APPLICATION OF SIMULATION MODELING FOR FORMATION OF PULL-PRINCIPLED PRODUCTION CONTROL SYSTEM

Abstract: Firstly the lean philosophy has spread in the field of the production systems, however it also appeared in the service areas in the last decade as well. One of the philosophy’s priority questions is realization of the push principle, namely the push systems’ transformation into pull systems. The pull system enables the more flexible satisfaction of the customer needs and the more efficient process improvement as well. The transformation’s process from push system into pull system has been already determined clearly, however we can increase this process’s efficiency with use of the simulation modeling. Basically this paper presents these efficiency improvement possibilities.

Key words: lean philosophy, push principle, process improvement

1. INTRODUCTION

In practical life the strengthening of the market competition demands the continuous reduction of the wastes. Those companies which are not able to reduce their wastes quickly and dynamically will become uncompetitive and their market role will reduce. The lean philosophy’s device and rule system enable the reduction of the wastes, as a result of these the companies’ competitiveness will increase. If we would like to determine the lean philosophy’s essence, in our opinion the best definition is the reduction of the duration between the order and the payment with the elimination of the wastes [1]. The philosophy distinguishes 3 kinds of MU, namely the Muri (overburden), the Mura (unevenness) and the Muda (waste). The Muri and the Mura result in Muda, consequently most companies only speak about the Muda’s elimination. We can distinguish 8 types of the wastes namely the overproduction, unnecessary inventory, transportation, unnecessary motion, waiting over-processing, defects. We can achieve these wastes’ elimination with use of the lean philosophy’s devices [1]. The lean determines 5 kinds of principles, which principles are able to realize the wastes’ elimination efficiently. These principles are the following [1]:

- determination of the value,
- elaboration of the value stream,
- creation of the continuous flow,
- creation of the pull principle,
- continuous improvement.

We can tell that realization of the above steps will result in significant wastes reduction in the case of the ideal production systems, however, there are some cases when the mentioned principles’ realization is not possible perfectly (e. g. we can’t create continuous flow in the case of the heat treatment because of this equipment has a significant capacity, …, etc.) [2]. We will examine one of the priority principles, namely the transformation process which takes from the push-principled production system into the pull-principled production system. This paper will also introduce the simulation investigational possibilities in connection with this process.

2. EXPLANATION OF THE PUSH-PRINCIPLED AND THE PULL-PRINCIPLED PRODUCTION CONTROL PHILOSOPHY

The push-principled and pull-principled production control systems differ from each other therein that the push system is based on the forecast of the customer’s needs however the pull system is based on the effective customer’s needs. Consequently we can get overproduction and/or stock shortage in the case of the push system, however this can’t occur in the case of the pull system.

E. g. If we use the push principle for the car’s refueling then we have to determine the refueling’s amount on the basis of the expected running distance in the other case (pull system) we will refuel if we reach a given fuel level. We can establish that the pull system gives us more security.
Push-principled production control philosophy | Pull-principled production control philosophy
---|---
Production on the basis of the customer’s needs | Production on the basis of the effective customer’s needs.
Longer production lead time | Shorter production lead time
Higher work in processes | Lower work in processes
Ad hoc effort for the elimination of the wastes. | Systematic effort for the elimination of the wastes
The workers realize simple workflows. | The workers realize complex workflows.
Utilization of the available resources (human, machine) is lower | Utilization of the available resources (human, machine) is higher
Bigger area need | Lower area need
Bigger batch sizes | Smaller batch sizes

Table 1. Comparison of the push- and pull-principled production control philosophy

We can find the same at the production processes. One important objective of the pull system is the reduction of the production lead time. We do not have to keep WIP and finished goods if the production lead time is less than the order lead time. The figure 1 presents the differences between the push- and pull-principled production control systems.

3. PROCESS OF THE FORMATION OF THE PULL-PRINCIPLED PRODUCTION CONTROL SYSTEM

The transformation of the production logistics processes from the push system into pull system can be realized in two kinds of versions. In the first version the assigned total process will be transformed “simultaneously” (version A on the figure 1). In the second version the transformation will be realized in more steps, consequently we can use the realized process’ working experiences at the next process step’s realization (version B on the figure 1).

More important steps of the transformation process are the following [3]:

**Fulfillment of the prerequisites:** We have to realize the next lean devices before the pull-principled production control system’s creation:
- visual management,
- proposals system,
- 5S,
- standardization,
- creation of the company culture in the interests of the more efficient process improvement,
- kaizen.

**Creation of the group:** We have to create a group which will plan and coordinate the pull-principled production control system’s realization. We need to collect those company areas’s representatives in this group who will be touched in the transformation. It is very important to be at least one person in the group who has experience in the pull system’s realization.

**Creation of the schedule:** Determination of the implementation process’ more important milestones and their deadline.

**Education:** In this step we have to keep some training for members of the group in connection with the creation and actuation of the pull-principled production control systems.

**Drawing, analysis, evaluation of the current state:** We suggest the value stream mapping’s method [4] for mapping of the current state of process to be transformed. This method enables the current state’s understanding and objective evaluation.

**Planning of the future state:** Actually the planning of the future state means creation of the future state mapping [4] which is realized on the basis of more variations’ evaluation and the adequate variation’s selection. The map defines the principles of the working of the system, namely that where and what
kinds of device we need to locate, respectively how will the material- and information flow realize.

**Planning of the system implementation:** In this step we have to make a table with the followings data:
- tasks to be performed,
- period of the fulfillment (Gantt-diagram),
- indicators to be fulfilled,
- concerned persons (RASIC chart).

The scheduling of the implementation of the system can be realized during short lead time regarding the total examined process (variation A on the figure 1), respectively in more steps [4] (variation B on the figure 1). In the case of the variation B we can gain a lot of experience from the realized process steps which is usable at the next process step’s realization.

**Determination of the system working regulation:** In this step we have to determine the exact work instructions of the working persons in the case of different conditions (e.g. mode of the process improvement, regulation of the stock level in the case of different customer needs, …, etc.).

**Planning of the system’s device:** We have to determine the standard and the special kanban cards (e.g. pool kanban, express kanban, …, etc.), the heijunka boards, the supermarkets and/or FIFO lanes, the kanban storage areas, milkrun trains, …, etc.

**Realization of the system:** We have to realize the pull-principled production control system on the basis of the system’s implementation plan.

**Education of the system’s working:** In this step we need to keep some training for the workers in connection with the elaborated work instruction and the total system working. After these trainings we have to check the appropriate skills at the production area.

**Actuation and improvement of the system:** We have to actuate the system after the realization of the system and the workers’ training, which may result in several failures in the beginning. We also need to realize process improvement during the actuation of the system, consequently we can use the gained experiences at the next process step’s realization.

4. **APPLICATION POSSIBILITIES OF THE SIMULATION MODELING FOR FORMATION OF THE PULL-PRINCIPLED PRODUCTION CONTROL SYSTEMS**

If we would like to explain the simulation modeling’s term, then basically this is such a method which is able to make a model for the real/planned processes/systems. Consequently we can examine the status changes of the processes/systems beside different settings [5]. We can realize the optimization of the real or planned logistics system with use of the simulation modelling’s method [6]. The simulation modelling as a method is applied in a lot of cases e.g. optimization of the production scheduling [5], elimination of the planning failures [7], comparison of the different planning variation, examination of the stochastic processes, …, etc. The transformation from push-principled production control system into pull-principled production control system is a very complex process which is realized in a lot of cases without use of the simulation modeling. This chapter presents the efficiency improvement possibilities with use of the simulation modeling’s method. We highlighted those areas (thicker line) in figure 2 where the simulation investigational possibilities can result in efficiency improvement. In addition we will introduce these areas.

**Drawing, analysis, evaluation of the current state:** We can understand and evaluate the examined system with simulation modeling of the current state efficiently because in this case we can gain more information (we can use this information for the planning of the future state) [8].

**Planning of the future state:** We can create and examine more system variations rapidly with use of the simulation modeling. Thus we can make an objective decision on the basis of the assigned investigational aspects (area need, lead time, kanban cards’s amount, workers’ number, …, etc) [9].

**Determination of the system working regulation:** We can determine the action plans more efficiently with use of the simulation modeling in the case of different customer needs [10].

![Figure 2. Simulation investigational possibilities in the process of the transformation from the push system into pull system](image-url)
The kanban stock levels can also be determined more accurately, because we can take into consideration the stochastic effects with the simulation modeling. We can also define the production process’s work instruction more efficiently, thus the utilization of the human- and machine resources can be increased.

**Planning of the system’s device:** We can determine the necessary milkrun train’s types and their number, kanban cards’ types and their number, storage devices’ types and their number with higher precision if we use the simulation modeling. This application possibility can result in significant savings for the companies.

**Actuation and improvement of the system:** The realized system’s continuous improvement is necessary in the interest of the holding/increase of the competitiveness. We need to use simulation modeling in those cases when more value stream cross each other because in this case a failure process improvement decision can result in significant wastes (for example: purchasing of the lower performance equipment than it is necessary for the efficient production, …, etc.).

5. APPLICATION POSSIBILITIES OF THE SIMULATION MODELING FOR FORMATION OF THE PULL-PRINCIPLED PRODUCTION CONTROL SYSTEMS

One of the most important milestones of application of the lean philosophy is the formation of the pull-principled production control system. This system can increase the flexibility of satisfaction of the customer needs, respectively it enables more efficient improvement of the logistics processes as well. This system can be created with transformation of the push system into pull system at most companies. This paper presented this transformation’s process, as well as its improvement possibilities with the simulation modeling. All in all, we can tell, that the simulation modeling can decrease the planning failure, as well as can increase the utilization of the human and machine resources at the formation of the pull-principled production control systems.

6. REFERENCES


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