ADVANTAGES OF E-KANBAN SYSTEM COMPARED TO CLASSIC KANBAN SERVING PRODUCTION LINE

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Abstract: *In this paper will be analyzed implementation process and upgrade of kanban system from card kanban to e-kanban in real production environment in automotive industry in Lames d.o.o. Previously existed classic card-kanban system was improved by newly developed software which made possible usage of e-kanban system. The software covers only material flow between warehouse and raw material shelves in the production. This software is made in MS Access by authors of this paper, increased flexibility of complete system in the area of production plan changes, packaging changes, and variations of production capacities. There was no need for physical kanban cards printing. All kanban parameters are well connected and related in the database and each change automatically adjusts and recomposes complete material flow between warehouse and production. Also, each step of e-kanban system implementation, detailed comparison between classic kanban and e-kanban systems, and advantages of e-kanban are presented.*

Keywords: *e-kanban, automotive, stock optimization, software.*

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1. INTRODUCTION

Lean manufacturing has become leading industrial trend in the past few decades. In order to increase its competiveness and decrease costs, companies are streaming to keep their inventory levels reduced to a minimum while keeping excellent performance and quality of the production [1]. Pull-type production control mechanisms are widely used in automotive industry to control flow of material within the system. Kanban system is the most famous system as one of pull-type mechanisms generally used in automotive industry [2].

Lames d.o.o. is new green field automotive company in Serbia, part of the larger group with several factories located on three continents. The main products of the company are manual and electric window lifters for automotive industry. Lames group is supplier of many major car producers all over the world.

Demanding clients request high quality levels not only for product but also for all processes and organization of their direct suppliers. Lean approach is inevitable in order to achieve such standards.

One of the projects establishing new company was organization of the raw material flow between warehouse and production line. Like in many automotive industries, kanban concept is mostly used as the best concept for this type of lean production organization.

The main goal was to establish such system which will guarantee optimal stock replenishment of raw material in production shelves without any material shortages which could put in danger production continuity. In the same time, due to limited space in production, excessive stocks would be unacceptable.

2. THE FIRST PHASE OF KANBAN IMPLEMENTATION (CLASSIC KANBAN)

Since warehouse software and SAP modules for finished products and production planning do not support electronic kanban, in the first phase of kanban implementation, it was possible to implement classic kanban using cards. Production area consists of three production lines and three subassembly lines used for production of 24 different types of window lifters.

2.1 Calculation of kanban containers

Before start of kanban implementation several parameters have to be defined, such as desired level

of stocks in the production shelves [3]. In our case this level was supposed to be between 2 and 4 hours of production. That means that complete stock replenishment (stock turnover) will occur minimum two times during one production shift. Another important thing is capacity of the line. The higher capacity requires more material in the flow and the vice versa.

In order to define number of containers (kanban cards) which will be used in kanban cycle several other parameters have to be considered. Type of the packaging and quantity in the packaging are the last parameters needed for calculation of quantity of kanban cards needed.

The final formula for quantity of kanban cards is the following:

$$N = (T_{\max} \times Q_{cap} \times Q_{bom}) \div Q_{pack} \qquad (1)$$

N – quantity of kanban cards needed

$T_{\max}$ – maximum production time covered with raw material in production shelves

Q_{cap} – quantity of finished product produced in one hour

Q_{bom} – quantity of specific material contained in one finished product

Q_{pack} – quantity of material in the packaging

In case that final result is decimal number, that number should be rounded up.

Taking real example for metal shaft, which is packed in carton boxes containing 250 shafts, for production capacity of 225 final products per hour, each final product contains one metal shaft, and maximum stock coverage of 4 hours calculation would be the following:

$$N = (4 \times 225 \times 1) \div 250 = 3{,}6 \qquad (2)$$

Round up 3,6 = 4

N = 4 kanban cards needed for stock replenishment of production shelves for metal shafts. Since packaging contains 250 pieces, maximum quantity on the production shelf can be 1000 metal shafts (4 x 250).

In the similar way we can calculate minimum quantity (safety stock) in the production for that material. Previously defined minimum stock for 2 hours of production would be calculated with the same formula:

$$N_{\min} = (T_{\min} \times Q_{cap} \times Q_{bom}) \div Q_{pack} \qquad (3)$$

$$N_{\min} = (2 \times 225 \times 1) \div 250 = 1{,}8 \qquad (4)$$

Round up 1,8 = 2

$N_{\min}$ = 2 kanban cards as minimum stock, or 500 pieces of metal shaft (2 x 250)

The kanban calculation of the materials for one finished product can be seen in software application form as well as in the picture below (Figure 1).

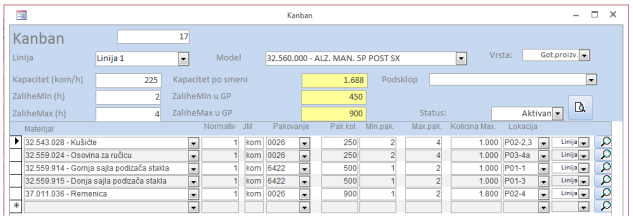

Figure 1. Kanban calculation of materials for one finished product

After calculation of quantity of kanban cards/containers, all elements for creation of kanban cards are available. These cards follow kanban containers on their way between warehouse and production until consumption of all material in them to feed the production process. The picture of one kanban card is presented below (Figure 2).

Kanban card contains much useful information such as: material code, the name of material and location of the shelf in the production. The card contains card number and total quantity of cards for specific material. In that way it is easy to check if some cards are missing and to establish FIFO (first in first out) system for material consumed in production.

Useful information that can be found on kanban card are also supplier's name, type and dimension of packaging, total quantity in the packaging, minimum and maximum number of containers that can be placed on the shelf in the production [4].

Very useful information for operators on the line is information for which production models the material is used. That reduces mistake of the operator to install the material in the wrong type of product. The picture of the material on the cards reduces possibility to associate any material with the card that does not belong to it. Further to make easier for the operators, cards for different type of products are printed on the different colour paper. If material is used for more than one type of product, its card is printed on white colour paper.

Kanban cards are printed on both sides of the paper and plasticised. Printing on both sides eliminates the need for turning over the card in order to read the information on it. That saves the time for operators and warehouse keepers. Plasticisation prolongs life time of the card and reduces possibility to get dirty and reduce visibility of information printed on the card.

Figure 2. Kanban card

2.2 Advantages of classic kanban compared to non-kanban system

After the implementation of kanban cards in Lames d.o.o., many benefits were recognized. Raw material stock control on production shelves was improved. As result of kanban cards implementation the stock was constantly on optimal level between 2 and 4 hours of consumption in production. Out of stock situations were practically eliminated because of improved communication between warehouse keepers and material needs presented with free kanban cards on the shelves. Excessive stock on production shelves was not possible because number of containers is limited by quantity of kanban cards.

In previous system warehouse keepers spent much more time monitoring situation on the shelves, checking each shelf, writing material codes and defining quantity that was supposed to be replenished. Such activities were time consuming and occasionally out of stock situations occurred following frequent communication between warehouse keepers and operators on production lines.

Using kanban cards communication between operators and warehouse keepers does not exist anymore. Free kanban cards are new means of communication. Production operators do not have to monitor material stock levels and can focus on production process [5].

Stock replenishment done by warehouse keepers now is significantly simplified. There is no need for writing any information on piece of paper about quantities needed, material code and position of the shelf on the production flour. All information needed is written on free kanban card. With that card warehouse keeper can go directly to ware house to pick up specific material and to return to the position specified on the card.

3. IMPLEMENTATION OF E-KANBAN SYSTEM

The advantages of classic kanan are enormous compared to non-kanban systems, but Lames d.o.o. was striving for further material flow optimization and process improvements. The next steps and Lames d.o.o. goal was leading towards e-kanban implementation. But, there were certain obstacles: SAP does not support implementation of e-kanban for the material flow between warehouse and production lines. In order to implement e-kanban, the development of special software was inevitable. New software was developed internally in MS Access and VBA by authors of this paper.

Previously mentioned kanban containers calculation and basics of new e-kanban concept were developed already in MS Access database. Only additional module was supposed to be created that would support material flow with electronic control instead of exiting flow with kanban cards.

Figure 3 presents one part of the e-kanban software that is used in warehouse for stock levels monitoring and stock levels replenishment.

Warehouse keeper monitors the basic screen where all components listed which is needed for current production on the production line. Also stock location is indicated with minimum and maximum allowed quantities on the shelf.

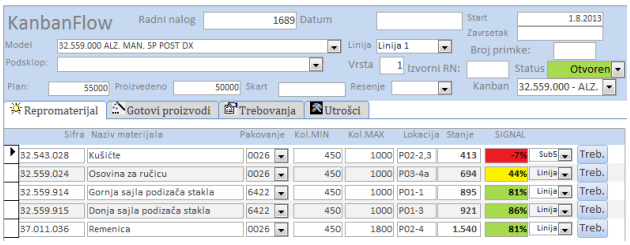

Figure 3. E-kanban form for stock level monitoring

Current stock level on the shelf is visible as well as coloured information about percentage of current stock optimization. If percentage is red, stock level is below minimum stock allowed (the stock is less than needed for 2 hours of production). Yellow colour means that the stock is less than average stock and close to minimum stock. The green colour means that there is still no need for stock replenishment because current stock level is between average and maximum stock (the stock enough for 4 hours of production).

There are two triggers that influence the stock level change. Stock increase trigger is the issue of material from the warehouse, and stock level decrease trigger is printing out of the finished product label at the end of the production line.

Issuing of material from the warehouse is simplified by software. The warehouse keeper just needs to click on the button next to material in e-kanban form which has become yellow or red, and automatically new screen appears with the list of available material in the warehouse in accordance to FIFO system. Next to required material, its location in the warehouse is displayed. With all information available, warehouse keeper has pretty easy job: to pick up needed material at defined position in warehouse and to take that to defined shelf positioned in the production flour.

After issuing of the material from the warehouse, the stock level on the shelf is automatically updated and stock signal is changed from red or yellow to the green.

As previously mentioned, stock reduction occurs permanently as result of printing of finished product labels at the end of the production line. The figure 4 presents how the label looks like.

The printing of label triggers stock reduction of all materials in the production shelves in accordance to the bill of materials defined in the database for each type of finished product.

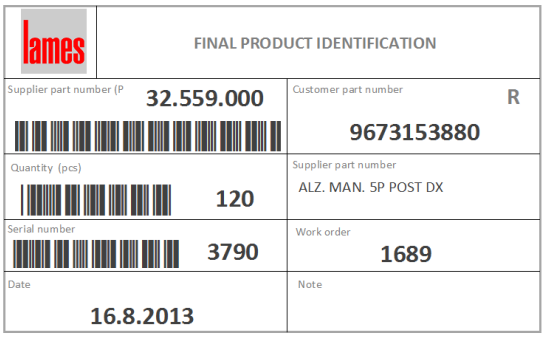

Figure 4. Finished product label

4. ADVANTAGES OF E-KANBAN

Compared to classic kanban system, e-kanban has brought many advantages making easier job for warehouse keepers:

- No need for kanban cards eliminates danger for losing the cards which can seriously harm functioning of stock replenishment system.
- In case of any change in the system (bill of material change, production capacity change) software automatically change quantity of kanban containers without need of kanban cards printing.
- Control of stock levels is improved due to easy monitoring of the stock levels in the system.
- Warehouse keeper does not have to go to production flour any more to collect free kanban cards. This has reduced working hours of warehouse keeper for 15%.
- Production operators do not have to collect free kanban cards anymore and to place them on the production shelves
- Classic kanban system for some materials cannot be implemented in case that request of minimum 2 containers cannot be met. E-kanban in that situations makes possible to monitor stock levels of such material on the production flour.

5. CONCLUSION

In accordance to Lames d.o.o. statistics out of stock situation occurred two times in the shift in average before classic kanban implementation. After kanban implementation, such situations are practically eliminated. Manpower need was reduced as well. In previous (non-kanban) system 3 warehouse keepers were able to provide stock replenishment for 3 lines. Using kanban cards 2 warehouse keepers are enough to perform the same activities. Further with e-kanban, men hours in the warehouse are additionally reduced for 15%.

Classic kanban sometimes can not include some materials in its system due to some specific reasons. For example window lifter motors because of its big packaging and lack of space on the production flour are excluded from classic kanban. In order to be implemented, at least two cards (containers) should exist for a material, but packaging of motors is too big and only one box can be located nearby production line.

In such situation e-kanban can offer solution because stock level of that material is still visible in the system thanks to existance of two triggers for stock adjustment.

There aren't two identical kanban systems. Each kanban system is tailor made for a specific company. It has to be adjusted to company specific needs and to support material flow and control in the best possible way. Some authors say that kanban is an easy concept to understand and very difficult to implement in the proper way [6].

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