= 12.60 ~ 13 / day

Also, total inventory per day = 13 * 48

= 624 / day

Though, there were some variances in between practically implemented and theoretically calculated values of inventory, they had kept practically implemented value of inventory as it is for most of the parts. That was, because to satisfy or to give response to customer's sudden require-ment. So, that excess inventory was coming under the opportunity cost. While they had also done some slight changes in practically implemented inventory value for some parts, according to their theoretically calculated value.

To Implement Kanban Card to Convert Present Push System of Material Movement into Pull System

After designing of Kanban card, the actual working or use of that card was started. Dual Kanban system was implemented for 8O43 piston cell. In this system two types of card were used, first one is Production Kanban card and second one is Withdrawal Kanban card. Production Kanban card should be use at the output side, while Withdrawal Kanban card should be use at the input side of cell. As there was a cellular manufacturing used for the production in the company, the pistons were also produced through different cells.

The production of 8O43 piston was through following stages.

1. Raw materials for 8O43 piston were supplied from store to soft piston cell.
2. After processing at soft piston cell, the outputs of that cell were supplied to heat treatment

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plant for carburizing operation. The cycle time for carburizing operation was 36 hours.

3. In this stage, carburized materials or parts were supplied to piston carburized cell for further processing.
4. After getting processed, they were supplied to again heat treatment plant for hardening operation. The cycle time for hardening operation was 12 hours.
5. This is the stage of production of finished 8O43 piston, where hardened materials or parts from heat treatment plant were supplied to piston hard cell for some final processing.
6. At this stage, the finished 8O43 hard pistons were supplied to washing and after getting washed, they were ready for final assembly operation.
7. After assembling of different parts at assembly section, the final power steering products were supplied to dispatch area, where products were ready for dispatching.

These all are the key stages which should be considered while implementation of Kanban system. As Kanban system is based on a Pull technology, researchers started implementing it from dispatch to assembly, assembly to hard piston cell, hard piston cell to heat treatment plant (hardening), heat treatment plant to piston carburized cell, piston carburized cell to again heat treatment plant (carburizing), heat treatment plant to soft piston cell & from soft piston cell to store at the end.

First researchers found the total number of models of power steering which were stored at dispatch for final delivery to the customers and collected information about the inventory or stocks they were maintaining for each of the total models. After discussing with the guide and supervisor of dispatch area, researchers divide total stocks into optimum batch size or lot size. This was the size which should be considered as trolley capacity in Kanban card. The inventory or stocks of a final product which they were maintaining at dispatch area was based on their practical experiences and monthly predicted demand of products from customers. It was not based on any theoretical formula of calculating number of Kanban which researchers have already mentioned above.

Following table gives information about types of power steering model, total stocks of respective model, trolley capacity and number of Kanban cards for each model.

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Model Name	Total Stock Quantity	Trolley Capacity	Number of Kanban cards
8O43-302	700	100	7
8O43-303	160	40	4
8O43-806	300	60	5
8O43-169	300	60	5
8O43-294	100	25	4
8O43-215	100	25	4
8O43-810	50	25	2
8O43-820	30	15	2
8O43-821	30	15	2
8O43-805	30	15	2
8O43-804	30	15	2
8O43-826	200	50	4
8O43-244	50	25	2

Note : The figures of Total Stock Quantity which have given in the table was based on the monthly predicted demand plan in the month of July.

The figures of stock quantity, trolley capacity and number of Kanban which have mentioned above are totally flexible and it will be adjusted according to the customer demands.

After deciding optimum trolley capacity and number of Kanban for each of the model of power steering, researcher handed over the calculated number of Kanban cards to supervisor of dispatch area and also explained the whole procedure to him about the functioning of this system. As per the functioning of Pull technology, dispatch area (succeeding process) had to pull material from assembly area (preceding process), so researcher also explained the each and every terms and functioning of Kanban system to assembly in-charge, supervisor and operators.

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The inventory they were keeping for each cell was as follows:

- For Hard Piston Cell,

  8O43 RH = 144 & 8O43 LH = 96

- For Piston Carburized Cell,

  8O43 RH = 144 & 8O43LH = 96

- For Soft Piston Cell,

  8O43 = 144

- For Hardening Cell of Heat Treatment

  Plant, 8O43 RH = 288 & 8O43 LH = 192

- For Carburizing Cell of Heat Treatment

  Plant, 8O43 = 288

With the help of quantity of inventories which have been mentioned above & capacity of trolley, I calculated the numbers of Kanban for each respective cell and for each sub-types of 8O43 piston were calculated. These are given bellow:

- For Hard Piston Cell,

  8O43 RH = 3 & 8O43 LH = 2

- For Piston Carburized Cell,

  8O43 RH = 3 & 8O43LH = 2

- For Soft Piston Cell,

  8O43 = 3

- For Hardening Cell of Heat Treatment

  Plant, 8O43 RH = 6 & 8O43 LH = 4

- For Carburizing Cell of Heat Treatment

  Plant, 8O43 = 6

Note: The mentioned data of number of Kanban cards and stock of inventory was according to the monthly predicted demand in the month of July.

After implementing the Kanban system from dispatch to assembly and from assembly to machining centre according to the Pull technology, it was implemented to store. In that, raw materials or parts were pulled by the soft piston cell from store. Here also, the functioning of

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the system was explained to each and every concerned person. While implementing Kanban system from soft piston cell to store, withdrawal card was kept at the input side of cell, which was giving withdrawing signal to store. For that optimum number of Kanban cards and trolley capacity was decided by discussing with guide and concerned persons which was 2 and 40 respectively.

Dispatch	Kanban card (for different models)
↓	
Assembly	Withdrawal Kanban (Trolley C. = 48)
↓	
Hard Piston Cell (output)	Production Kanban (Trolley C. =48)
↓	
Hard Piston Cell (input)	Withdrawal Kanban (Trolley C. = 48)
↓	
Hardening (output)	Production Kanban (Trolley C. =48)
↓	
Hardening (input)	Withdrawal Kanban (Trolley C. = 48)
↓	
Carburized Piston Cell (output)	Production Kanban (Trolley C. =48)
↓	
Carburized Piston Cell (input)	Withdrawal Kanban (Trolley C. = 48)
↓	
Carburizing (output)	Production Kanban (Trolley C. =48)
↓	
Carburizing (input)	Withdrawal Kanban (Trolley C. = 48)
↓	
Soft piston Cell (output)	Production Kanban (Trolley C. =48)
Soft Piston Cell (input)	Withdrawal Kanban (Trolley C. = 40)
↓	
Store (Raw material)	

FINDINGS

There was a difference in practically implemented and theoretically calculated inventory value of different parts of power steering. They have kept practically implemented value of inventory

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as it is for most of the parts of power steering as an opportunity cost to satisfy customer's sudden demands.

They have made few changes in inventory value of some parts of power steering according to the theoretically calculated value of the inventory.

RECOMMENDATIONS

1. A more detail study should be done to avoid excess of inventory in order to reduce opportunity cost.
2. As implementation has been done for the piston cell, it can be implemented to other cells as well as for the other products.
3. Implementation of basic Kanban card has been done but in future, Barcode Kanban card system can be implemented to control system centrally.

LIMITATIONS OF THE STUDY

1. Since this is a special activity, there was some restriction to share information.
2. Calculation of daily demand for different components on every production line is a time consuming process.
3. In some cases concern person did not give desired information at the required time and also some were showing resistance to change. It means, they were opposing to the implementation of new system.
4. Kanban system includes the manual intervention & hence it is not possible to eliminate the errors 100%.

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