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MODELING OF A SHAFT PRODUCTION SYSTEM

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ABSTRACT

In the last twenty years, in industry a particular emphasis has been put on how to improve the production system and production planning. So, with much less effort there has been trying to attempt activities that occur between product development and manufacturing system operations. To optimize the production system we can achieve its modelling, a modeling that provides important data in making decisions. This paper presents the modeling of a shaft production system before and after application of Kaizen concepts in order to improve the technical and economic performance of the enterprise. Modeling production system supports the decisions of planning and system development.

KEYWORDS: production system, Kaizen, VSM, shaft

1. INTRODUCTION

In the last twenty years, in industry there has been a particular emphasis on how to improve the system of production and production planning. So, with much less effort there has been trying to attempt activities that occur between product development and manufacturing system operations. Although the design of an entirely new plant has been done quite often lately, modernization of the old ones has become a more frequent thing. Due to the size of such projects and their associated costs, a more efficient development process is imperative [1, 3, 5]. The successful development of a new production system is a necessary step in delivering timely and cost effective products that meet customers' needs.

Solving the decision problems arising in a production system becomes more complex. Production system designers require support from analytical methods and managerial expertise, those playing an important role in the decision making process. Most companies have their own design processes and production system development. For an optimization of the production system can achieve its modelling. This provides important data in the process of decision making [4].

2. IDENTIFICATION OF THE TECHNOLOGICAL FLOW

The production process that we want to model is based on the technological processing of a shaft that was identified inside Mehid S.A. enterprise. For a better understanding of the entire production system of the shaft, there was identified the value stream of the enterprise. In the value stream there are six workstations: the milling machine, the centring machine, the turn roughing machine, the turn smooth machine, the washing station, and the final control station. From the control centre, weekly production planning goes to each workstation and weekly order to suppliers. Here are receiving weekly orders from customers and suppliers. The daily order from customers is for 200 pieces. Production is done in three shifts of eight hours each, with a total of six operators per shift workstations. Frequency of production is ten parts per machining cycle. Supply parts by suppliers are done once a week and delivering orders to customers is done once per day. Between workstations were identified the stock levels with the following values: S1 = 500 pieces (stock entering the production system), S2 = 300 pieces (stock between workstations 1 and 2), S3 = 250 pieces (stock between workstations 2 and 3), S4 = 175 pieces (stock between workstations 3 and 4), S5 = 75 pieces (stock between workstations 4 and 5), S6 = 75 pieces (stock between workstations 5 and 6), S7 = 70 pieces (stock entering the final store). At the end of the production flow, the following were identified: total leading time with a value of 14.47 days, Takt time with a value of 4.80 min and total processing time equal to 11.07 min. The flow value is shown in Fig. 1, which was identified with the Value Stream Map.

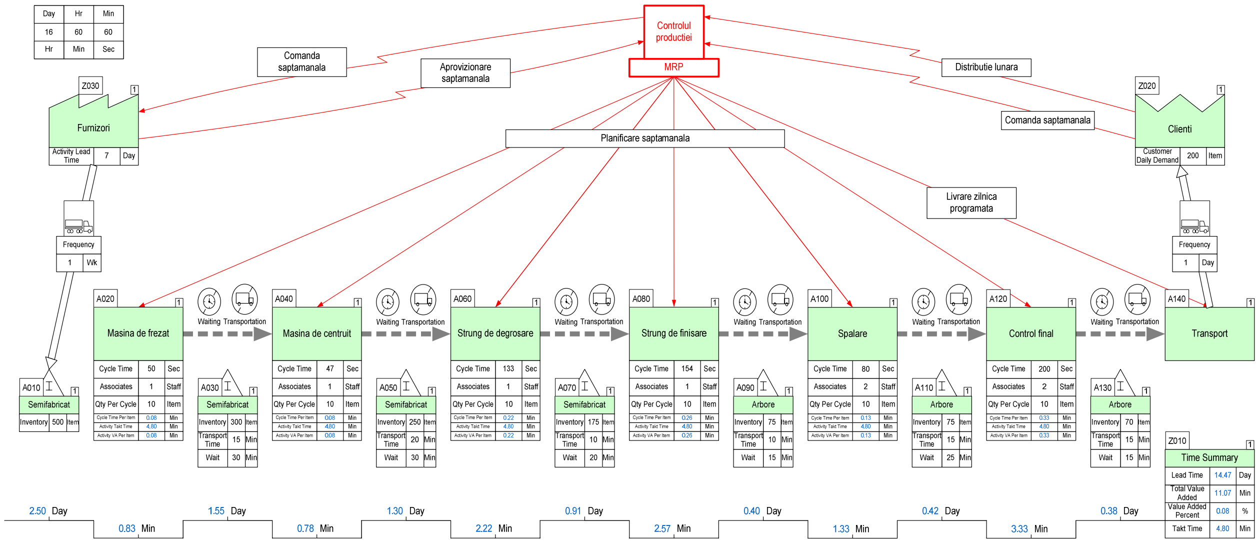

Fig. 1. *Flow value of the shaft production system identified with the Value Stream Map*

3. MODELING OF THE PRODUCTION SYSTEM BEFORE APPLYING THE KAIZEN CONCEPTS

To improve the technical and economic performance of the system of shaft production, production system modeling was performed before and after application of Kaizen concepts. The necessary data were extracted from the technological modeling of the production system and are presented in the current state map in Fig. 1. The initial model of the production system was created with the Tecnomatix Plant Simulation v11.0.1 software.

To create the model of the production process, the six workstations were introduced in the model. For each workstation there is one work post, each having access path between the workstation and the workshop. After creating workstations and access routes, settings are made for each workstation in part, by entering data in the value stream. For each workstation were introduced the processing time and the cycle time. Three types of errors were considered, based on simulation time, operating time and processing time. For the first type of error it was considered that the workstation has an availability of 90%, for the second 95%, and for the third 90%. Stock parts between entering the production process are 500 parts/week. Fig. 1 presents the model for simulation process before applying the Kaizen concepts

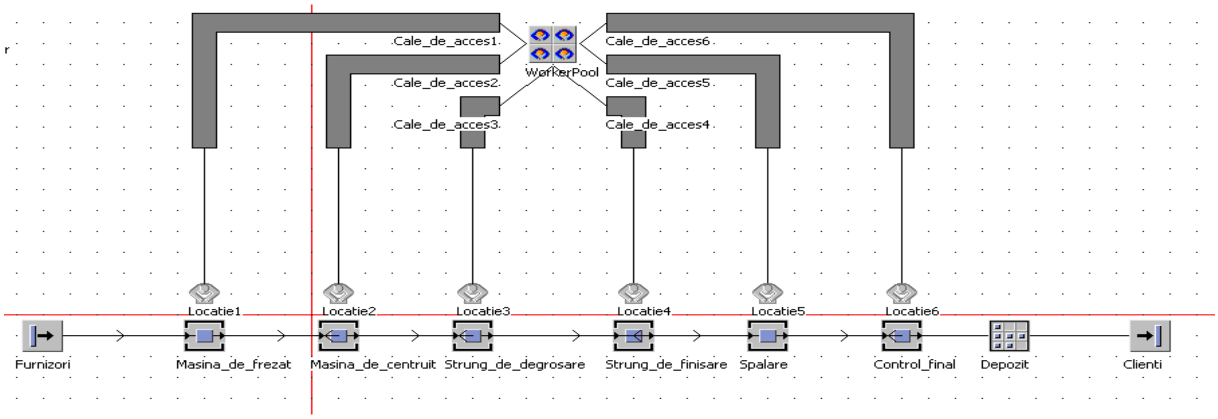

Fig. 2. *Model created for the simulation process before applying Kaizen concepts*

As a result of the manufacturing process simulation, the statistical report revealed a total leading time of 13.07 days, the takt time value remained at 4.8 min, a daily distribution to customers of 200 parts and the value added per product of 0.5%.

4. MODELING OF THE PRODUCTION SYSTEM AFTER APPLYING THE KAIZEN CONCEPTS

4.1. Modeling after applying K1

Concept K1, reducing the lead time, can be implemented in the production system modeling by reducing the stocks of workstations, reducing travel time and waiting time between workstations. To reduce the waiting time, the stock is sized so as to produce a batch minimizing transport, which leads to the appearance of a steady production line. To reduce inventory between workstations a number of warehouses were introduced that are designed to take over the station and deliver it to the next workstation in the shortest time possible, thus the time transport between stations being also reduced. Applying concept K1 in the production process, after simulation, the total lead time fell to a value of 12.55 days to 12.93 days initially, the takt time increased to 5.2 min from 4.8 min initially, and the processing time decreased from 11.07 min to 10 min.

4.2. Modeling after applying K2

The implementation of the concept K2 - reducing the operating time in modeling the production system - is done by maintaining the best possible processing conditions and arranging in advance the tools necessary for the production in special storage areas closer to each workstation. Thus, to optimize the production process, racking tool were introduced in the process before each workstation in order to reduce the time an operator needs to access it through the path of the tool store and each workstation.

4.3. Modeling after applying K3

The implementation of the third concept K3 in modeling the production system can be translated by reducing the processing cycle on each workstation in hand, working in normal shifts, and reducing waiting times. Thus, for each workstation we kept one operator and two 8-hour work shifts. In this way: the takt time decreased to a value of 3.5 min compared to 4.3 min as it was originally; the waiting time per workstation decreased; the leading time decreased from 12.97 days to 10.96 days; the processing time decreased from 7.12 min to 7 min.

4.4. Modeling after applying K4

The implementation of concept K4 – rearrangement of the work space - in manufacturing system modeling the workstations that cannot be used in achieving a continuous flow are replaced with a parallel process, because they are used with other product families. It helps to distribute the tasks of the parallel workstations simultaneously, thus placing a constraint on the production flow, in our case, three workstations, namely the centring machine, the turn rough machine, and the turn smooth machine. The parallel process cycle time is equal to the cycle time of the three workstations. This way are reduced the inventory levels at stations 2, 3, and 4 because there is a certain process before storage rack located parallel. The total lead time drops to a value of 7.5 days and the total processing time decreases to 10.2 min. With the installation of this parallel process, the number of operators is reduced from 3 to1. In the model between the milling machine and the new parallel process, a control flow cell has been introduced that is designed to control the technological process in the parallel process and to avoid process errors.

4.5. Modeling after applying K5

To implement Kaizen concept K5 - the 5S in modeling the production system - there must be a reduction in the number of defective parts, crowded work areas and implementation of just-in-time delivery. Thus we have identified in the technological production process overcrowded work areas and those with problems such as: workstations 1, 2, 3, 4 show a high level of inventory and their customers' orders are satisfied with a significant delay. Therefore, in the model the supply frequency from suppliers was increased to 2 times a week, instead of once a week as is done in the initial model. The first step is to identify the current value stream map of busy work areas and problems. Thus, the supply can be seen that we have a low frequency in the right workstations 1, 2, 3, and 4 meet crowded work areas due to the large number of pieces on each stock in the workstation 7 meet a number than defective parts and in the delivery of customer orders to meet a delay in their delivery. As a working method for each station was selected the FIFO (first-in-first-out) method, which has reduced inventory levels and flow balancing technology, not experiencing significant variations in any point of the production system.

4.6. Modeling after applying K6

The application of concept K6 - kanban system implementation - in production system modeling leads to reducing inventory levels, time lock and the process time for errors. Consequently, before each workstation we place a Kanban post that helps streamline production. An important step in implementing the Kanban card is the pull production as value stream is always preferable to be shot in the line of production. To achieve pull production, before each station will be placed a supermarket accompanied by one Kanban card which makes the stock level adjustment between workstations. A Kanban is a tool to help achieve just-in-time (JIT) production. Kanban is a card that is usually placed in a rectangular plastic envelope and thus there are two types of cards: Kanban and withdrawal Kanban production control. Along with placing these supermarkets, buffers will be placed between workstations which are designed to reduce the risk of overproduction by taking surplus. The buffer is meant to take stock at the exit of the workstation and then was placed on the workstation at the entrance, before which it was located, if it is not available.

4.7. Modeling after applying K7

To implement concept K7 - maintaining constant production being processed by reducing inventories (CONWIP cards) - in production system modeling, it is important to keep a steady production flow by reducing inventory between workstations. Partially processed parts that are currently in the process are called work-in-process (WIP). The CONWIP system (constant work-in-process) regulates the flow of work cards as crossing a circuit that includes the whole production line. A card is attached to a standard container in the early parts of the production line. When the container is used at the end of the production line, the card is removed and sent to the beginning of the line where it waits in a series of event cards to be attached to another container parts. The process can be abandoned due to parts that are temporarily stored and awaiting customer approval due to changes and new instructions.

To reduce inventory, between workstations we place supermarkets with CONWIP cards (cards for maintaining constant output). A CONWIP card regulates the flow of work and frees the workspace. And thence, between workstations, were placed buffers which are controlled by CONWIP cards and are designed production balance when stocks reach high levels. The buffer is meant to take stock at the exit of the workstation and then placed on entrance of the workstation before which it was located, if it is not available. Answering these stocks by damper control is based on the CONWIP card. The buffer holds the stock until the CONWIP card confirms that the workstation after the buffer is available.

After implementing concept K7 in manufacturing system modeling, there were achieved low levels of inventory for each workstation and less waiting time. The statistical report obtained from the simulation of the production process after applying concept K7 revealed that the leading time has decreased from 10.69 days to 9.76 days, the takt time value decreased to 4 min from 4.8 min, and the processing time is 5 min from a baseline of 5.52 min.

5. RESULTS AND DISCUSIONS

Figures 3, 4, and 5 present the variations of the main time parameters (processing time, takt time, and total lead time), before and after applying the kaizen concepts in the simulation production system. It can be noted that the leading time registers the lowest value in the system after applying the fourth concept K4. The takt time has a constant evolution, registering the highest value after applying the third concept K3. The processing time registers the lowest value, of 5 min, after applying the seventh concept K7. All this data were collected from the statistic report of the production system's simulation.

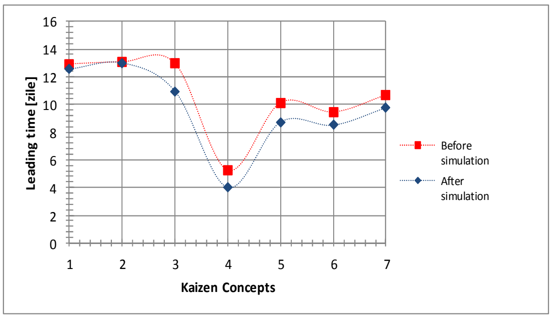

Fig. 3. *Leading time variations for each concept before and after the simulation process*

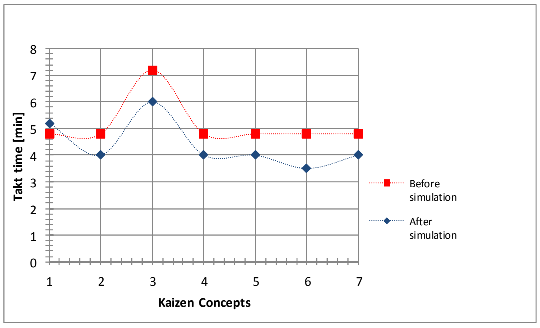

Fig. 4. *Takt time variations for each concept before and after the simulation process*

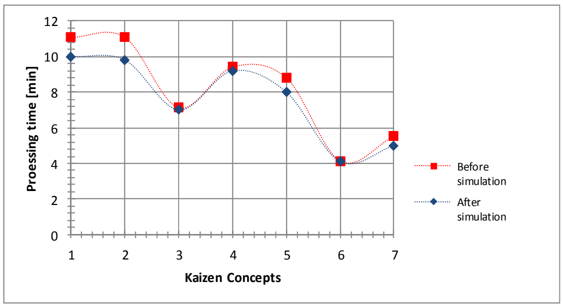

Fig. 5. *Processing time variations for each concept before and after the simulation process*

6. CONCLUSIONS

This paper presents the advantages that production system modeling has in taking future decisions and in production planning. Creating the models for the production system, before and after applying the Kaizen concepts, helps taking the “what-if” decisions, the data collected after the simulation processes being used for planning future production. Modeling the production system leads to reducing productivity costs by creating data bases that help in future decision taking.

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