

After studying this unit you should be able to

- Understand Kanban concept
- Know the Kanban strategies
- Learn Lean Inventory
- Know Types of Kanban systems
- Discuss the Kanban process
- Understand Virtual or electronic Kanban (e-Kanban) systems
- Explain Kanban Inventory Management System
- Implement the Kanban
- Calculate Kanban quantities

16.2 THE KANBAN CONCEPT – ORIGIN AND HISTORY

Kanban (means signboard or billboard in Japanese) is a visual scheduling system with ‘visual signal’ or ‘card’ related to just-in-time (JIT) inventory/production that tells “what – when – how much” to procure/produce. Kanban, in the automotive industry is also known as the *Toyota Nameplate System* because the system takes its name from the cards which track the



to work in process inventory and thence avoids overcapacity. One of the objectives of the kanban system is to limit the build-up of excess inventory at any point in production. Limits on the quantities of items waiting at supply points are instituted, so that the inefficiencies are identified, reduced and/or removed. Thus when a limit is found exceeded, then that point of inefficiency can be addressed.

The Empty Box Concept – Two-bin System

The system originates from ‘*an empty box*’, the simplest visual stock replenishment signalling system. Its first development could be seen in the UK factories producing Spitfires during the WW-II, which was named “two-bin system”.

The Supermarket Shelf-Stock Concept

During late 1940s, Toyota started studying the idea of shelf-stocking techniques in supermarkets to apply to the factory floor. In a supermarket, customers generally retrieve what they need at the required time—no more, no less,

because the customer has a assurance of getting whenever it is required if not now. On the other side, the supermarket stocks only what it expects to sell in a given time, based on what its customers take or what they need. Further, it can assure future supply. This observation led Toyota to view a production process and its various stages as customers while the inventory stores as the supermarket.

Kanban aligns inventory levels with actual consumption. A signal tells a supplier to produce and deliver a new shipment when a material is consumed. This signal is tracked through the replenishment cycle, bringing visibility to the supplier, consumer, and buyer.

Kanban uses the rate of demand to control the rate of production, passing demand from the end customer up through the chain of customer-store processes. In 1953, Toyota applied this logic in their main plant machine shop.

.16.3 KANBAN STRATEGIES: PUSH VS PULL KANBAN

A manufacturer always desires to make what the customers want. The challenge is to know what exactly they want, and when they want it. In general, approaches to supply chain management in manufacturing include a push system or pull system, but the question is, which is the best strategy for the company?

While designing the best suitable strategy for a given the following strategic approaches are considered

1. Push Kanban: Unlimited WIP and Demand Dependent and
2. Pull Kanban: Limited WIP and Demand Focused
3. A combination of Push and Pull Strategies

We shall have little discussion on these.

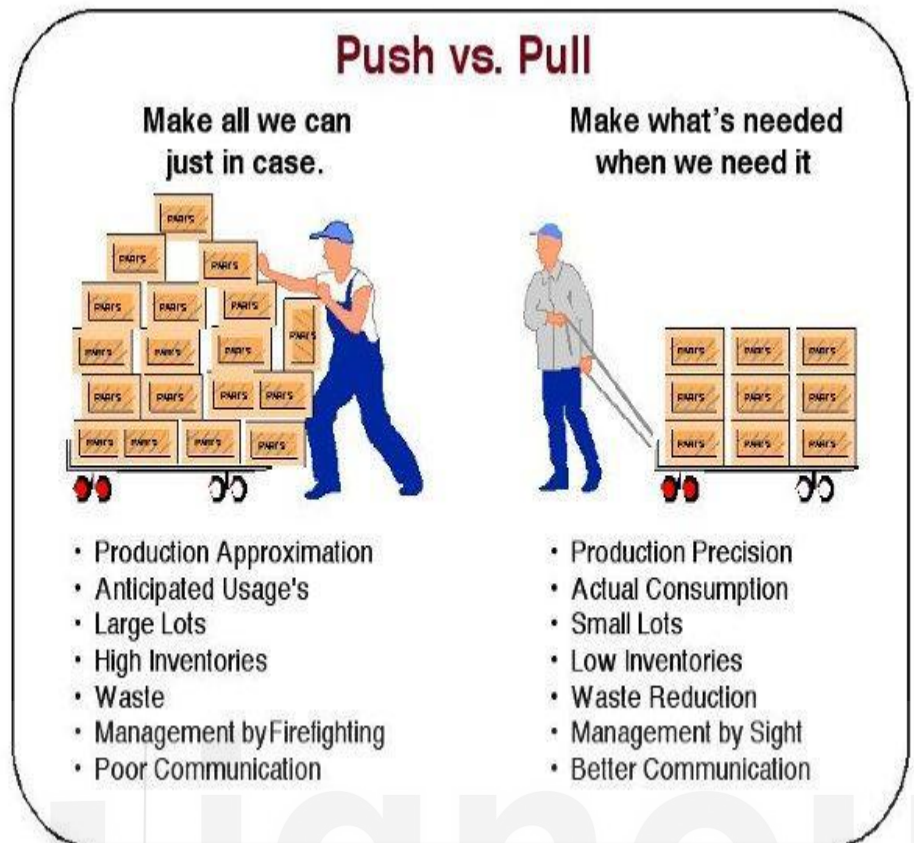


Figure 16.1: Push Vs Pull Kanban

16.3.1 Push Kanban: Unlimited WIP and Demand Dependent

This strategy is built up on two main aspects viz, the first is that WIP is not limited and the second is that the production is demand driven (Ref: Figure 16.1)

Thus Push-based inventory strategy is better applicable for maintaining the lowest possible inventory when Material Requirement Planning (MRP) process is driven by demand forecast to ensure the availability of materials for production. However, the forecast may not always be accurate so there could be excess inventory, especially when shifts occur in lead times.

Push Production

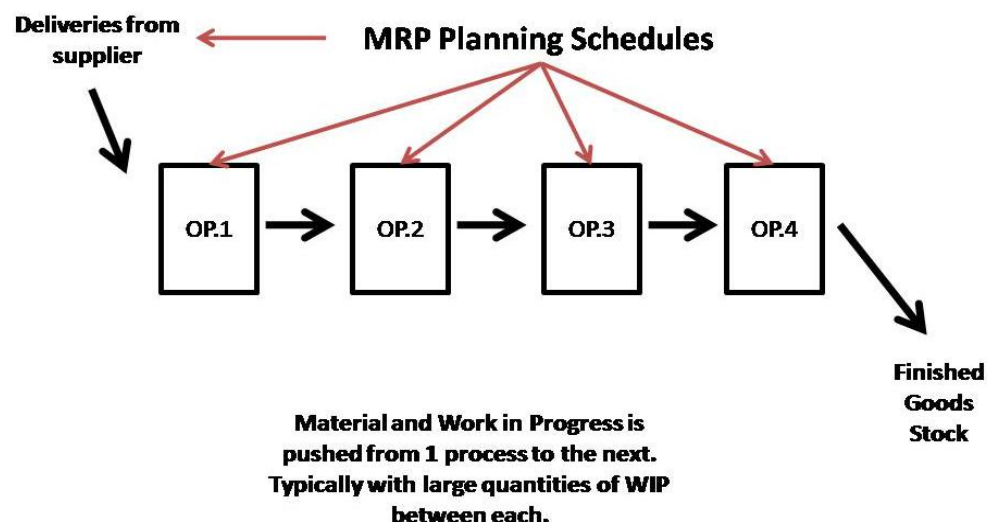


Figure 16.2: Material Flow in Push Production

The push manufacturing, or push inventory (Refer figure 16.2) will tend to have a lot of work in progress (WIP) due to high variety products and the material features also have complex structures. Therefore, Push production environments tend to be characterized by long lead times and/or make to stock (MTS) situations. This will have processing large batches of items at a maximum rate, based on forecasted demand, then moving them to the next downstream process or into storage.

16.3.2 Pull Kanban: Limited WIP and Demand Focused

This strategy also stands on two main aspects viz, the first is that WIP is limited and the second is that the production is demand focused (Refer fig: 16.3).

The pull-based lean manufacturing environment works on the assumption as, to make nothing until there is demand. So, finished goods are not produced without a specific customer order. Replacements for intermediates and materials are not acquired before existing items have been used.

Pull manufacturing strategy works best when demand is high and steady for a relatively small variety of products.

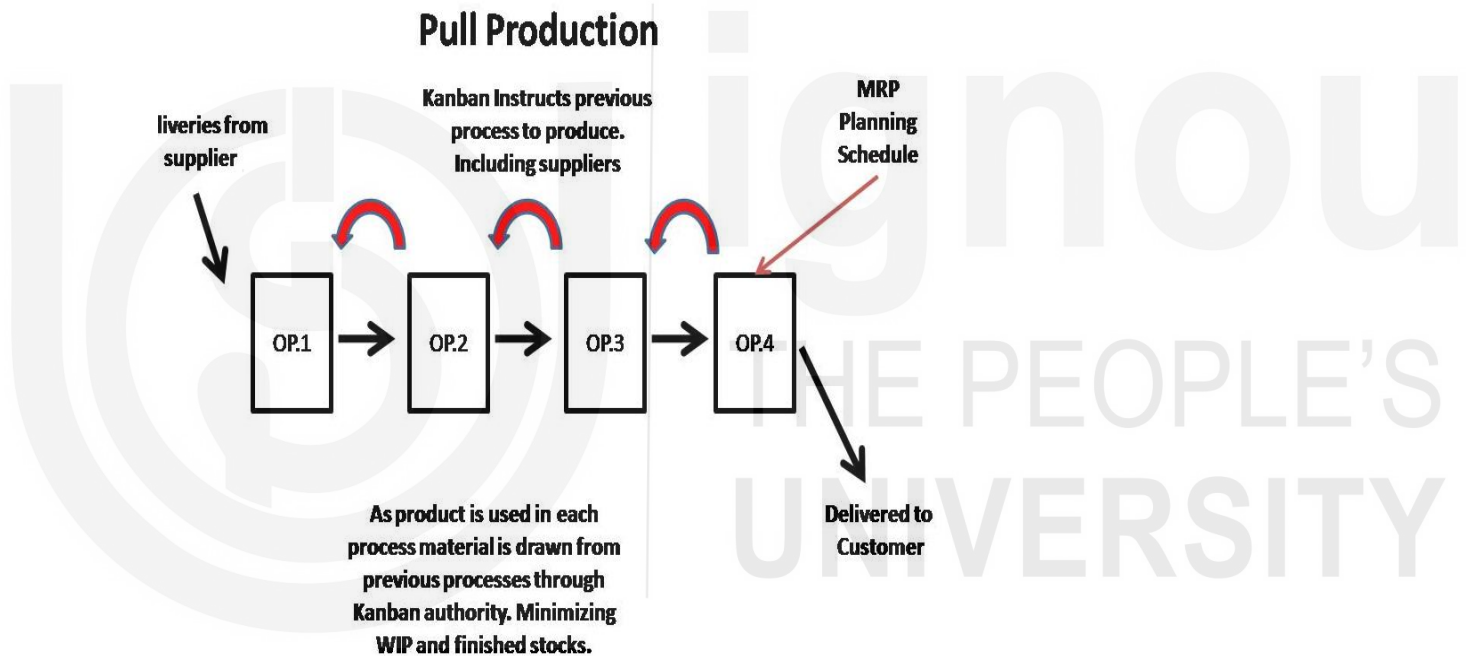


Figure 16.3: Material Flow in Pull Production

16.3.3 Push, Pull, or a Combination of Both?

Both these approaches have merits and demerits. In present world, the organization needs strategies and tools to support more efficient and effective performance shrinking product cycles, product proliferation, global competition, mass personalization, and volatile demand. MRP's forecast-driven approach alone may not be up to the mark, given its tenuous ties to demand. By the same token, pull-based lean manufacturing means we need to be constantly on top of demand. A suitable blend of the two might be the best approach.

16.3.4 Key characteristics of Pull-based Lean Manufacturing

The manufacturers can observe the following key characteristics while planning their production and materials management in pull based lean manufacturing environment

- Ensured continuous flow of production from raw materials to finished products
- Buffering critically constrained resources.
- Maintains full utilization and establishes supplier relationships and supply management practices
- synchronized delivery of raw materials (and sub-assemblies) to the point of use at the time of production.
- Enables faster throughput,
- shorter manufacturing lead times, and
- reduced the amount of inventory needed
- support to customer service objectives
- lowered production costs
- Limited work in progress (WIP) inventory levels.
- Just-in-time (JIT) material deliveries
- demand-pull scheduling that restricts the excess inventory.

To start producing parts it relies on Kanban production to signal upstream work centres. (This is analogous to work order). The upstream station does not begin manufacturing the parts until it receives a signal. Thus Kanban signals control the movement of raw materials and semi-finished products through subsequent workstations. Of course! Not all Kanbans on a production line are of the same size—they depend on the nature and usage of the part.

Accounting for cycle time intervals using buffer—the time it takes production to shift back to making a part after making other parts. The buffer also accounts for transportation time, safety stock, seasonality, and promotions. Finally, the buffer puts a cap on the amount of WIP in the system and enables the start of continuous improvement initiatives to reduce lead times through setup and batch-size reduction.

The outcomes with a pull-based lean environment,

- ✓ deliveries go on-time,
- ✓ meet customer demand, and
- ✓ improve the reliability of the supply chain.

In contexts where supply time is lengthy and demand is difficult to forecast, often the best one can do is to respond quickly to observed demand. This situation is exactly what a kanban system accomplishes, in that it is used as a demand signal that immediately travels through the supply chain. This ensures that intermediate stock held in the supply chains are better managed, and are usually smaller. Where the supply response is not quick enough to meet actual demand fluctuations, thereby causing potential lost sales, a stock building may be deemed more appropriate and is achieved by placing more Kanban in the system.

SAQ-16.1

- Briefly explain Kanban concept?
- What is 'The Empty Box Concept'?
- What is 'The Supermarket Shelf-Stock Concept'?

- d) List of Kanban strategies.
- e) Explain Push Kanban Strategy in detail.
- f) Explain Pull Kanban Strategy in detail.
- g) Explain combination of Push and Pull Strategies in detail.
- h) Discuss Key characteristics of Pull-based Lean Manufacturing.
- i) Write outcomes with a pull-based lean environment.

ACTIVITY-16.1

In which manufacturing company is Push Kanban Strategy (Unlimited WIP and Demand Dependent) used? Explain your answer with an example.

In which manufacturing company is Pull Kanban Strategy (Limited WIP and Demand Focused) used? Explain your answer with an example.

16.4 LEAN INVENTORY

Lean manufacturing/ inventory is a philosophy of continuous flow of product through the manufacturing process. Excessive amounts of inventory in a lean environment lengthen the cycle time for any one part in the production flow. The increased cycle time for a part is a form of waste in the lean production environment. High levels of inventory also tie up company funds and occupy warehouse space. When an organization stocks a high level of inventory, the potential exists for stocking defective materials for a longer period before its discovery.

16.4.1 Lean Inventory Guidelines

To be effective, TaiichiOhno stated that kanban must follow strict rules of use. Adhering and close monitoring of these rules is a never-ending task, thereby ensuring that the kanban does exactly what is required.

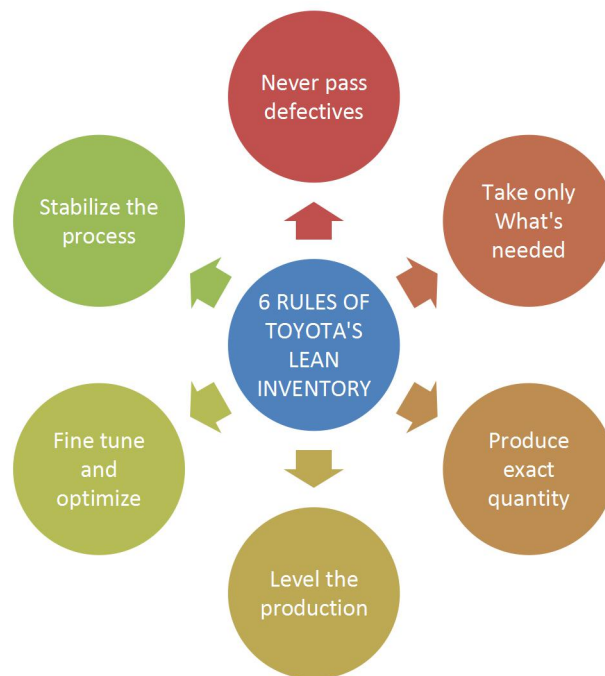


Figure 16.4: The Six Rules of Toyota of Lean Inventory

16.4.2 The Six Rules of Toyota of Lean Inventory

Toyota made the following six simple rules (Refer figure 16.4), and

1. Never Pass Defective Products

Upstream processes must meet the level of quality and standards that are expected of them. Remove all defective products; they are dealt with outside the production line.

2. Take Only What's Needed

Downstream processes should only take what is needed to prevent overproduction. This also lowers costs and makes operations reflect market demands.

3. Produce Exact Quantity

Avoid overproduction, which leads to excess inventory and more costs.

4. Level the Production

Keep production to capacity to achieve a steady flow of work.

5. Fine-Tune and Optimize Process

After implementing kanban, continue to explore ways to add efficiencies.

6. Stabilize the Process

Maintain quality level production and optimize processes to gain stability, and thence it can be standardized.

Under the kanban inventory system, we can summarily understand the following.

Each process issues requests (Kanban) to its suppliers when it consumes its supplies. Each process produces according to the quantity and sequence of incoming requests. No items are made or transported without a request. The request associated with an item is always attached to it. Processes must not send out defective items, to ensure that the finished products will be defect-free.

Limiting the number of pending requests makes the process more sensitive and reveals inefficiencies.

16.5 TYPES OF KANBAN SYSTEMS

There are two most important generally applied types of Kanban Systems in industry classified under General types here for convenience while others are categorized under customized Kanban.

A. General Types of Kanban Systems

1. Withdrawal Kanban
2. Production Kanban

B. Customized Types of Kanban Systems

The concept of Kanban when applied to other fields, they assumed the following names

- (i) Transport Kanban
- (ii) Express Kanban
- (iii) Emergency Kanban
- (iv) Through Kanban
- (v) Supplier Kanban

We shall now briefly discuss these.

A. General Types of Kanban Systems

In an industry, the kanban system adjacent upstream and downstream workstations communicate with each other through their cards, where each container has a kanban associated with it. It also uses Economic Order Quantity as an important input. A brief description on these kanban is given below:

1. Withdrawal Kanban System

This system is used to indicate the type and amount of product which the next process should withdraw from the preceding process.

A Withdrawal Kanban gives the following information

- (a) Name and identification number of the item.
- (b) Quantity in each box or container and its type.
- (c) Preceding and succeeding workstations and/or processes.
- (d) Store shelf location
- (e) Name or identification number of the final product where this item is used.
- (f) Sequence number of Kanban i.e. the sequel number of Kanban in total of the Kanbans. For example, out of 2/5 indicates 2nd Kanban of 5 Kanbans.
- (g) This also known as move cards or conveyance kanbans. Whenever a component is to be shifted from one production part to another this type of kanban are used for signaling. The card is usually connected to a stipulated number of parts that are taken to the working place where

they are needed. When these parts are used, the cards are returned as a signal for sending the same part with the same number back.

2. Production Kanban System

This system is used to indicate the type and quantity of product which the next process must produce. A Production Kanban can be designed in two ways,

1. A Kanban that does not immediately initiate production and
2. A Kanban that immediately initiates the production

The former contains the same information except items (e) and (f) as mentioned above while the latter one indicates the need for starting manufacture of the next production lot. It is usually of a different shape and is called Signal Kanban. A Signal Kanban would also contain the same information as above along with some additional information such as Production Lot Size, Re-Order Level (ROL) and Machines to be used for production.

Thus Production (Signal) Kanban provides the following information:

- (a) Name and identification number of the item.
- (b) Quantity in each box or container and its type.
- (c) Preceding and succeeding workstations and/or processes.
- (d) Store shelf location
- (e) Need for production
- (f) Production Lot Size
- (g) Re-Order Level (ROL)
- (h) Machine/Equipment used
- (i) Delivery Due Dates

B. Other Types of Kanban Systems

While the above discussed two kanban are most common Kanban systems in manufacturing industries, the concept applied to different areas have shaped up into some the customized Kanban systems as described below:

1. Transportation (T) Kanban

A Transportation Kanban or simply T-kanban authorizes the transportation of the full container to the downstream workstation. The T-kanban is also carried on the containers that are associated with the transportation to move through the loop again.

2. Express Kanban

This is a type of Kanban is used when there is an unanticipated shortage of parts. They signal the increasing number of a particular part is required. The chief objective is to make sure that there is no slowing down of the manufacturing process. Express Kanban is sometimes called signal Kanban. They are purposely used for triggering purchases.

3. Emergency Kanban

This set of Kanban is applied to the replacement of defective parts or for signalling a sudden change in the quantity of the product to be manufactured.

Indifference from the express Kanbans, the organizations make use of emergency Kanbans when a part fails to work to its rated/expected efficiency or when there are certain alterations in the manufacturing conditions. The express Kanban is also utilized to make the original production to run seamless.

4. Through Kanban

These kanban comprises of production and withdrawal Kanbans. They are used in a situation whereby both the work centres are situated adjacent to each other so that it speeds up the process of production. For instance, the storage for the components is exactly beside the assembly of the product, to save time this Kanban system can be employed.

5. Supplier Kanban

This Kanban moves right away to a supplier, which is in fact, an organization from where the manufacturer purchases material. The supplier type of kanban is entered as a representation of that of the manufacturer.

Kanbrain

A third type involves corporate training. Following the just-in-time principle, computer-based training permits those who need to learn a skill to do so when the need arises, rather than take courses and lose the effectiveness of what they've learned from lack of practice.

SAQ-16.2

- a) What is Lean inventory?
- b) Describe the Six Rules of Toyota of Lean Inventory.
- c) List out the types of Kanban Systems.
- d) Write General Types of Kanban Systems.
- e) Write Customized Types of Kanban Systems.
- f) What is Withdrawal Kanban? Which information does it give?
- g) What is Production Kanban System? Which information does it give?
- h) Briefly explain the following Kanban systems.
 - i. Transportation (T) Kanban
 - ii. Express Kanban
 - iii. Emergency Kanban
 - iv. Through Kanban
 - v. Supplier Kanban

ACTIVITY-16.2

How the six Rules of Toyota of Lean Inventory can control inventory cost in a manufacturing company? Explain it with an example.

16.6 THE KANBAN PROCESS

The process of functioning of the Kanbans is listed below:

1. Used as a means for process improvement to help reducing the level of in-process inventories.
2. To tie different manufacturing processes together i.e. to check the interchangeability between a preceding workstation supplying partially processed items or components to a succeeding workstation.
3. To ensure that the right amount of materials and parts reach the right place at right time.

16.6.1 Kanban Rules

- The later process collects product from the earlier process
- The later process informs the earlier process what to produce
- The earlier process only produces what the later process needs
- No products are moved or produced without Kanban authority
- No defects are passed to the later process

16.6.2 A Demand Driven System

Kanban cards are a key component of kanban. They signal the need to move materials

- from an outside supplier into the production facility or
- within a production facility

The kanban card is a message that signals a depletion of product, parts, or inventory. When received, the kanban triggers replenishment of that product, part, or inventory. Consumption, thus drives demand for more production, or in other words, the kanban card signals demand for more product—so Kanban cards help create a demand-driven system.

It is widely held by proponents of lean production and manufacturing that demand-driven systems lead to faster turnarounds in production and lower inventory levels, helping companies implementing such systems be more competitive.

16.6.3 Kanban Cards

Kanban cards, in keeping with the principles of kanban, simply convey the need for more materials. These are usually simple cards or sheets of paper that are attached to a batch of material. Usually there are just two or three cards for each product in the system although there may be more if larger batches are handled and if the product size itself is large. These cards will typically detail what the product is, where it is used, and the quantities that should be there. For multiple cards systems it will also say which card it is in the total set (for example second card among five cards is denoted as Card 2 of 5 or 2/5).

When a process finishes using the materials to which the Kanban card is attached the card is returned to the previous process. This is then used as authority for that previous process to manufacture replacement parts. In multiple card systems, the process will typically have to wait for a set number of cards to be returned before they start to manufacture the next batch. A red card lying in an empty parts cart conveys that more parts are needed.

16.6.4 Kanban Bins

Bins are used in a very similar way to Kanban cards. However, instead of their being cards attached to the materials the container that they are kept within

becomes the actual Kanban. These will usually be labelled with similar information to the cards and will be returned to the previous process as authority to produce when they are emptied.

As with cards, we can have 2-bin Kanban systems, 3-bin systems and upwards depending on the amount of stock that is required within the system.

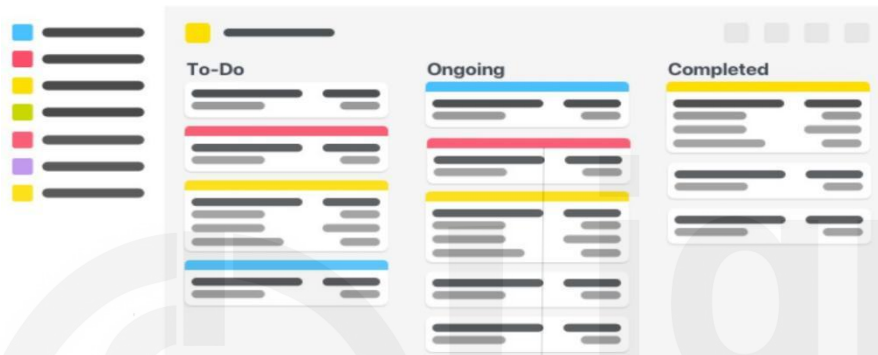
16.6.5 Three-bin system

A simple kanban system is a "three-bin system" for the supplied parts, where there is no in-house manufacturing. The three bins usually have a removable card containing the product details and other relevant information are placed as given below:

First Bin: On the factory floor (the initial demand point)

Second Bin: In the factory store (the inventory control point)

Third Bin: At the supplier (the supply point)



“To Do” → “On-going” → “Completed”

Figure 16.5: A Three Bin Kanban Board

When the bin on the factory floor is empty because the parts in it were used up in a manufacturing process, the empty bin and its kanban card are returned to the factory store i.e.the inventory control point. The factory store replaces the empty bin on the factory floor with the full bin from the factory store, which also contains a kanban card. The factory store sends the empty bin with its kanban card to the supplier. The supplier's full product bin, with its kanban card, is delivered to the factory store; the supplier keeps the empty bin. This is the final step in the process.

16.6.6 Heijunka Box

The process never runs out of product—and could be described as a closed loop that provides the exact amount needed, with only one spare bin so there is never oversupply. This 'spare' bin allows for uncertainties in supply, use, and transport in the inventory system. A good kanban system calculates just enough kanban cards for each product. Most factories use kanban with the coloured board system.

SAQ-16.3

- Write the process of functioning of the Kanbans.
- List out the Kanban Rules.
- What is Demand Driven System?
- Discuss the Kanban Cards.
- Explain Kanban Bins.

- f) What is Three-bin system? What are the three bins? Explain them.
- g) Describe Heijunka Box.

ACTIVITY-16.3

Identify any national or international company in your vicinity which is using Kanban Process. Explain the procedure how the company is using Kanban Process.

16.7 VIRTUAL OR ELECTRONIC KANBAN (e-KANBAN) SYSTEMS

With the advent of developments in technology, it is often possible to have paperless kanban systems with the use of scanning barcodes or each machine simply telling the previous that it has cycled. Kanban system uses the electronic processing and transmission of data works in the same way as that of any other system.

Many manufacturers have been implementing **electronic kanban** (e-kanban) systems to eliminate common problems such as manual entry errors and lost cards. The e-kanban systems can be integrated into enterprise resource planning(ERP)systems, enabling real-time demand signalling across the supply chain and improved visibility. Data pulled from e-kanban systems can be used to optimize inventory levels by better tracking supplier lead and replenishment times.

In the recent past, sending kanban signals electronically has become more widespread. Though this trend is reducing the physical use of kanban cards in aggregate, it is still in practice in modern lean production facilities. In various software systems, kanban is used for signalling demand to suppliers through email notifications. A "kanban trigger" (manual/ automatic) occurs when stock of a particular component is depleted by the quantity assigned on kanban card. Then a purchase order is released with predefined quantity for the supplier defined on the card, and the supplier is expected to dispatch material within a specified lead-time. Today's online markets are successfully practicing this.

IT enabled Kanban System

After noticeable improvements to the productivity and efficiency of Toyota, the Kanban system was also introduced to IT and Software Development in the year 2004 by **David J. Anderson**.

IT enabled e-kanban is a signalling system that uses a mix of technology to trigger the movement of materials within a manufacturing or production facility. Electronic Kanban differs from traditional kanban in using technology to replace conventional elements like kanban cards with barcodes and electronic messages like e-mail or Electronic data interchange.

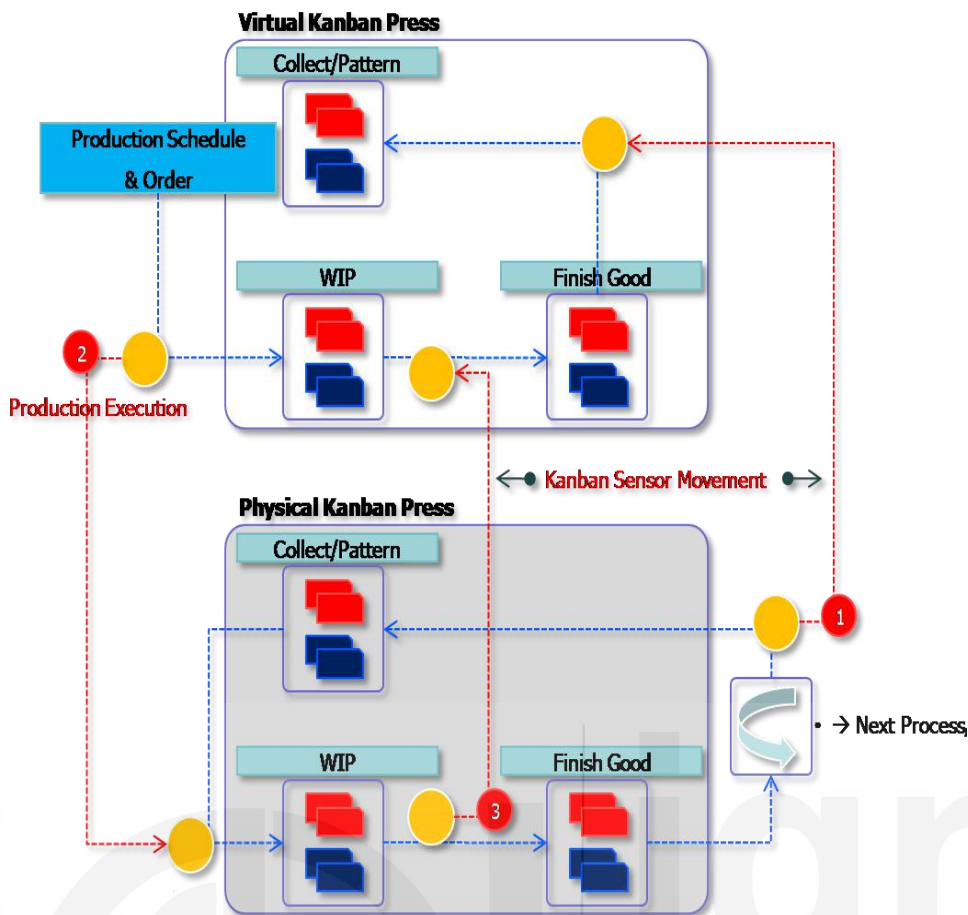


Figure 16.6: Electronic-Kanban (IT-enabled) System

Typical IT-enabled e-kanban system (Refer figure 16.6) uses barcodes for inventory, which can be scanned at various stages of the manufacturing process to signal usage. The scans relay messages to internal/external stores to ensure the restocking of products. The e-kanban uses the internet for routing messages to external suppliers and as a means to allow a real-time view of inventory, via a portal, throughout the supply chain.

16.8 KANBAN INVENTORY MANAGEMENT SYSTEM

Kanban is a visual tool, ideal for managing inventory flow. As developed by Taiichi Ohno, an industrial engineer at Toyota, Kanban boards made the car company restock its inventory only when needed. This revolutionary approach raised Toyota to such a big heights.

As discussed in the beginning of this unit, the Kanban concept evolved from the observation of operations in the supermarkets. They didn't touch or restock the products already in ample quantity. They closely monitored the products which were continually getting sold. Stocks of only those products were replenished. This concept is taken as the core of Kanban Inventory.

16.8.1 Kanban Inventory Beliefs

Kanban Inventory Management System works on the following two basic beliefs

Belief-1: Always initiate with whatever is there!

Kanban does not believe that something would fall from heaven. It does not go on trying to get beyond what is there now, because a bird in hand is worth two in a bush.

Further, Kanban must be applied to an existing inventory system. There are chances of getting hung at times, but it believes that a gradual acquaintance is guaranteed. Ensure that the inventory management approach remains unchanged, as this decreases the efficiency rather than optimizing the workflow.

Belief-2: Better to grab an evolutionary change rather than revolutionary.

Slow and steady wins the race. Eye a small, incremental change. Outcomes would need patience. And it is strongly believed that patience pays. Unlike other methods, the Kanban inventory system doesn't impose any organizational or functional changes to existing inventory system.

This gradually happens. So, neither pressurize the team for sudden changes nor expect sudden outcomes.

We have understood that Kanban Inventory Scheduling System (KISS) allows companies to stock only needed components. Lean systems use the Kanban as a technique to keep inventory levels lowest. In lean manufacturing, the process pulls materials through the production or distribution and the Kanban system provides a signal for reordering or replenishing stock.

As already mentioned above, the Kanban Inventory Management System (KIMS) doesn't possess any additional functions, but simply optimizes the process flow. Kanban system controls the entire chain – from suppliers to the end-sellers.

The main reason for the Kanban inventory system to be more efficient method is that it facilitates maintaining a minimum amount of stock in the inventory.

Thus, kanban inventory management is a way to have 'only the minimum amount of stock on hand' that is necessary at that time. This avoids purchasing excess than needed and also avoids allocating space to warehouse for the extra inventory. Moreover, kanban avoids bottlenecks in the workflow.

Customers anticipate faster fulfilment than ever, particularly with mobile access, yet supply chains are increasingly complex and often distributed across facilities. Having an efficient inventory management system sets competitive edge and a kanban inventory system can save costs off bottom line and give that edge.

16.8.2 Kanban Signalling

A company can use several methods to signal stock replenishment while Kanban signalling is one such. For instance, coloured bins or reorder cards are some of the kanban that signal to replenish materials.

Companies can apply Kanban system at two points...

- ✓ on the production floor to signal replenishment from inventory stock or
- ✓ in the stockroom to signal a repurchase

In a Kanban system, the following three actions are occur for three possible signalling conditions:

➤ **RED SIGNAL**

Condition-1: Bin empty

Kanban Action: Order the stock internally or pass the information to purchasing for a stock purchase,

➤ **YELLOW or ORANGE SIGNAL**

Condition-2: Bin having some quantity

Kanban Action: Estimate the time to empty referring to customer's demand, and supplier's lead time to supply and plan replenishment accordingly.

➤ **GREEN SIGNAL**

Condition-3:Bin Full

Kanban Action:No material movement, observe consumption patterns and previous records

If any of the above three conditions prevail unchanged continuously for more than a predetermined specified period (usually 2 or 3 weeks), plan for discarding or redesigning the kanban.

Customer demand is an alarm

Best way to identify the restocking threshold is the customer demand for a specific product. As per the Kanban inventory management, there is no need to replenish the stock unless there is an empty slot for the incoming volume.If a particular product selling amazingly then can there be a plan for another stock for the same.

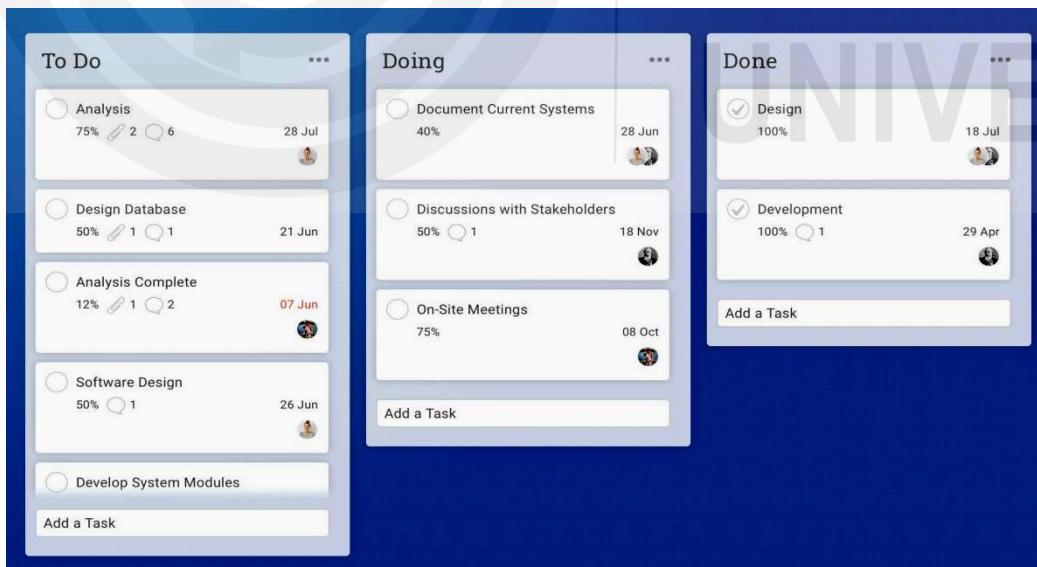
16.8.3 Functioning of Kanban Inventory System

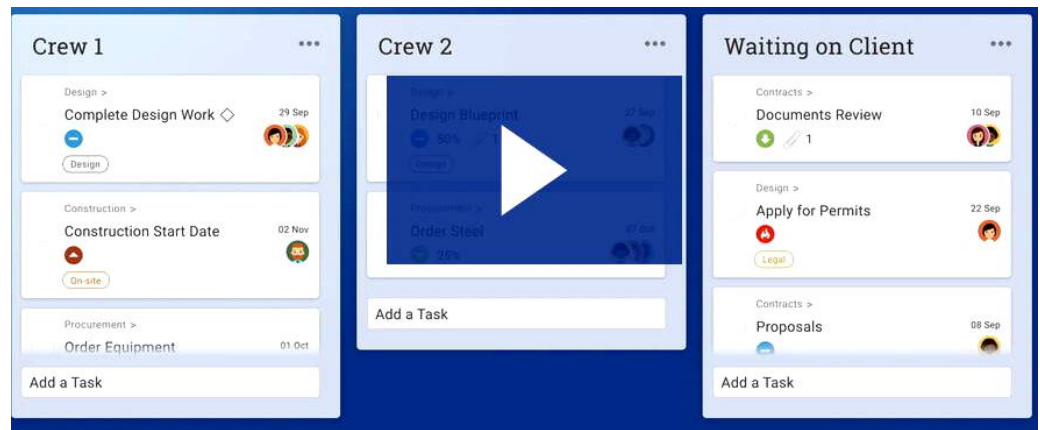
Here's how to setup a functioning kanban inventory system

A traditional kanban board is divided into three columns (can edit their names to suit the business needs).

1. "To-Do" column, which is where identified tasks are collected
2. "Doing" column for those tasks that are being worked on currently
3. "Done" column to place tasks that have been successfully completed

These tasks move across the column boards as they are being worked on, which provides an easy way to track the work.





16.8.4 Kanban Cards for Specific Inventory Items

With the kanban inventory system, the production is split into tasks, so that a manager can control and track the work through the production cycle. Each inventory item, shipment (or some metric) is placed on an individual card. These are then transferred from column to column on the board as they're worked on.

Each card in turn has the specific information that is needed for that task at each stage of production, such as supplies and materials that is required further on down the line. These can be represented on the kanban card in the form of comments, files and task descriptions.

Of course, the more complex the production and inventory, the more detailed kanban can accurately reflect the process.

Whatsoever, never forget to follow the Toyota's six principles.

16.8.5 Kanban Boards: Solution for Inventory Management Issues

- Stock-Out and Lead Time Issues:** To prevent stock outs, an organization should decide the appropriate levels of stock on hand, lest, it leads to production shut downs or outages. The lead-time for parts and materials from vendors is one factor to determining the optimum level of inventory. Of course, the organization needs to adjust the Kanban levels several times before finding the best quantity of material to keep on hand for production or distribution.
- Issues with multiple supply points:** There are many stress points that can cause a supply chain to slow down, particularly when supplied from multiple warehouses or multiple countries. However, kanban cards can represent each of these various links in the supply chain and make it easier to know where to coordinate delivery.
- Issues with identification and evaluating business needs:** Inventory management can also suffer from inaccurately identifying and evaluating the business needs. It's important to know the gaps in the system, to prioritize and fill them. A kanban inventory system offers a clear visual map of whatever, whenever and wherever it is needed. But it is often challenging to align with business plan to make sure both sides are realistic.
- Issues with inventory system optimization:** If inventory system is not optimized, then it is not known what or when needed, in turn, it makes forecasting future inventory needs impossible. The cards on kanban board are capturing the inventory and identifying where it is in the pipeline. This makes it easier to see opportunities, so can act and add more efficiency to the supply chain.

- **Issues with balancing inventory level and customer needs:** Monitoring and optimizing the inventory levels, while meeting customer needs, is the major issue for a balanced business venture. This reduces the level and cost of inventory and avoids unnecessary storage costs by only stocking what and, when it's needed, and timely resupplying.

16.8.6 Outcomes of Kanban Inventory Management System

The implementation of Kanban Inventory system is expected to produce the following outcomes.

1. Reduced inventory costs

When inventory in the store is less, there will be a lot of unused space and that additional space can be occupied by work stations. These savings as the profit gained out of business is not invested in purchasing any extra (unnecessary) stock.

2. Streamlined order fulfilment

The kanban system acts as a watch-tower over the entire supply chain, particularly order-flow process, from the point of receiving an order from different channels to confirming the order to shipping and completing the order fulfilment. One can set orders on priority as per the demand or any concurrent conditions and fulfil them accordingly in a streamlined manner.

3. Access to progress reports

A Kanban system focuses on tracking continuously on the entire supply chain. When applied to efficient inventory management system, the same idea enables accuracy in the record of the sales and inventory also. This helps the management to realistically plan, practically organize and optimally improvise the business workflow.

4. Avoids over-stocking

There are cases when organizations wrongly or over estimate the demand for a specific product, only to end up stocking it unnecessarily for months. Oversight, over expectations and ignorance are few reasons for leading to such situations overstocks. This situation then compels them to either dispose of that stock or sell it off at discounted rates. In such cases, it eventually becomes hard to keep the right track of stock. The Kanban system helps avoiding such situations at the earlier stage itself.

5. Meet Customer Demands

Kanban maintains minimum inventory levels, at the same time, it also responds to customer demands. It identifies the products selling more and restocks them before depleted, thus focuses on what is needed and 'on hand'. The customer is treated as driving force to inventory and meeting customers demand is viewed on top priority.

6. Quick Status Reports

Kanban inventory system provides the added benefit for managers by giving easy access to progress reports. They can see what's been started, where it is in the production cycle and when it's been completed. Thence, they can decide or revise the delivery due dates vis-à-vis prepare a good promising forward plan.

7. Cleaner Warehouse

Kanban also keeps the production area clean by removing all unnecessary storage. It makes sure only the parts to the production line when needed are delivered. This also makes the production space focused, means production, not storage. This all nicely cuts nails and tails, which naturally grow without adding any value or productivity. Thus Kanban fits into lean manufacturing, which is a philosophy of continuous flow of product through the manufacturing process.

SAQ-16.4

- a) Explain virtual or electronic Kanban (e-Kanban) systems.
- b) How does IT enabled Kanban System work?
- c) What is Kanban inventory management system?
- d) Explain Kanban Inventory Beliefs in detail.
- e) Discuss Kanban Signalling?
- f) What are the three actions for three possible signalling conditions of kanban?
- g) Explain how to setup a functioning kanban inventory system?
- h) What is the significance of Kanban Cards?
- i) What are the Kanban Boards? Explain them in detail.
- j) What are the Outcomes of Kanban Inventory Management System?

ACTIVITY-16.4

How do you suggest whether the Virtual (e-kanban) system is useful or not for the Indian Industries? Justify your answer.

16.9 IMPLEMENTATION OF KANBAN

Rome was not built in a day. No one gets fruits immediately after the tree is planted. Kanban is not something that is going to work overnight, nor is it something that can be just dropped into place without explanation or training. There is also no 'one size' fits all solution that is going to be right. Further, the resistance due to machine unreliability, set-ups are other issues and challenges.

So, the organization should prepare the ground and an ideal environment before implementing, patience and careful monitoring during implementation.

16.9.1 Ideal Environment for Kanban Implementation

The following are the ideal conditions necessary for the application of Kanban. The farther from these conditions, the harder it will be to implement and the larger the safety margin into the system to prevent problems:

- **Regular demand from the customer:** If the customer demand is highly irregular and it is difficult to predict and so is hard to hold Kanban stocks in the traditional supermarket style. Holding larger than necessary stock and work in progress levels without some careful thought about organizing the system can ruin the entire. So, it needs to ensure the regular demand and focus on these products.

- **Low product variation:** If many different products are maintained, then hold stocks of them could easily increase the carrying cost. To reduce this burden, ensure making or holding commonly used parts/products and if not unique, see that they are latest.
- **Clear flow:** Facilities that are organized in a silo style with all similar processing being done in one location are hard to control with a kanban system, although not impossible by any means. A better arrangement is one in which all processes are organized together to provide a flow line or cell.
- **Small dedicated machines:** Many companies will invest on large mass producing machines. Often these machines will drive the use of large batches and may create a bottleneck for the facility. Far better if smaller dedicated machines are used within product flow lines.
- **Quick changeovers:** Many machines and processes can take a long time to set up to run a new product or variant. This again drives large batches and can create significant bottlenecks within the production line. The use of Shigio Shingo's concepts of Single Minute Exchange of Die can make a significant impact in this area.
- **Repeatable and reliable processes:** If machines are vulnerable to breaking down and processes are not repeatable then it will be hard to control any form of production system let alone Kanban. The use of Total Productive Maintenance (TPM), 5S Kaizen, operator driven quality improvements, and standardized operations will help to put in place the foundations that are required.
- **Reliable suppliers:** Supplier's reliability is a vital part of Kanban process and needs ensuring that they are able to support the kanban processes to implement reliably.

16.9.2 Care while Implementing Kanban Inventory System

There are tons of benefits of implementing a Kanban inventory system in business. It saves money, efforts, time and space and thus enhances the efficiency. But, before introducing the Kanban inventory management system to the business, there are a few obstacles that needs attention.

- Carefully monitor inventory quantity to be ordered to restock. A little carelessness can mess up whole system
- It will surely make the process go slow for some time. So, marginal ups and downs can be expected initially. But, the moment things are streamlined, it will start showing results.
- Figure out the numbers that will go into a single bin and how much time it will take for them to be in that bin. If it is to be restocked in a bin in say 10 days, make sure that supplier sends the stock within 6 to 8 days so as to avoid production delays.

A Kanban System needs to observe the following 6 principles during the implementation process.

- Earlier processes never push production onto later processes
- Nothing is ever made without Kanban authority
- Nothing is made if there are no Kanbans
- Defects are identified as close to the source as possible

- Large batches or lots of plan changes should not be planned
- Wherever possible demand should be smoothed

Not having these conditions does not mean that implementation of Kanban and Just in Time is impossible. It just means that a little more thought is to be given on how the systems are designed and how they will work. Irregular demand and large variations in products for instance needs to apply CONWIP systems rather than the more usually seen cards or bin systems. Unreliable machines need a larger factor of safety in the quantities.

Often, companies starting with JIT and Kanban with large Kanban quantities and slowly reduce the amount of stock over time in a planned fashion to highlight and remove problems. Lowering the inventory levels may uncover the many issues.

16.9.3 CONWIP Systems

CONWIP is **CON**stant **W**ork **I**n **P**rogress. This system is more like the actual idea of using supermarket shelves where the Kanban is the actual location on the shop floor. So when a process removes a product from the previous process the empty space is the Kanban and the previous process will work to fill the hole.

This works well for systems in which one can achieve near to one-piece flow and within which variation is limited.

However, that being said it can also be used very successfully within those areas in which there is a large amount of variation if combined with a “make to order” type approach to planning. If the Kanban location becomes vacant, the process will simply build the next component or batch on their list.

16.9.4 Benefits of Kanban Inventory System

A Kanban system allows a company to reduce inventory levels, which reduces the cost associated with stocking and storing materials in the organization. Cost reductions occur in the expense of the inventory itself as well as the cost of warehousing and maintaining inventory. Companies that use a Kanban system in a lean environment allow actual customer demand to determine the need for materials and not forecasts of the demand.

By summarizing the concept of Kanban Inventory Management System (KIMS), the benefits of kanban can be listed as given below:

1. Kanban boards help monitor and optimize inventory levels, so the company can always get whatever it wants and whenever it needs
2. Customer needs drive production, so inventory is always at the right level to deliver only what the customer wants
3. Because only needed inventory is stocked, the production floor is clutter free
4. Managers are able to easily track progress and see where there are gaps or bottlenecks in their supply chains
5. Limiting inventory to what is needed, which means there is no money wasted on warehouse space and storage

16.10 CALCULATING KANBAN QUANTITIES

One of the main aims for any Just in Time system utilizing Kanban is to try to reduce the amount of stock held within the system. Therefore, it is necessary to

know how to calculate the number of component within each bin or batch and the number of actual Kanbans in the system.

Kanban Calculation

$$\text{Kanban Quantity} = D.LT.F / C$$

Where D = Daily Demand

LT = Lead Time in days

F = Factor of Safety

And C = Container Capacity

Illustration-16.1

Suppose 20 units are used per day and if the lead time is say 5 days with one factor of safety. Calculate the number of kanban with the containers of 25 capacity.

Solution:

Demand (D) = 20 per day

Lead Time (LT) = 5 days

Factor of safety = 1

Container Capacity (C) = 25

No of Kanbans = $DLTF/C = 20 \times 5 \times 1 / 25 = 4$ Kanban

Calculating Daily Demand

It is always better to use real data than making a rough guess the daily demand. Demand may vary seasonally and may be affected by a host of other issues so use a figure for Kanban that effectively copes with any situation. In most cases, the best figure is around 90% and above of peak demand. If more variation in demand is larger, then higher safety factor may be used.

Calculating Lead Time

As with demand use actual data and aim for a figure that is 90-95% of the peak. A lot of variation in lead times will indicate that the problems with machine reliability and repeatable processes so as to look at improving them. If lead times are long then large batches should really be looking to implement SMED to reduce them.

Factor of Safety

This factor should be defined by the confidence in the system used. If the confidence on the reliability of processes is high, then it can be set as 1. If there are issues with anything from machine reliability to supplier delivery performance then it is set higher. A higher safety factor will help to protect from stock outs when issues do occur; however, they will increase stock holdings.

Reducing Kanban Quantities

One of the largest wastes of the seven wastes (MUDA) is inventory. To remove as much inventory from the system as possible as this hides many of the issues that are within the processes:

By reducing the size of Kanban quantities, problems will start to break the surface, and force to take action. This is an effective way to highlight issues and to start making continuous improvement within processes.

Decreasing the size or number of Kanbans within the system will increase the systems sensitivity to changes or problems. This is often the best way to highlight issues within the process and to drive improvements.

SAQ-16.5

- a) What are the ideal conditions necessary for the Implementation of Kanban?
- b) What type of care should be taken while Implementing Kanban Inventory System?
- c) List out the 6 principles during the implementation process.
- d) What is CONWIP System?
- e) What are the Benefits of Kanban Inventory System?

ACTIVITY-16.5

List out few national or international companies which need Implementation of Kanban? Explain any one among them why it needs Kanban.

16.11 SUMMARY

Kanban (means signboard or billboard in Japanese) is a visual scheduling system with ‘visual signal’ or ‘card’ related to just-in-time (JIT) inventory/production that tells “what – when – how much” to procure/produce. Kanban system can visualize both – the planned workflow and the actual work passing through the flow. A manufacturer always desires to make what the customers want. The challenge is to know what exactly they want, and when they want it. Lean manufacturing/ inventory is a philosophy of continuous flow of product through the manufacturing process. There are Six Rules of Toyota of Lean Inventory. There are two most important generally applied types of Kanban Systems General Types of Kanban Systems, Customized Types of Kanban Systems. In the Kanban process, there are Kanban Rules, Kanban Cards, Kanban Bins, three-bin system and Heijunka Box. Many manufacturers have been implementing electronic Kanban (e-Kanban) systems to eliminate common problems such as manual entry errors and lost cards. Kanban inventory management is a way to have ‘only the minimum amount of stock on hand’ that is necessary at that time. This avoids purchasing excess than needed and also avoids allocating space to warehouse for the extra inventory. Moreover, kanban avoids bottlenecks in the workflow. The organization should prepare the ground and an ideal environment before implementing, patience and careful monitoring during implementation Kanban. CONWIP is **CON**stant **W**ork **I**n **P**rogress. This system is more like the actual idea of using supermarket shelves where the Kanban is the actual location on the shop floor.

16.12 KEYWORDS

Kanban: a visual scheduling system for lean inventory and lean manufacturing.

JIT: Just-In-Time

WIP: work in progress

Push Kanban: Unlimited WIP and Demand Dependent

Pull Kanban: Limited WIP and Demand Focused

MRP: Material Requirement Planning

MTS: Make To Stock

ROL: Re-Order Level

Kanban cards: convey the need for more materials

Heijunka Box: The process never runs out of product

ERP: Enterprise Resource Planning

KISS: Kanban Inventory Scheduling System

KIMS: Kanban Inventory Management System

Red Signal: Bin empty

Yellow or Orange Signal: Bin having some quantity

Green Signal: Bin Full

TPM: Total Productive Maintenance

CONWIP: CONstant Work In Progress.

16.13 FURTHER READINGS

- [1] N.V.S.Raju. (2018), *Operations Research, Theory and Practice*, BS Publications, Hyderabad, India, and CRC Publication (A unit of Taylor & Francis) ISBN: 978-93-5230-190-4
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MWR– 02
ADVANCE INVENTORY PLANNING AND CONTROL

BLOCK 1 : *MATERIAL PLANNING*

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- Unit 2 : Issues and Challenges of Materials Management
- Unit 3 : Material Requirement Planning (MRP)
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BLOCK 3 : *SUPPLY CHAIN MANAGEMENT AND ERP*

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