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Process Improvement and Reorganization of Kanban Inventory in an Industry of Machinery and Equipment: A Case Study

Bianca Siqueira Martins Domingos[1,*], Rosinei Batista Ribeiro[1,2,3], José Glênio Medeiros de Barros[3], Antônio Henriques de Araújo Júnior[3], Francisco Santos Sabbadini[3]

[1]Universidade Federal de Itajubá, Instituto de Engenharia de Produção e Gestão, Itajubá, Minas Gerais, Brazil
[2]Faculdades Integradas Teresa D'Ávila, Instituto Superior de Pesquisa e Iniciação Científica, Lorena, São Paulo, Brazil
[3]Universidade do Estado do Rio de Janeiro, Faculdade de Tecnologia, Resende, Rio de Janeiro, Brazil

Abstract The purpose of this research is the reduction of losses due to excess inventory and unnecessary movement in the Kanban inventory in a multinational industry manufacturer of machinery and equipment, located in the State of São Paulo, Brazil. The justification of this project is based on the concept of Kanban intrinsically linked to minimize fluctuations in stock as a result of this reduction, which is one of the pillars of Kanban philosophy. The goals of the research is to analyze the supply chain, whereas the current process, mapping all storage and mobility of materials in order to detect the amount of pieces in lean process. The methodology is based on the following steps: diagnosis of individual supply chain inputs for the manufacturing and assembling of machines and cranes, data collection of the items in the supplier/manufacturing relation, application of 'lean production system' in the reception, distribution, mobility, storage, as well in the mounting sequences.

Keywords Logistics, Lean management, Kanban inventory, Supply chain, Production reorganization

1. Introduction

The present study deals with the reduced (lean) and reorganization of the Kanban stock of the line of excavators and shovel loaders assembly line of the Guaratinguetá plant Liebherr Cranes and Machinery Brazil LTDA. The objective of this study is the mapping of the Kanban inventory in order to identify items that require smaller storage boxes and the removal of items that are no longer used in order to make the stock more reduced or lean, maximizing space for deployment of new items. After completion of this process, it was performed the reorganization of all inventory items, according to criteria accessibility of Kanban parts car assembler and parts Division. This new process will impact positively on the assembly times, avoiding unnecessary drive losses due to handling, excess inventory and waiting time losses.

In practical terms, the Kanban system runs with the assumption of a certain quantity of parts in the inventory, which is usually located next to the production line or workstations. The amount of inventory items varies due to many factors, including: diversity of products manufactured, level of use of certain items, lead time of parts delivery, etc. After delivery, there is a supply of the inventory and availability of these items for production.

The use of this scheme makes possible the use of different symbols of identification and may include the use of electronic Kanban (e-Kanban).

The introduction of Kanban stock in the company studied was motivated due to problems with location of items in the layout, disorganization and loss by unnecessary movement (for instance, production workers had to find items), including loss of parts. In other words, this system enables the stock monitoring by visual control with a better production organization and ensuring the stock required to meet the production schedule without shortages or excesses of parts and components.

2. Literature Review

In recent years, the term just-in-time (JIT) has become a common term in repetitive manufacturing. It is used to describe a management philosophy that encourages change and improvement through inventory reduction. JIT can be defined as the ideal of having the necessary amount of material available where and when it is needed.

The advantages of JIT production include reduced

* Corresponding author:
biancamartins@unifei.edu.br (Bianca Siqueira Martins Domingos)
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inventories, lead times, scrap and rework rates, higher quality, reduced ability to keep schedules, increased exibility, easier automation, and better utilization of workers and equipment. However, there is a limit to the extent that JIT can be usefully applied in many industries: the major JIT successes are in repetitive manufacturing environments. If the demand cannot be predicted accurately and product variety cannot be constrained, it may not be possible to implement JIT efectively.

The Kanban system is integrated with the 'Just in Time system' derived from the Toyota Production System (TPS), which has emerged with the goal of effectively controlling the utilization frequency of parts and controlling inventory quantity inserted in supply chain organizations.

The term Kanban in an etymological sense, means *visible note* or *visible plaque,* emphasizing visual control as one of the main pillars of the system.

According to [1] Kanban can be defined as a purchase order and production oriented coordination system, controlling the production of the required products, in the quantity and time required.

As reported by [2] the fundamental idea of Kanban is to utilize visual signals to synchronize the workflow with productive capacity, avoiding waste with the interruption of work, minimizing excess inventory and avoiding rework.

In practical terms, the Kanban system works on the assumption of a certain amount of parts in inventory, which is usually located next to the production line or workstations. The amount of inventory items varies due to many factors, including: diversity of products manufactured, the level of use of certain items, lead time of parts delivered, etc. Just after delivery, it occurs the supply of the stock and the availability of these items for the production. The use of this scheme is varied, with the possibility of use of different symbols for the identification and use of electronic Kanban (e-Kanban).

To [3], the Kanban stock can be easily viewed by a Kanban frame, divided by different types of products in three different areas:

- *Green Zone:* Although this area represents the highest cost of production, it has low priority in the productive process;
- *White (or yellow) Zone*: Represents a normal production flow and it has the same priority as the green zone, although requires a sign of attention, revealing the possibility of going to the red zone;
- *Red zone:* Represents an emergency signal. This means that the stock ran out for a particular production flow and needs to be reset immediately.

In direct connection, Lean Thinking philosophy (lean mindset) acts as a helper to the Kanban system, identifying points of improvement of primary value flows and supporting processes. According to [4] and [5], the application of 'lean thinking' makes possible the association of quality with cost reduction, focusing on five key concepts: 1) specification of what creates value to the company, from the perspective of the consumer; 2) identification of the value flow, i.e. in all activities until the generation of the final product; 3) support to a continous flow, minimizing queues and production interruptions; 4) Enhancement and support to a pull production system; 5) effort to perfection.

In short, this research proposes the application of Lean Thinking on some items previously identified by Kanban inventory mapping, according to [6] and [7].

3. The Production System Currently Used in the Company

3.1. Description of the Study Object

The Kanban stock at Liebherr is located on the side of the assembly line, consisting of boxes and pallet rack structure of BIN 7 type. The pallet rack are made up of structures of 3,000 mm long, 1,500 mm height and depth that oscillates between 1,500 mm and 1,800 mm, mounted on fasteners, providing flexibility for future modifications. These structures of the Kanban system:

- ease the parts location, as there is provision of homogeneous items;
- generate a cost distribution according to the FIFO method, where the material stocked first is requested first;
- make easy an acquisition and re-supply of materials in slightly inclined plan, and access to boxes;
- use a 3 floor-pallet, making possible a linear breakdown;
- help to avoid an access to materials outside of production planning due to its location;
- create a weight capacity of 1,500 kg between the pallets stringers (floors);
- is extremely resistant to external impacts.

This process is based on a back supply and inventory control of materials and a front acquisition as shown in Figure 1a and 1b.

Storage boxes of BIN 7 type are rectangular plastic boxes with thickness ranging between 5 and 10 mm, with support for vertical structures and car supply. Have easy visual control, for it has chamfers on the front, facilitating inventory control. In the implementation of Kanban inventory were considered factors such as the size ratio of the box and the size of the item to be stored, amount of items used monthly, among others. The boxes are conditioned on a total of 43 structures.

(a)

(b)

Figure 1. Structure that contains pallets flow with 3 levels, in slightly inclined surface, placed between two columns of the shed

The relationship between the size of the box and the size of the item to be stored was defined through a footage process, considering the deployment of the Kanban stock, and quantities of items used monthly, which varies according to production demand and delimited by PCP (Planning and Control Production). The reduction process started by the following steps, shown in Figure 2:

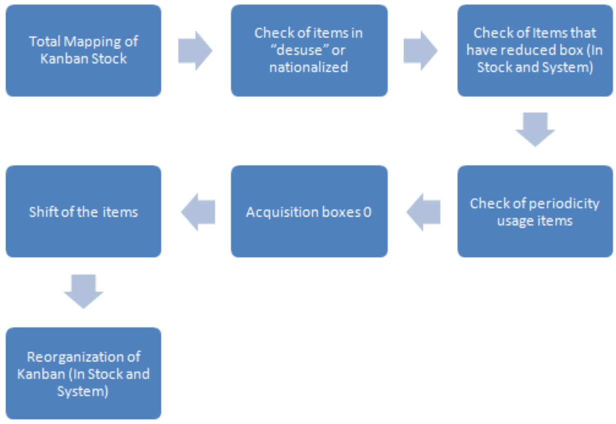


Figure 2. Flowchart of the Kanban stock reduction process

In Figure 3 are indicated the location of Brazilian company's suppliers, as included in the research, Figure 3:

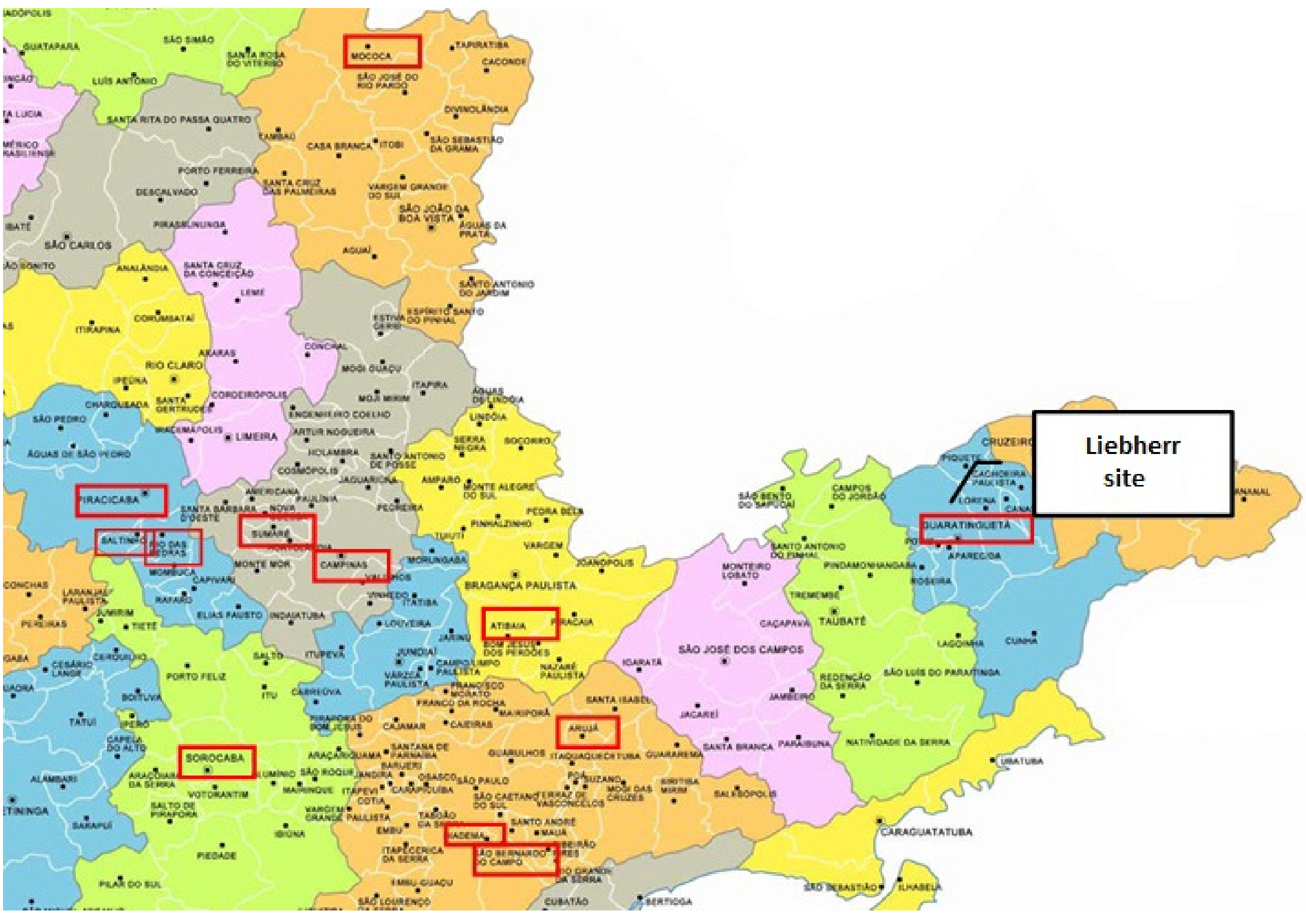


Figure 3. Liebherr´s Kanban Suppliers, as implanted in the Kanban System

The suppliers are located in a radius of 400 km away from the company, which is located in Guaratinguetá, a medium sized town in the federal State of Sao Paulo. As shown on the map above, suppliers are situated in the cities of Atibaia (2), Diadema (2), Saltinho, Sao Bernardo do Campo (2), Arujá, Sorocaba, Mococa, Rio das Pedras, Campinas, Piracicaba and Sumaré.

The frequency of the deliveries works on a weekly, monthly and yearly basis, parallel with the Milk Run System deliveries, to the company. The principles of both systems (Kanban and Milk Run) are those of reducing transportation costs and minimizing inventory costs, with consequent optimization of the logistic processes.

4. Methods, Results and Discussion

Initially, we performed the mapping of all items belonging to the yellow product line (wheel loaders and excavators) and white line (mining machinery), being objects of analysis the supply box storage type, the box storage capacity, the check out of nationalized items (supporting the nationalization process of Kanban items), verification of boxes in which items can be reduced and including possible corrections of names of items, location number, among other data.

The mapping process required a total of 16 hours to run. After this step, it was examined under some criteria, for instance, the item order time.

(a)

(b)

Figure 4. Box size "0"

For domestic items, was taken as the base term of the Kanban stock as one month, whereas for imported items, it was considered a demand of 3 months duration (average time to import them). At the end of the mapping we realized the need to purchase a box with less than #1 box size, since 735 items that belonged to the storage size #1 demanded an even smaller box.

The next step in the Kanban inventory process was the purchase reduction of was approximately 300 cartons size "0" with a storage capacity of 0.5 L, Figure 2 (a) and (b).

The next step of reducing the Kanban stock was the acquisition of 300 boxes size "0", with a storage capacity of 0.5 L, Figure 4 (a) and (b).

The total number of items in Kanban stock is 2040 items, and the number of items covered by the mapping was 1600, with a total of 200 items that fit in the process of inventory reduction, Figure 5.

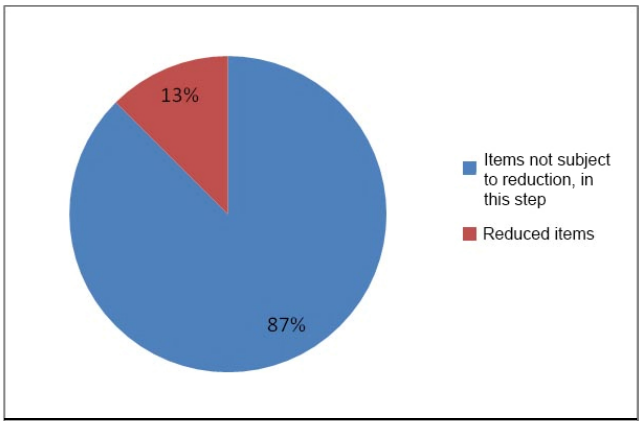


Figure 5. Kanban items with box size reduction

It could be observed during the inventory reduction process that the number of domestic items was smaller than the amount of imported items, for the duration of the national inventory item is not longer than 1 month (Figure 6).

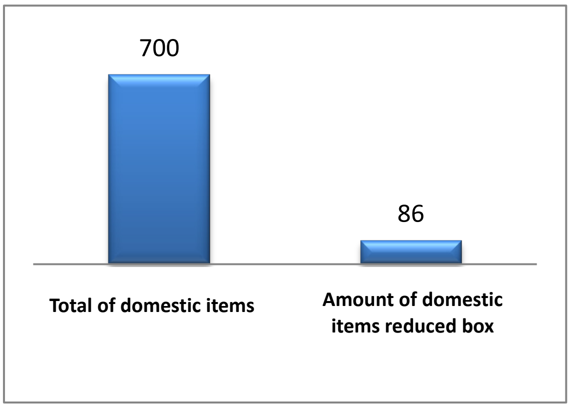
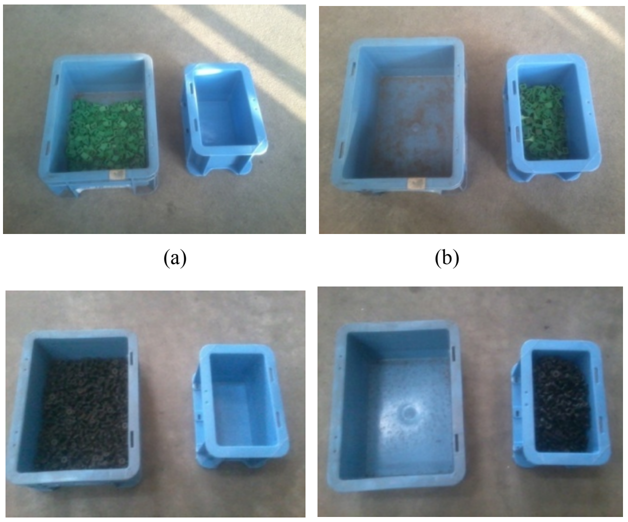


Figure 6. Comparison of the reduction of domestic items in Kanban stock

This process made possible the deployment of waiting items in the Kanban system and the elimination of unnecessary space on the shelves, which eased the application of inputs and the stock supply, turning the process "leaner", more agile, versatile, optimized and synchronized, reducing wastes, excess inventory and production costs.

There was a significant reduction of space used to transfer items from a #1 to the new selected # "0" box, eliminating unnecessary BIN boxes (Fig. 7 (a), (b), (c) and (d) and Fig. 8).



(a) (b)

(c) (d)

Figure 7. Comparison between BIN model boxes #1 and # "0"

Figure 8. Boxes eliminated in the inventory reduction process

A further step to reduce space in the Kanban process was the reorganization of the BIN boxes in structures that contains pallet. As a parameter, we proposed the conditions:

- Appearance and homogeneous distribution of BIN boxes;
- Better accessibility for the assembler and the Kanban car;
- Classification and division by types of items;
- Facilitator agent in the checking process.

The reorganization process will occur continuously, changing the location of items in the physical inventory and reallocating them into a better position, always being changed in the system to prevent discrepancies between physical inventory- system, Figure 9 (a) and (b).

(a)

(b)

Figure 9. Screws rearrangement in the company Kanban stock

5. Conclusions

Using the Kanban technique, this study aimed to obtain an inventory space reduction, by means of decrease in thenumber and size of boxes utilized in the assembling process, which made it possible a rearrangement of components and parts into categories. With this reorganization process it was possible the deployment of waiting items and the elimination of unnecessary space on the shelves, acting as facilitator in the issue of parts/items orders and acting directly against the cost and waste of excess inventory.

At this initial stage there was a reduction in the size of the boxes in 13% of the items, with approximately 86 items from domestic suppliers and also from imported parts.

The reorganization and realignment process will cover in future 100% of the items, replacing them strategically in order to give assembling workers a better accessibility.

The lean process required the purchase of a new type of box, the box labeled type "0", with dimensions smaller than the box type 1, including the transference of approximately 100 items.

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