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STUDY ON THE APPLICATION OF KANBAN METHODS IN A PRODUCTION FLOW

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Abstract: This scientific paper proposes methods for optimizing supply flows. The design of manufacturing flows is directly related to the design of the products, their construction and technological peculiarities and the size of their production series. The design of manufacturing flows is made for enterprises or production units along with the design of the enterprise and, for existing enterprises, on the occasion of the study of modernization or development of different production units. The optimum design of manufacturing flows requires the creation of appropriate conditions for the constructive and technological realization of the products.

Keywords: efficiency, Kanban method, production management, information flow, technological process.

1 INTRODUCTION

The Kanban method is often incorrectly described as a simple pull technique or a concept that tries to keep stocks to a minimum; so the Kanban method involves the following: Well-regulated production and supplier scheduling systems, where stocks are minimized by supplying them only when needed; Encourages human resource management, where team members are responsible for well-defined work activities; employees are encouraged to participate in the continuous improvement of the Kanban process. Kanban is a simple cardboard sheet that is attached to the containers of parts on an assembly line or storage line.

The Kanban method is used in a production system due to the following advantages: Ensures communication between business processes; Provides inventory control; Indicates the storage and delivery locations, the standard quantity and the type of container, the method / frequency of transport and allows the identification of any defects that may occur; Provides visual management.

Kanban is a simple but efficient system that programs and controls production, is easily introduced and adopted in different production environments.

The Kanban method is a continuous system of supplying parts, components so that workers have everything they need, where they need it and when they need it. At present, Kanban

means any signaling device that authorizes and provides instructions for production and / or transport in a PULL-type production system.

A supplier, factory and supplied customer its only the products that were to him previously ordered by the customer through the a system physical information materialize on the base of labels (cards Kanban) that improve circulation OF INFORMATION between the client and supplier .

Principles of operation of the system Kanban: Respect contract from client X and provider It is provided through circulation LABEL Kanban; The client commits to express his requests to the supplier in the depending on consumption his.The supplier does not manufacture and does not deliver customer so much time how much did not 199 oncomitan label Kanban specifying number of spare parts and which represents 199 customer order oncomi.

Forms of the Kanban system: A Kanban system can be both classic ("two-card" system - use production and withdrawal cards) and "One card" system (use one of the following: card, triangular plates, containers, strollers, colored balls, card electronic etc.)

Table 1. Forms of the Kanban system

Criteria	Product type		
	Container	Card	Electronic
Easy to implement	Picked up	environment	Low
Visibility	environment	Picked up	Low / Medium
Easy to maintain	Low	environment	Picked up
The most used	For constant demand, products in the immediate vicinity	When the preliminary requirements are met	After acquiring the Kanban card

Kanban system operating rules:

1. Labeling In a kanban loop, all containers containing parts will be labeled so that the situation of the parts in the container is known at all times.
2. Production Do not manufacture or transport without order. It is the consequence of the basic principle: the renewal of the real "consumption" in the customer section.
3. Priorities The launch orders of the manufacture are the exact reflection of the “consumption” of the customer section, being imperative to respect the production order.
4. Size of the batch The size of the batch must be observed. This size is determined so that the manufacturing batch is the optimal one.
5. Anomalies All anomalies (car breakdown, lack of workers, quality, etc.) are subject to particular labeling.

Benefits of the Kanban system:

✓ Inventory Reduction - As components are not delivered until they are needed, the need for large stock and large storage space is greatly reduced.

✓ Waste and scrap reduction - With Kanban, components are only manufactured when needed, so the production of extra components is eliminated. As there is no extra production, cutting waste and scrap are reduced.

✓ Brings flexibility in production - If there is a sudden drop in demand through Kanban, it is ensured that the manufacturer does not run out of products. In this way, a production flexibility is achieved in order to respond quickly to new demands and changes, ie it can produce at any time other parts different from the one produced until then, depending on the demand.

Kanban also brings flexibility in the way the production line is used. Production lines are not fixed on a single product, they can be produced with minor changes and other landmarks. The only limit is the type of machine, the equipment used and the skill of the employees.

Increasing production. Kanban flow stops if a production problem occurs. By stopping the flow of Kanban, it is immediately noticed that a problem has arisen and allows it to be solved as soon as possible. Kanban reduces waiting time by making stocks more accessible and breaking down administrative barriers. This results in an increase in production using the same resources.

Reducing the total cost. Kanban reduces the total cost by: Preventing the additional production of products; Development of flexible workstations; Waste and scrap reduction; Reducing waiting time and logistics costs; Reduction of stock level and additional costs ; Saving resources by organizing production; Reducing inventory costs.

Essential features of the Kanban System:

• It is ideal for large series and mass productions with a small variety of parts; Vulnerable to fluctuations in demand; Vulnerable to changes in production processes and possible damage to equipment; Ineffective in case of irregular orders or when solving unforeseen special orders; Vulnerable to lack of raw material stocks and changing delivery times.

Kanban withdrawal cards. They are found among different companies, such as those of customers and suppliers. The card contains information specific to both companies (part number, location, etc.). Each Kanban card serves as a mandatory business order based on a purchase order at which various terms are specified.

Through the card Kanban is transmitted information regarding the need replenishment a job. The system Kanban correlated all level operations _ productions on the flow, through cards , buffer stocks . For Hi system operation _ Kanban , the signaling system through CARDS It is used simultaneously with the realization of surfaces Kanban or others _ methods of the same category. (Li & Barnes, 2000)

The Kanban card is the most common and well-known signaling method that travels with the parts between the supplier's and customers' processes (from downstream to upstream) ;

Contains information (readable by humans and machines), such as: Part name and part number; Number of pieces in the package; Supplier process name; Customer process name; Quantity to be manufactured; Delivery address; Storage address; Withdrawal frequency.

2 APPLICATION OF THE KANBAN METHOD IN AN ELECTRONIC COMPONENT DEPOSIT

Kanban is often seen as a central element of Lean Manufacturing and is probably the most widely used application system. Kanban can also be associated with Just-In-Time (JIT). However, Kanban is not yet a name for Just-In-Time, it is a component part of the Just-In-Time system, Kaizen and the 5S. A requirement for Kanban to work is for people to work as a team.

The steps to implement the Kanban system at factory X are as follows: 1. Familiarize yourself with the Kanban system and the goals it pursues. 2. Select Kanban components that are suitable for the X factory. Kanban may be optimal for some products and not for others. In some cases the traditional kanban will work great, and in other cases automating the Kanban system is the ideal option. 3. Kanban system planning. Kanban involves more than manufacturing. Other functions such as: purchasing, sourcing, shipping / receiving, quality control, transportation, design will also be involved in planning the kanban system. 4. Set the goal of the Kanban system. Based on the planning done, establish a program for achieving the goals, what you want the kanban to accomplish and when. Determine what will be evaluated and how it will be evaluated. Make sure you set the current level of the manufacturing and inventory system before implementing the kanban system. 5. Start implementing the Kanban system. The most common way to implement kanban is to

introduce a large number of kanban (containers, pallets, bags, etc.). Then the number of containers is reduced until a balance between demand and production is reached. When we notice that the production is delayed due to the insufficient number of containers in this case it is necessary to reintroduce an extra container to bring the system back into balance. (Lei, Ganjeizadeh, Kumar & Ozcan, 2017)

In essence, the application of the Kanban method requires compliance with the following rules: - the downstream workstation (place) indicates to the upstream workstation (from which it must receive parts) that it has started to process the first part of the part container that is waiting; Upon receipt of the signal and the sheet mentioning the parts in the required quantities, the upstream workstation executes the required parts and quantities; the workstation, located downstream, is replenished with a new container at the right time, in order to ensure the continuity of work; upstream workstations must supply only good quality parts or products; stabilization and proper adaptation of production cycles.

Implementing the Kanban method in a repository. To tell that one of the components it needs factory X to assemble _ components electronic is a resistance with a diameter of 8 , 5 mm and these wine livery in the boxes. There are 100 pieces in a box. When box It is empty , a person in charge of the assembly components by takes label glued to the box and send it back to manufacturer . Then another box with parts with a diameter of 8 , 5 mm is manufactured and sent to assembly .

A new box with components of 8,5 mm is not product until not received again label. This It is Kanban in its form the May simple.

An example probably more realistic would be with two boxes with 8.5 mm pieces . assembling components would be made from the box "2" in time what the other components are made by the manufacturer to fill box number “1”. If would be an assembly station with the possibility assembly a large volume of components It is possibly the boxes to be emptied in the a few minutes, and would can be even 15 or 20 assembly stations . _ _ so would be a continuous stream of labels that are sent to the manufacturer leading to the appearance a continuous flow of component boxes to those who assemble. Kanban system applied by a supplier. Factory X produces 15,000 components/month with the help of 1,200 employees. All components from the supplier are controlled by the Kanban system. The sorting and distribution center for Kanban withdrawal cards is provided by the supplier. It is also necessary to carry out two complete production checks.

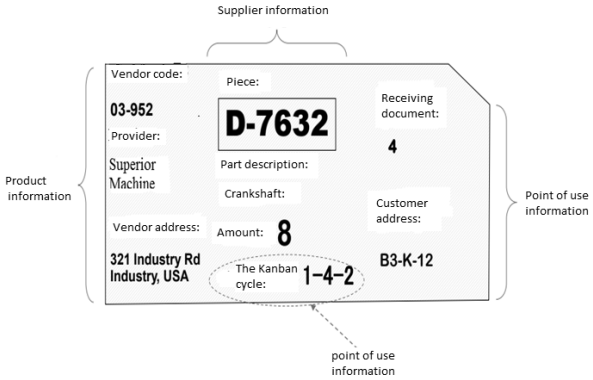

Figure 1. Example of the supplier's Kanban card

Kanban cycles applied by the supplier

The meaning of "1-4-2" on a Kanban card:

1 = the parts on the card will be delivered within one day;

4 = a truck of the supplier will deliver these parts to the supplier four times a day;

2 = this Kanban card will not be returned on the next truck, but on the next one that arrives.

The Kanban provider 's communication is represented by the Kanban forecast which consists of an electronic signal sent a few hours before the physical cards based on the schedule established in the daily or weekly plan; used for short materials and when suppliers are in the same area; adjustments can be made quickly based on actual use. In the case of Kanban

broadcast, the electronic signal is sent a few hours before the physical cards, but this time the actual use is used; is used for longer materials; the safety stock may or may not be consumed and may become a "planned firing".

Kanban system parameters. The Kanban calculation determines how many parts are needed in a system (Kanban shape and circulation), how many signals are needed in a system (total cards and total containers). It also specifies when the Kanban card will be recharged.

The variables in Kanban calculus are as follows: Average Daily Demand (AD) assumes that a smoothing of production has been achieved (using the heijunka method) based on demand and available volume; allows buffer stocks of up to 10% in AD based on standard deviation, can be determined by calculating standard demand deviation based on time window for average (heijunka) ; the frequency of the AD recalculation is based on the request time window .

1. (RT) represents time period from the signal order until completion reloading the material in the supply process to the point of use; may be be May little than time the production process since the shooting goods at the finished goods supermarket (instead of manufacturing) .
2. Security Factor (Safty Factor = SF) - Fault factors _ take in the account are : stopping ; quality issues; delays in transport; delays meteo; stop labor force. SF calculation expresses the amount failure factors as x% of total requested: stops=5%, defects=3%, delays deliveries=2%; so that a TOTAL of 10% results (we transform in the decimal: 10% = 0.10); SF = (1 +0.10) = 1.1

Calculation amount Kanban - is made for Kanban in process or inter - process with the help next algorithm :

$$\text{Nr. of cards Kanban} = \frac{\text{ADX(RT)X(1+SF)}}{\text{CQ}}$$

Table 2 Exercise Calcutta Kanban

Model	Average daily demand	Replenishment time	Safety factor	Container Quality
A	100	1	8%	20
B	20	2	5%	20
C	45	3	7%	40

The amount of Kanban is also calculated for the Kanban signal using the formula below:

$$\text{Nr. of cards Kanban} = \frac{\frac{\text{MD}}{\text{CO/M}} + [\text{ADX}(1+\text{SF})]}{\text{CQ}}$$

Table 3 Exercise Calcutta Kanban

Model	Average daily demand	Replenishment time	Safety factor	Container Quality	Model
D	50	1200	3	5%	50
E	35	700	1	3%	30
F	45	1000	3	6%	40

The following formula applies to the Kanban supplier:

$$\text{Nr. of cards Kanban} = \left[\frac{\text{a(c+1)}}{\text{b}} + (\text{SFx}\frac{1}{\text{b}})\right] \text{x} \frac{\text{AD}}{\text{CQ}}$$

a , b, c are variables cyclic Kanban

Table 4 Exercise Calcutta Kanban

Model	Average daily demand	Replenishment time	Safety factor	Container Quality
A	100	1:4:2	10%	20
B	20	1:3:2	8%	20
C	45	1:3:3	15%	40

2.1 Kanban system management

Managing the Kanban system in Factory X involves the following two aspects:

- Implementation of 6 premises;
- Observance of the 6 "Golden" rules.

The implementation of the 6 premises implies the construction of a required stability foundation, as well as the construction of a process of capabilities and responsibilities.

Premise number 1 is represented by the Heijunka method which achieves an average

production volume; without this method the Kanban system would have excess resources to respond to changes in demand, excessive inventory levels (setting the amount of Kanban card to maximum demand), the need to constantly adjust the quantities of kanban and materials in the process of increasing and decreasing to match the request.

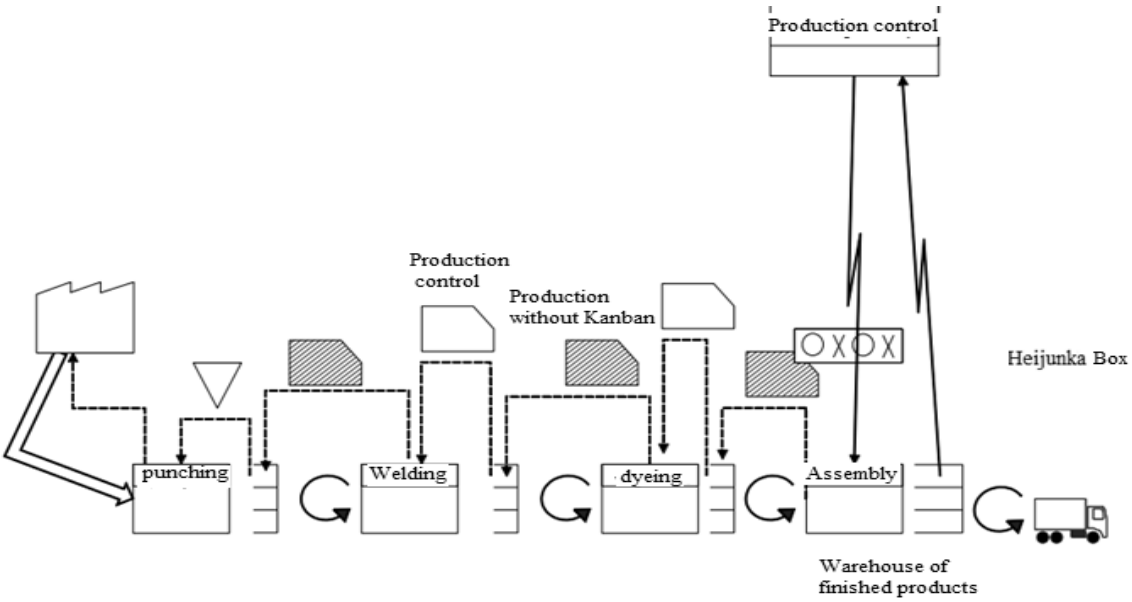

Figure 2. Heijunka method (Stoll, Mascolo, Furmans, 2012)

Premise number 2 is represented by the production of small batches and consists in minimizing configuration times and other factors that increase the batch size. Without the production of small batches, the Kanban system would have had more Kanban cards due to the large size of the batch, the storage areas for parts that are not needed in the Kanban system (overproduction) would have been offline, there would have been less reaction to downstream changes (attracting the customer), resulting in more inventory and related waste.

Premise number 3 is the defect-free delivery where the quantity of the container must be correct and free from defects. Without defect-free delivery, the Kanban system would have presented a mismatch between the information and the actual materials, a deficiency when there are defects, and the inventory in the processes for which the defects must be covered would not have fulfilled the purpose of the Kanban system.

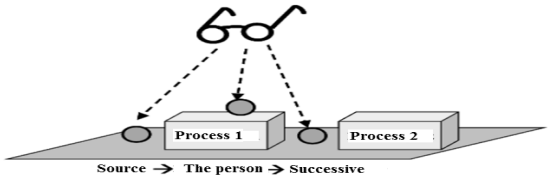

Figure 3. Defective delivery method

Premise number 4 is the attachment of the Kanban to the container which highlights the fact that information and materials always travel together; without it, there would be inconsistencies in the Kanban system between the information and the actual materials, and the visual control function of the kanban to instruct the production or movement of goods would be lost. Premise number 5 is represented by the 5S discipline and contains the location of

the material, and the quantity and orientation must be controlled. Without 5S discipline, the Kanban system would have been lacking materials improper , delays due _ searching for materials non- compliant , again lack adherence to controls would _ be objectified through the existence of excess materials.

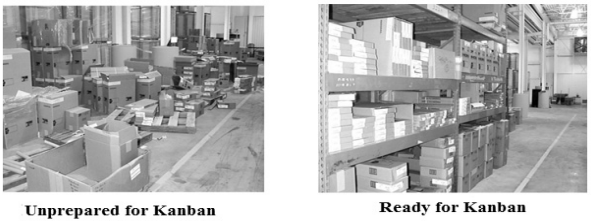

Figure 4. Discipline 5S

Premise number 6 is represented by the use of Kanban for exposing and solving problems; Kanban should be used as a tool in the development process, not to hide problems with an inventory. Without exposing and solving problems, the Kanban system would make inventories more often and there would be a disconnect between culture and continuous improvement. The 6 "Golden" rules of Kanban are:

1. The downstream process withdraws the elements it needs through this rule, the customer takes what he needs, uses precise amounts (no kanban = no withdrawal), and the operator can move to obtain materials.
2. The upstream process takes what is withdrawn - this rule involves the following: precise amounts based on kanban production instructions (no kanban = no production); the production sequence follows the precise sequence based on kanban (first input, first output); can be used for batch processes, model production or batch making boards.
3. The kanban is attached to the material - this rule emphasizes that the kanban and the material container travel together; Kanban can be visibly and physically attached to individual items; Kanbanes without a part or parts without kanban should raise an alarm. Wrong or bad materials are never allowed downstream - the calculation of the quantity of kanban includes a safety factor (loss of quality accounting); quality must be built into every process, a kanban is never knowingly attached to defects; each process must discover and remove its own flaws. Kanban is only used for minor adjustments (± 10%) - it does not change more than 10% in the monthly plan; a variation also results in lack of capacity, lack of parts and urgency- Provide a smooth signal to the supply chain. The quantities of Kanban are continuously reduced: the quantity of kanban represents the inventory in the system; removing kanban cards from the system reduces the inventory (buffer) and exposes the problem; these problems are continuously eliminated by kaizen. (Pena, Ferreira, Silva, Sá, Fernandes & Pereira, 2021)

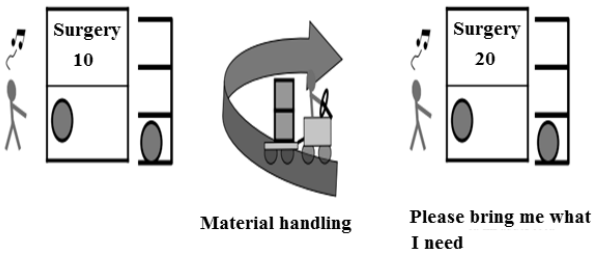

Figure 5. Downstream pull process

Traffic steps _ you system Kanban. The movement steps of the Kanban system include the following conditions that must be met only by the operator who: He is instructed to produce in accordance with the rules of the Kanban system; Take the first piece from the raw material storage area and place it at the beginning of the line; Removes the Kanban withdrawal card when the first part of the container is picked up; Position the Kanban withdrawal card in the Kanban position; Put the Kanban production instruction on the raw

material container; Place the completed parts with the production instruction in the finished product warehouse. (Balve, Krüger & Sørensen, 2017)

The mode of circulation of the Kanban system is highlighted by the following aspects: it produces only the quantity specified on the production instruction, in the frequency that has been indicated. Regarding the time / quality ratio, it should be noted that the transport inside the factory is based on a fixed quantity , and the transport outside is based on a fixed time (in this case the quantities vary). Another important role in the circulation process of the Kanban system is played by the material handler who has the following responsibilities: Collection of withdrawal cards from the Kanban station after a certain period of time or after a fixed amount of cards; Transportation of withdrawal cards to the upstream process; Withdrawal of parts and quantities specific to Kanban cards; Remove production instruction cards from containers of parts that have been withdrawn; Place the Kanban cards in the Kanban production station with the appropriate instruction; Attach withdrawal Kanban cards to withdrawn containers; Transport the parts from their containers with withdrawal kanban; the cards are attached to the downstream process; Place the parts containers with the withdrawal cards attached to the store of incoming goods. (Millstein & Martinich, 2014)

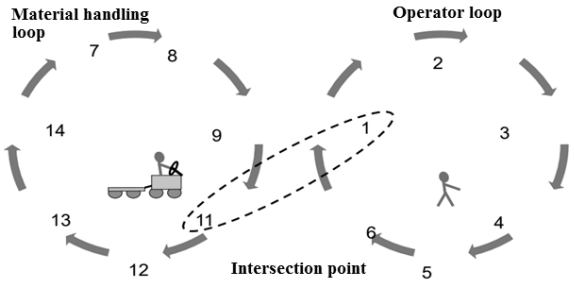

Figure 6. Kanban circulation

Implementing the Kanban system. (Piplani & Wei Hern Ang, 2018) implementations system Kanban is made with the help of the following development phases: Phase 1:Establishing the initial conditions is characterized by the fact that demand is stable and predictable; in this case the Heijunka method and that of the production of small batches by rapid changes are used; this phase provides material information such as: defect-free delivery, Kanban container attachment. He also deals with the continuous development of the system using the 6S method and recommends the use of Kanban to expose and solve problems. Phase 2: Implementation of the internal Kanban system involves compliance with a plan that consists of: verifying the existence of preconditions, selecting pilot processes (upstream and downstream) to connect them through Kanban, performing a part selection analysis, calculating the quantities of Kanban, determining the location and size of the factory, establishing the route for handling materials and temporary standard works, creating a standard operating procedure, performing checks, exposing problems, improving and updating standard work, expanding into other areas. (Widyadana, Wee & Chang, 2010) Phase 3: Establishing the initial conditions for suppliers follows the same capability setting process as in phase 1. Phase 4: Implementation of the external Kanban system follows the same process of implementation of the Kanban system as in phase 2. Phase 5: The implementation of the electronic Kanban system for suppliers is done 100 weeks after the implementation.

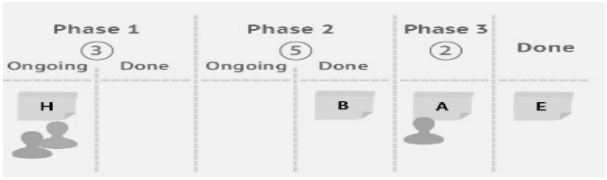

Figure 7. Phases of system development Kanban

3 CONCLUSION

The following tips should be followed when designing a Kanban system:

Packaging: It is recommended to use reusable containers and specially built pallets.

Dimensions of batches of parts: quantities must be delivered in pieces, their increase or decrease is determined by market demand.

Control point: it is located according to the Kanban signal and the preparation of the material; withdrawal is based on quantity, and position is determined by time. The container is a basic element in the design of the Kanban system; it must put the user's safety first; the amount in the container must be less than one day of use. Factors such as the presentation of the material to the customer, the weight and the space available must also be taken into account. In the process of implementing the Kanban system, certain 'traps' can be encountered that we must avoid; these are: using Kanban to manage stocks in inappropriate areas, connecting processes and disposing of them in a single stream, setting up safe stocks; trying the Kanban method for seasonal items, MRP payment time offsets should not be changed when batch size has been reduced, use of Kanban and MRP systems to release material, but also use of Kanban to cover issues such as machine reliability, debris or miscellaneous changes. To implement the Kanban method in an organization, the following steps must be followed: identifying services, choosing the right service for the customer, understanding the sources of dissatisfaction with the current system, analyzing demand, analyzing capacity, workflow modeling, and designing the Kanban system. The Kanban system is introduced in organizations to balance demand and flow across multiple services and to contribute to continuous improvement; services are improved in isolation, the result is "under-optimization". The Litmus Kanban Test is designed to help organizations, assess your progress with the Kanban system, and identify areas for effective improvement. It consists of a series of four questions; the former serve as premises and are as follows:

1. Has the online customer interface changed through Kanban?

2. Has the customer's contract changed due to the Kanban system?

3. Has your business model with service benefits changed?

For any Kanban system to work efficiently and the benefits to be fully realized, a manufacturer must have a flexible, capable and committed supply chain. Manufacturers need to find suppliers in each commodity who have the flexibility to adapt their systems to conform to those of the manufacturer. Suppliers must also have the ability to consistently deliver a quality product at exactly the right time and place. Finally, the manufacturer and suppliers need to enter into a true partnership, where information is freely shared and there is a daily open dialogue. For a supplier to engage in an efficient kanban system, the supplier must feel like a true partner with the manufacturer and secure in their position with that manufacturer.

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