

IMPROVEMENT POSSIBILITIES FOR THE METHOD OF VALUE STREAM MAPPING

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Abstract: The coordinated development of the production processes in logistics systems is a decisive competitive factor, because it can significantly reduce logistics costs and/or improve the level of services. The value stream mapping method used in the lean philosophy can be very efficient when it comes to the development of logistics processes of distinct product families. In the case of simultaneous production of multiple product families using material flow processes, that intersect each other, as well as the processes are characterized by significant randomness (eg.: machinery and material handling equipment failure etc.), then the process improvement methods cannot be used very effectively in practice. Of course, there are many attempts to develop logistics processes in intermitted manufacturing systems, which are discussed in detail in the literature review. For better understanding we present the value stream mapping method through an example. Then we give a little insight into the new opportunities of process development, which is the combination of value-stream mapping with simulation modeling. This new trend provides opportunity to perform wider range of process development tasks. The detailed elaboration of this new area requires several research tasks to perform, which are presented schematically in this article.

Keywords: *value stream mapping, process improvement, logistics*

1. INTRODUCTION

The satisfaction of unique customer needs is gaining more attention at production companies, and has resulted in a major challenge for them. Compliance with unique needs has led to an increase in the number of product types and thus the growth in complexity of production processes. The application of the Lean philosophy has become indispensable in the everyday life of industry. Here we present one of the instruments of its philosophy, the value stream mapping method, and we will discuss the further development opportunities as well. Actually the fundamental objective of this Lean tool is to minimize logistical losses.

The present method is simultaneously used for the development of product line processes; however, it is less effective in the development of more complicated and more complex processes. For this, it is essential to develop a test system that permits a more efficient development process. In further parts of the thesis it will disclose impact of Fourth Industrial Revolution production area these are the following: the opportunities of process development of the mass production, the shortcomings of used methods and the development opportunities.

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2. THE IMPACT OF THE FOURTH INDUSTRIAL REVOLUTION

During the industrial revolution an explosion of development and modernization took place in the economy of whole nations, which launched changes in society, demographics, infrastructure, and the fields of arts and sciences. These changes typically impacted not only industry but also the entire world. Today, we hear more and more of the Fourth Industrial Revolution and the Internet of Things, these are not a new ideas but for the creation it is necessary that the information and communication technologies are truly capable of supporting Internet-enabled devices and billions of objects, and able to transmit, store and process the huge amount of data which is generated by them [1]. Basically the objective of the Fourth industrial revolution is to realize custom manufacturing characterized by mass production and unit costs in the field of production [2, 3]. This would allow the realization of specific customer demands with fast and efficient service. This may seem a very big jump compared to the current situation; however, a significant part of the required implementation technologies is already available today.

In order to achieve these objectives several conditions must be met, which are as follows [4]:

- Connecting to a network of production assets (components, packaging, material handling equipment, process equipment etc.).
- The collection and processing of real time devices' information.
- The collection and processing of data from the external environment (customer, suppliers, materials handling, warehousing data) in real time.
- Universal use of short-run-time processing technology equipment.
- High degree of automation of operation of material handling equipment, technological equipment.
- Control algorithms that affect the operation of devices.

The spread of the fourth industrial revolution and the appearance of cyber-physical systems is creating new expectations for logistics systems regarding design and operation. Just as people keep in touch through social networks such as Facebook, on the Internet of Things a wide variety of items are able to share information about current conditions during production or maintenance. The systems linking the digital and physical world use built-in sensors, wireless communication functions and actuators and semantic memory, as show in a number of successful projects supported by the Federal Ministry of Education and Research (BMBF) in Germany.

The fourth industrial revolution is marked by 4.0 Industry concept, in which the products and their components are given a key role in the production and logistics processes management. The products are intelligent because they “know” which component installed in them in the assembly line, and which will be needed. At the end of the production the demands for packaging, transportation and storage will given, and they will send this information to their environment in every stage of production. The product under production uses built-in sensors to control itself during production, judging by the requirements stored in its memory, and immediately sends an alert if it detects any difference.

As a result of these manufacturing processes, many logistics processes tasks are generated in the field of series production. *Figure 1* shows that high volume series production is able to carry out the manufacturing of multiple product lines.

The figure shows that series production in high volume is able to carry out the manufacturing of multiple product lines. When creating product lines, many principles are applied in practice:

- Production systems where the manufacturing operations are simple, the products form a single product line where technological processes are the same.
- Production systems with complex manufacturing operations can define product lines. If the operations of a product is at least 80 percent is the same as other products and operation time is not differ than 30% then they are in the same product line.

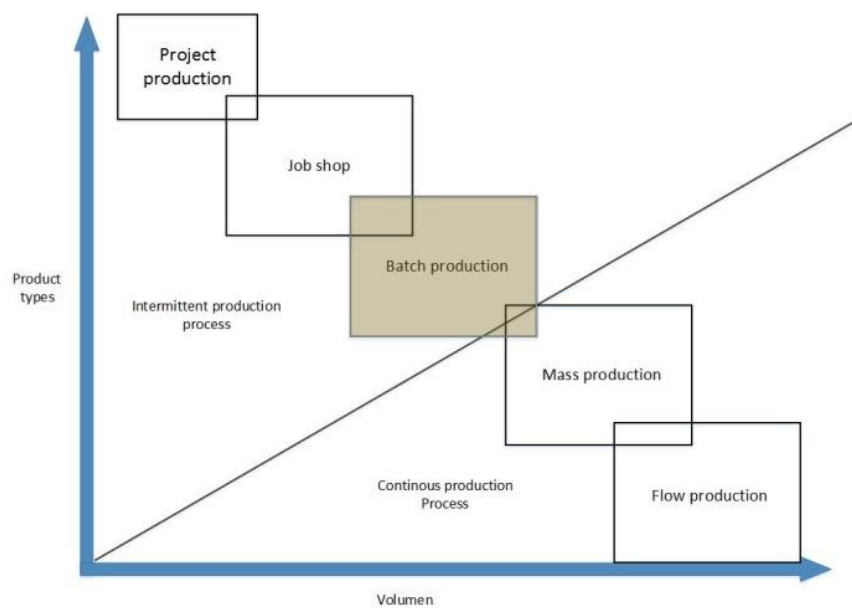


Figure 1. Grouping by manufacturing process [7]

3. VALUE STREAM MAPPING (VSM)

The basic aim of enterprises is permanent sustainability which means being able to carry on their activity, or in other words, stability. This permanent subsistence only can take place if the enterprise produces positive results in the long run, achieving profits through its economic activity. Inputs withdrawn during the economic activity are transformed to outputs whose economic value exceeds the value of economic sacrifice [5]. If we examine enterprise as a capital investment activity, then the aim of any enterprise is increasing capital, thus maximizing profit.

Producing income is not the only requirement for the subsistence of an enterprise but the range of necessary additional organizational and other activities [6]. The other feature of stability is that the enterprise can adapt to varying market surroundings, while it improves and increases continuously. It needs investment for improving and increasing but is hard to decide what to change in order to develop in the expected direction. The method of value stream mapping (VSM) helps the enterprise in this.

3.1. Review of Value Stream Mapping

VSM is a strategic tool which helps to identify waste, and is also called *Value Process Mapping* [7]. It was created by Toyota as Materials and Information Flow Diagram. The main issue is with flows of materials and information related to these flows. The method was published by ROTHER and SHOOK (1999) in their book *Learn to See* [8]. Beside this aim there are several other prosperous features of VSM:

- transparency of logistic processes,
- helps to understand examined processes,
- identifies waste,
- helps to determine development steps [2].

Value Stream Mapping as a tool caused a significant improvement in different industries. There are several applications, e.g. humanitarian aims with the complex system of Humanitarian Supply Chain (HSC) [9]. They started to use the method of VSM to reach their aim because this tool of Lean management enables users to collect the data of effective operation and it accurately highlights the incompleteness of the examined system, [10]. VSM is also used graphically (e.g. in producing bearings). This is mostly used for improving material and information flow. Customer satisfaction can be achieved with this approach [11].

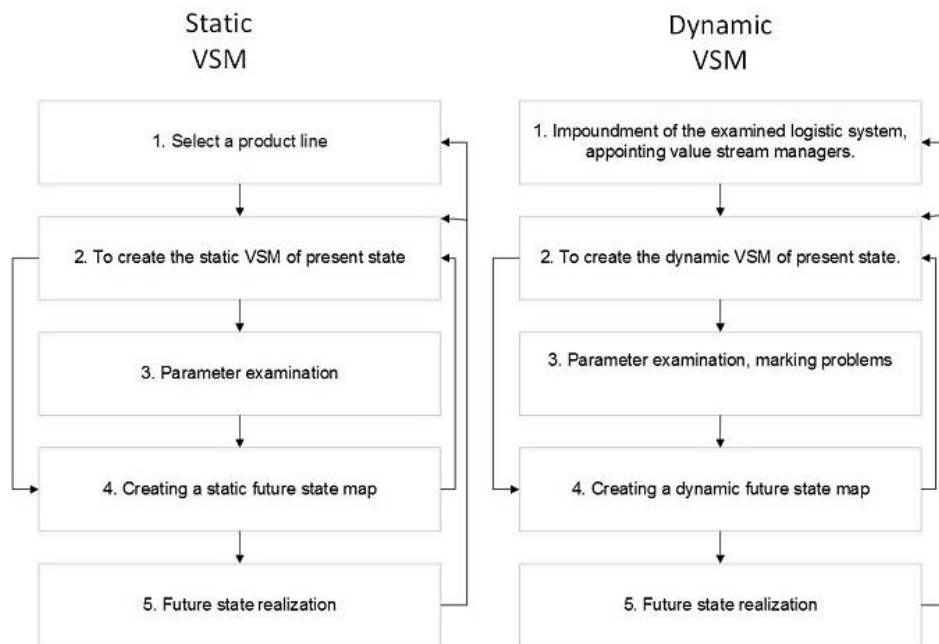


Figure 2. Types of value stream processes [12]

Basically there are two types of VSM: static and dynamic. Fixed data are used in case of static VSM and varying ones in dynamic VSM (e.g. variate, various production plans, parameters etc.) for process developing [12].

Static VSM is based on Toyota's Material and Information Flow. It is a paper-and-pencil tool used for reviewing the examined system, and can identify most of the losses. Furthermore, raising some defined questions can show us the production's problematical areas and after it the desired future state map can be created. This is not suitable for examine several product lines.

In contrast, dynamic VSM is based on the technique of simulation modeling; a simulated framework is used for creating present state and future state maps. Understanding the examined processes and collection of data must be done before creating the present state map, of course. In most frameworks symbols used for mapping are the same as in static VSM [12]. Steps of the static and dynamic VSM methods are shown in *Figure 2*.

Using the method of dynamic VSM in practice has the following steps:

1. Impoundment of the examined logistic system, appointing value stream managers. Define the occurrent product line in connection with the appointed logistic system, taking account the previously presented rule then to assign the value stream managers who are responsible for developing their value stream.
2. To create the dynamic VSM of present state: value stream managers have to understand the process of material and information flow of product line(s) assigned to them. They have to collect the needed data for mapping and have to create a complex value stream map for the particular system by using these collected data. Examination of a particular system can be done using this map.
3. Parameter examination, marking problems: changing all the logistic parameters that affect the working of the particular system can be analyzed with the dynamic value stream map. (e.g. effect of decreasing switch time on average supply and lead time, different alignments for satisfying customer demands, effects of technological faults on the particular system's operation etc.). As a result of the tests most of the problems of material and information flow of present system can be determined.
4. Creating a dynamic future state map: we have to create dynamic value stream map while eliminating the defined problems.
5. Future state realization: we have to define value stream loops and the action list as in static VSM. Then we have to create the annual value stream plan and the realization under controlled work [7].

Feedback can occur between the steps of the process because there can be data during creating future state map which the present state map doesn't have and after the realization of future state the steps of the process return cyclical.

Unfortunately, there is no exact procedure for the method of dynamic VSM that would help to determine the way and measure of process development optimally [13].

3.2. Using of the method of static value stream mapping at a food supplement company

In this chapter we review the improvement of a real logistic process using the method of static value stream mapping. The aim of this chapter is to present the currently applied method in practice.

1. Selection of product line, setting of value stream manager: First step is the selection of product line and setting of value stream manager. The examined company produces 30 types of finished product. The manufacturing process of these are absolutely the same so the products created on one product line.

2. *Creating present state map:* Figure 3 shows the examined present state map. Suppliers ship the raw material for producing capsule on a monthly basis which makes up for data of run out of stock weekly by production system. Realizing of production passes on squeezing principle. We reviewed the information belongs to each part of the process in a datasheet/chart (e.g. CT – Cycle Time, CO – Changeover Time, quantity required by buyers monthly, number of employees, quantity of stock, number of shift). Flow of information happens in an electronic way between buyer and production control as well as production control and supplier while operations of production control and production process happens on paper.

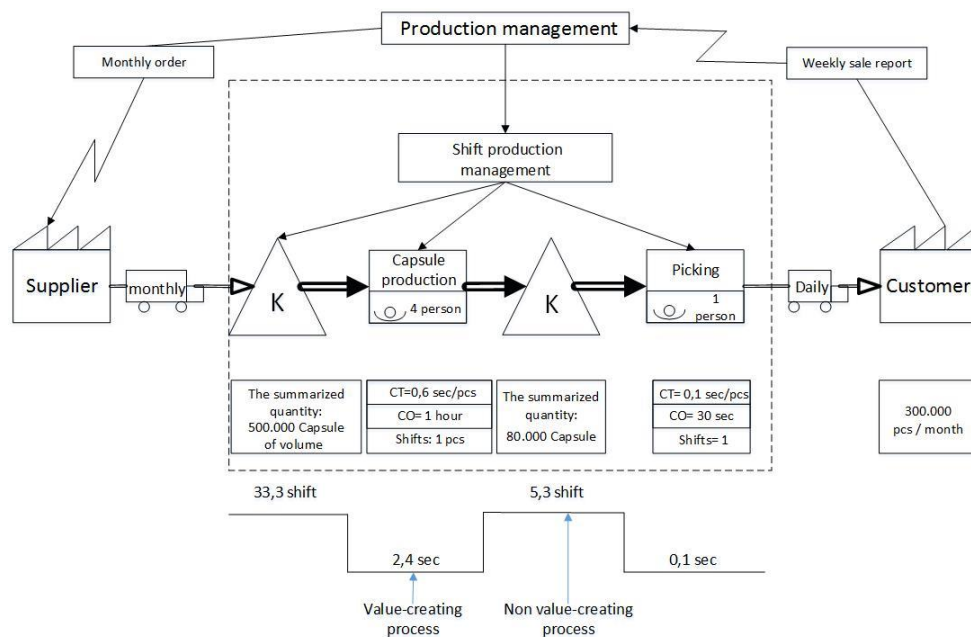


Figure 3. Current State Map

We determined the time-line components to rate the featured logistic system so the lead time of value maker and non-value maker activities. After that we determined the ratio of value maker activities.

Determined lead time:

- Store of raw material has an actual stock of 500,000 capsules which serves 33.3 shifts if the average consumer demand is 15,000 capsules per day (300,000 capsules per 20 workday in a month).
- Store of finished product has an actual stock of 80,000 capsules which serves 5.3 shifts if the average consumer demand is 15,000 capsules per day (300,000 capsules per 20 workday in a month).
- 4 people work at producing capsules at a 2.4 seconds per capsule lead time on the whole.
- The commission department fulfills consumer demand at a 0.1 second per capsule lead time.

Ratio of value maker activities: Ratio of value maker activity can be determined by the quotient of value maker activity (producing capsules and commission) and the whole lead time. This ratio is $2,25 \cdot 10^{-6}$.

3. *Signing problems on the map:* The following problems can be defined using recommendations based on LEAN philosophy:

- timing in production happens on several steps instead of one,
- flow of products based on squeezing principle instead of pulling principle,
- periodic flow of products instead of consistent,
- low frequency of ordering raw materials.

We examined the frequency of suppliers creating Future State Map.

4. *Creating Future State Map:* Checking the company's possibilities the frequency of ordinance can raise 4 times per month. Ordering often can cause higher costs because of unused capacities in transfer. Necessary modification is shown on *Figure 4*.

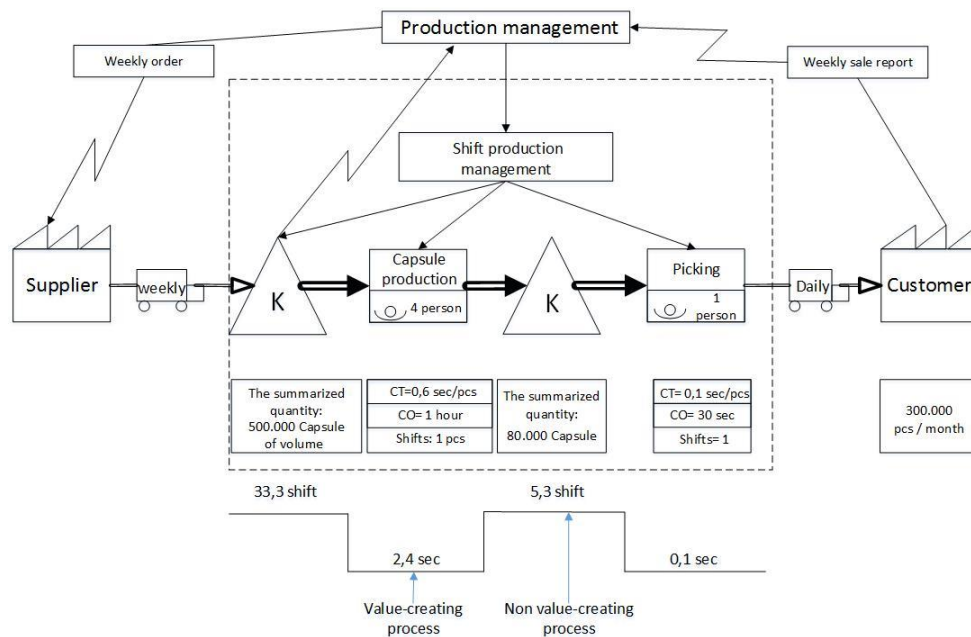


Figure 4. Future State Map

We only have to determine the lead time of stock of raw material to evaluate Future State Map (determining the ration of value maker activities). Other data are the same with Present State Map.

Determination of the lead time: Stock of raw material store on the basis of the company's stockpiling model using weekly refill (quantity of utilized product during the term*refilling time+stocked out products at one time+allowance) became 100,000 capsules. It is 15,000 capsules per day at average consumer demand which serves 6.6 shifts.

Ratio of value maker activity: Ratio of value maker activity can be determined by the quotient of Value maker activity (producing capsules and commission) and the whole lead time. This ratio is $7,3 \cdot 10^{-6}$.

We can set out on the basis of Future State Map that the ratio of value maker activities triplicates changing only monthly ordinance to weekly one. It raises the company's liquidity significantly.

5. Implementation of Future State Map: It doesn't need any investment. Only ordinance must be realized on a weekly basis.

4. DETERMINATION OF THE RESEARCH POSSIBILITIES

Steps of method of dynamic Value Stream Mapping are squarely defined while determining the method of stream improving is just trial and error, empirical and based on intuitions (possibilities are examined on the base of a simulation model). In our opinion there is a potential to work out an examination system in this field which is able to make developmental decisions that suits the most examination terms and aims using fulfilled datas of predefined data structures.

Is could give the possibility to use an examination method for those companies who produce a varied product line. It could also give a significant competitive edge to them.

We propose to work out this examination system using the following steps:

- to work out connected processes in connection with the examination system (who takes part of using the system, what are the exact tasks),
- determining connection among data structures and data charts of examination system,
- to work out possible terms and objective functions of the examination system,
- determining functional algorithms of the examination system,
- adapting these methods to Plant Simulation Framework,
- testing the examination system using practical datas.

5. DETERMINING RESEARCH POSSIBILITIES

The steps of the method of dynamic VSM are unequivocally determined, while defining mostly the way of process development is based on trials, experiences and intuitions (we examine the possibilities on a simulation model). In our opinion, in this field there is the potential to work out a test system that would be able to make development decisions that are the most suitable for research terms and aims, after predefined structures of data have been filled in.

This would enable companies who produce several product lines to have an efficient test system, which would give them a significant competitive edge.

We plan to create this test system with the following steps:

- set out operating processes connected to the test system (identify which participants take part in applying the system and the exact task of each),
- define the structure of data with the connection among databases,
- create potential terms and objective functions of test system,
- determine working algorithms of the test system,
- adapt the elaborated methods into a Plant Simulation framework.
- check the test system using real data.

6. SUMMARY

The coordinated development of the logistics system of production processes is a decisive competitive factor as it can contribute significant to the reduction of logistics cost and/or improvements of services. The applied value stream mapping method in the Lean philosophy can use very efficient in cases where it has to realize the development of a range of logistics processes. In the event of simultaneous it has to realize the production of some product families' products and their material flow processes intersect with each other, as well as the processes are characterized by considerable randomness (for example: failure of machines and material handling equipment etc.) then process improvement methods used in practice cannot be applied enough effectively. Of course, there are many attempts to develop phased manufacturing systems for logistics processes, which I discuss in detail in the form of a literature review. Following an overview of the current situation, we discuss the process of new orientation of development opportunities that is the value stream mapping method combines with simulation modeling which provides an opportunity to perform a wider range of process development tasks. The detailed elaboration of this new research requires of completion of many research tasks, which presents outline of the thesis.

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References

- [1] BAUERNHANSL, T.–TEN HOMPEL, M.–VOGEL-HEUSER, B.: *Industrie 4.0 in Produktion. Automatisierung und Logistik*. Springer Vieweg, 2014.
- [2] TAMÁS, P.–ILLÉS, B.: *Novel conception for the improvement of the logistics processes*. OGET, 2016, in press.
- [3] GUBÁN, Á.: *Organisation technology (in Hungarian)*. E-learning material, TÁMOP 4.2.1/A. 2014.
- [4] TAMÁS, P.–ILLÉS, B.: Smart logistics in the production process (in Hungarian). *Gép*, Vol. 2 (2015), 28–40.
- [5] KÁSA, R.–GUBÁN, Á.–GUBÁN, M.–NAM SON, H.–MOLNÁR, L.: The concept of perception driven service process reengineering by entropy reduction. *Pannon Management Review*, Vol. 3 (2014), 11–54.
- [6] AKÇAGÜN, E.: Using Value Stream Mapping at apparel industry. *6th International Textile, Clothing & Design Conference – Magic World of Textiles. Conference Paper*, October 7–10, 2012.
- [7] KOVÁCS, GY.–TAMÁS, P.: *Introduction and classification of production processes (in Hungarian)*. Dual education material. 2015.
- [8] ROTHER, M.–SHOOK, J.: *Learning to see: value stream mapping to add value and eliminate muda, lean enterprise institute*. Lean Enterprise Institute, 2003.
- [9] CHARLES, A.–LAURAS, M.: An enterprise modelling approach for better optimisation modelling: application to the humanitarian relief chain coordination problem. *OR Spectrum*, Vol. 33 (2011), 815–841.
- [10] LAURAS, M.–COMES, T.: Humanitarian Value Stream Mapping: Application to the Ebola Outbreak. *Conference Paper. ISCRAM 2015 Conference*, May 24–27, 2015.

- [11] SARASWAT, P.–KUMAR, D.–KUMAR SAIN, M.: Reduction of work in process inventory and production lead time in a breaking industry using value stream mapping tool. *International Journal of Managing Value and Supply Chains (IJMVSC)*, Vol. 6, No. 2 (2015), 142–148.
- [12] TAMÁS, P.: Application of value stream mapping at flexible manufacturing systems. *Key Engineering Materials*, Vol. 686 (2016), 168–173.
- [13] BIN ALI, N.–PETERSEN, K.–BERNARD B.–DE FRANCA, N.: Evaluation of simulation-assisted value stream mapping for software product development. *Information and Software*, 2015.