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Product analysis using value stream mapping

doi:10.2478/mape-2019-0047
Date of submission to the Editor: 04/2018
Date of acceptance by the Editor: 07/2018

MAPE 2019, volume 2, issue 1, pp. 467-475

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INTRODUCTION

The process of confectioning conveyor belts consists of the following activities:

- Dimensioning. In addition to the cutting machine, there is also a roll-off machine and a rewinder for the cut material.
- Joint processing – after cutting the tape at right angles, a connector is mounted, allowing quick and easy disconnection and re-joining of the tape. Another type of connection is flexproof. At the ends of the tapes are cut teeth that allow for a permanent connection. The layered construction of different types of tapes imposes the need to press them during the joining process.
- Equipping - it is installing additional elements on tapes, such as guides and carriers. The guides perform the function of guiding the belt on the conveyor during its non-uniform load, or the function that guides the product on the belt if mounted on the upper side, called the conveyor. Gears allow the product to be transported in between levels, and the product does not slip on the belt.
- Perforation – the process of making holes of the desired size, in specific places and with the right amount on the conveyor belt. Drilled holes in finished products have different functions. Tapes during operation are blown with air to keep them clean. Sometimes, the openings function as a drain. This applies to tapes that transport frozen, wet or those that are rinsed during handling.
- Inspection – tape dimensions, material quality, and whether the right connection and quality are used. It is checked whether the tape is armed with elements that it should have, whether these elements are properly mounted, properly selected, and whether the design of the tape agrees with the technical drawing.
- Packaging – the way of packing goods for shipment depends on the dimensions of the product and the mode of transport.

ANALYSIS OF THE CURRENT STATE BY MEANS OF VALUE STREAM MAPPING

The value stream map is a drawing showing the record of activities that make up the "process of wandering" of the product through the production system (Molenda, Biernot, Cierna. 2018). In the case of the analyzed process, the value stream map is to clearly present information related to:

- customer requirements,
- customer demand and its volatility,

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- how to communicate with the client,
- the form and duration of information flows within the organization,
- inventory and details of the manufacturing process,
- time needed to convert the invested cash into cash, which affects the customer.

In practice, there are strong but diverse production processes depending on the length of the production cycle (Marchwiński, Shook, Schroeder, 2010).

AREAS OF THE EXISTING STATE MAP

The production processes under investigation lead to the production of the following assortment:

a) straight and closed tapes,

b) open and closed reinforced tapes

The scope of the company's activity has been divided into several areas: customer, manufacturing process, supplier, information flow.

1. Customer. Clients are divided into the following groups:
- a group of long-term connections
- "one-time" customer
- distribution group – using products in devices, manufactured or offered by the customer.

2. The production process. The area covering the manufacturing process consists of several manufacturing operations, control operations, storage of materials and products, storage and transport.

3. Supplier. Commodity orders are realized in two ways:
- automatic notification of the need to purchase material.
- orders that do not occur systematically.

4. Information flow

Flows of information within the planning process, reporting, inventory, forwarding forecasts, demand and ordering are carried out electronically using the MRP system. All departments can cooperate with each other and communicate in a convenient and fast way. The quality of the management processes of these elements is important (Molenda, Biernot, Cierna, 2018), (Molenda, Hąbek, Szczęśniak, 2016).

IDENTIFICATION OF VALUE STREAMS

In the analysis, the method of "Group separation technology" was used. The division data on tape processing is shown in Table 1.

Table 1
Division into tape processing.

Type of product	Operations					
	Cut	Flexproof	Press	Perforation	Profile	Drivers
Straight, closed	X	X	X			
Straight, closed with elements	X	X	X			
Armed, open with fence	X				X	
Armed, clesed with fence	X	X	X		X	
Armed, open with drivers	X					X
Armed, closed with drivers	X	X	X			X
Armed, open with perforation	X			X		
Armed, closed with perforation	X	X	X	X		
Armed, closed, type „Full”	X	X	X	X	X	X

THE VALUE STREAMS REPRESENTATIVE

The selection of the appropriate representative of the analyzed value stream must take into account several basic criteria specific to the product.

- high rotation in the map, a period of time,
- cover the most operations,
- shipments of this product should correspond to the average shipments of all products produced in this stream.

Figure 1 shows the course of the operation which the representative product is subjected to.

Fig. 1 Operations to which the representative is subjected

ANALYSIS OF SHIPMENTS

Seasonality

Shipping data for 2014-2018 is shown in the Table 2.

Table 2
Number of sent products in 2014-2018

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	2014	14	15	14	10	40	38	36	46	44	20	44	17
	2015	15	20	18	18	42	30	37	50	38	21	38	15
	2016	18	13	17	24	50	30	37	50	38	25	39	16t
	2017	14	15	15	26	42	29	35	49	40	20	47	18
	2018	19	12	16	22	46	31	35	50	40	24	52	14

The average shipments of 2014-2018 expressed in units for particular months are shown in the graph below (Figure 2).

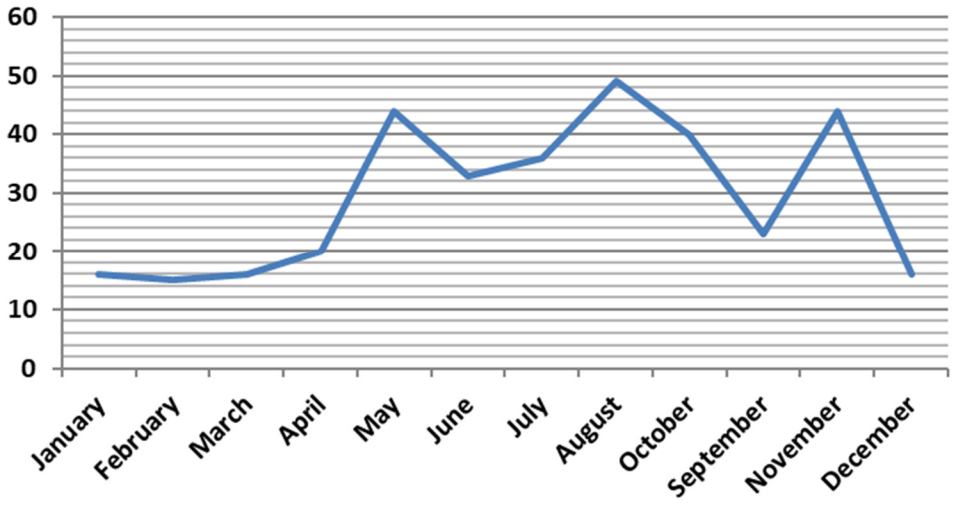

Fig. 2 Average shipments in 2014-2018

Average daily requirement

Table 3 presents orders in the period from July to September 2018.

Table 3
The representative's orders in the part of 2018

Type of product	Orders													AWD – average season	ADD – average season	Average deviation [quantity]
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13			
Representative [quantity]	6	10	9	7	12	12	8	11	15	9	7	6	12	9.54	1.91	2.27

Using the data from the table above, it is possible to determine the tact of the client enabling the determination of normal generating capacities. These abilities are ten pieces per week, while going to one day they are two pieces per day.
The ability to fluctuate such as reducing or increasing production by three is the best for the company.
Counting the customer's measure, you need the time available in one day, and the average daily demand for stream products. This can be determined at the level of eight hours per one piece.

ANALYSIS OF THE MANUFACTURING PROCESS

Table 4 shows the times that are needed to process a product at a given workplace.

Table 4
Data for production processes

	Proceses						
	Cut	Flexproof	Press	Perforation	Profile	Fence	Packing
Machine cycle time [s]	420	120	1800	900	24000	8000	300
Product cycle time [s]	420	120	1800	900	24000	8000	300
Adding value [s]	350	90	1500	850	22000	6000	250
Changeover time [s]	300	220	600	600	360	1200	100
Number of product/cycle [quantity]	1	1	2	1	1	1	1
Time in day [h]	16	16	16	16	16	16	16
Number of positions	1	1	1	1	2	1	1
Number of operators	1	1	1	1	1	1	1
Amount of product	1	1	1	1	1	1	1

In the case of ironing, it is possible to process several pieces of tapes in one cycle. The number of tapes that can be ironed at one time depends on their width. Representative is a belt with a width of six hundred millimeters, and the capacity of the device used for this process is one thousand four hundred millimeters. In the case

of the profiling process, multi-workshop support can be used. One employee handles two or more workstations in this case. In others from processes, one employee only supports one work station.
In-house transport is carried out using: human strength, electric trolleys with or without electric drive and an electric forklift. The method of transport depends on the dimensions of the product. The goods are transported by an employee who has been working on the product entrusted to him, he has completed this treatment and transfers the product to the next position. The employee decides how to transport the product because he is familiar with the legal regulations regarding lifting, and is obliged to choose a safe way to health and life, and at the same time the fastest.

Table 5
Transport of materials

	Place of transport						
	Magazine – Cut	Cut – Flexproof	Flexproof – Press	Press – Perforation	Perforation – Profile	Profile – Fence	Fence – Packing
Kind of transport	Forklift	Forklift/ manually	Trolley/ manually	Trolley /manually	Trolley/ manually	Trolley/ manually	Trolley/ manually
The length of route [m]	200	20	20	90	15	15	90
Time of transport [s]	40	16	16	70	12	12	70

STOCK ANALYSIS

The material that is delivered to the work station has no target dimensions. During processes, some of the materials provided are considered as production waste, or returned to the warehouse for production materials such as:

1. Cutting station: the material provided is a roll of material which is cut into six hundred millimeter wide belts, and the rest of this material goes to the warehouse,
2. Flexproof: where by punching the connecting teeth the right dimension of the tape is obtained in terms of its length. The rest of the material goes to the warehouse,
3. Profiles: To make one profile, you need a length corresponding to the length of the tape and the finishing allowance used to connect the profile. The rest of the profile goes to the warehouse,
4. Strippers: additional material occurs in sections about two thousand four hundred millimeters long. The unused portion of the material returns to the warehouse.

THE MAP OF CURRENT STATE

Completing the current state map, information is used on: customers, suppliers, direction of information transfers, machining processes, material transport, problems. The main problems are: confusion with stocks of production in progress, postponing orders for their completion, chaos at workplaces, poor performance of used equipment, or untimely execution of orders. It shows Fig. 3.

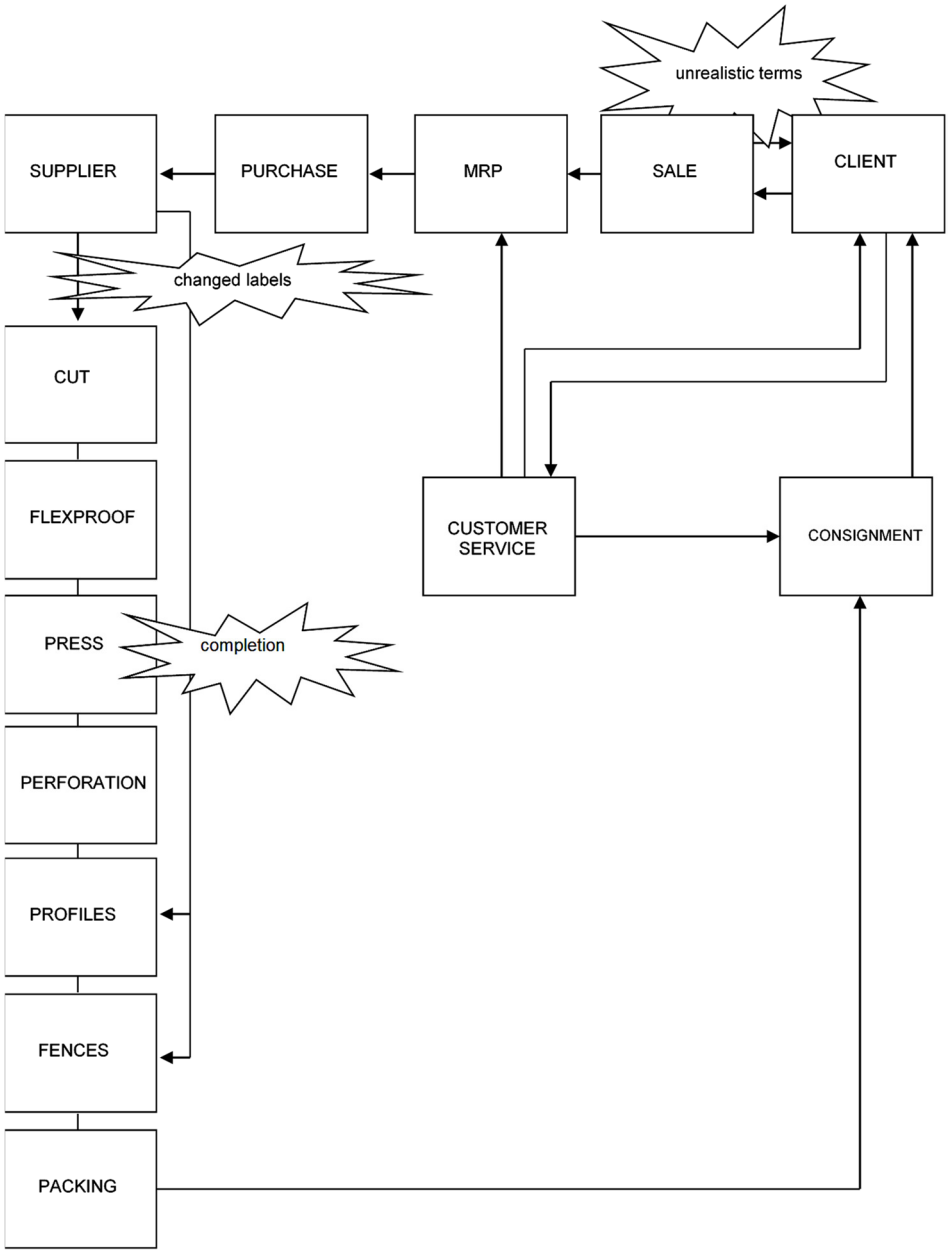

Fig. 3 Map of the current state

DISTURBANCE IDENTIFICATION

On the map, the existing problems identified in the fabrication department, warehouse area and in the area of customer service were marked. The existing problems are summarized in Table 6.

Deposition of production materials in progress – ironing; problem affecting production on days when there are a large number of orders that need to be sent on the same day. The picking is done by employees to improve the process, but this is not always the case. The situation does not occur if the number of orders is not large, and employees can freely process the material that reaches the workstation on an ongoing basis. The completion of the picking process may be an improvement for the problem, but in another place in the production process.

Table 6
Existing problems

Lp.	Problem	Reason I	Reason II	Reason III
1	Depositing production materials in progress – press	Depositing production materials in progress - ironing	Pressing devices allow you to press up to 2 pieces of tape of the same size	
2	Chaos in the position – fence	low productivity of the production equipment fences and long changeover time	little space for production in progress stock	there is no space for storing tapes already prepared for processing
3	Replaced labels in the warehouse	lack of concentration of employees with simple tasks	no control of labels with actual dimensions by warehousemen	
4	Ignorance of the production process by the customer service department	bad way of training new employees	lack of time for training on production for new employees	
5	Unrealistic deadlines for certain orders	urgent orders – urges from clients	lack of knowledge about the time which is needed to execute orders being in production	lack of adequate knowledge about product processing by the customer service department, setting too short delivery times

Chaos on the stand – drivers; the problem occurs only periodically and concerns the time when there is a large number of orders in production. The machine used at this station allows shortening the heating cycles of belt carriers, but at the expense of the quality of connection with the belt. The company values customer satisfaction the most, so it can not afford to deteriorate the quality of its products. Orders awaiting processing are placed in specially designated places.

Replaced labels in the warehouse; the conveyed belts from production to the warehouse are marked with labels. There are situations when the dimensions of the tapes do not correspond to the dimensions given on the labels, or when the material is different from the one given on the label. The situation may be caused by inadvertent placement of labels on the tapes. Errors of these types can occur throughout the entire production process. The solution to the problem is the obligation to check the width of the tapes before attaching labels to them. Also, check the width of the belts at the stage of processing.

Checking the width of the tape, which takes about three to five seconds, should be a standard. This eliminates unnecessary machining's carried out on bad-sized tapes and ultimately delivery of bad-sized tapes to customers, which results in a complaint

Ignorance of production processes related to the customer service department – the problem is directly related to the next problem: unrealistic deadlines for certain orders. Problem regarding orders with short lead times, so-called urgent orders. Establishment of such orders takes place between the customer service staff and the client. Employees of this department can rarely determine correctly how much time is

needed to complete the order. The solution to the problem is the knowledge of production processes by people deciding on the time of order execution. The problem is also the lack of direct contact between production and the customer service department, which makes it impossible to monitor the work load in the production area. An employee of the service department who sets deadlines for the order should take a correction for those orders already in progress (Midor, Zasadzień, Szczęśniak, 2015), (Zasadzień, Zarnovsky, 2018)

CONCLUSION

Within one year, three periods can be distinguished: when shipments of the product recognized as a representative of the value stream are at a high level. The best period is the months of July-September. This period is characterized by the customer's ten-piece per week. Such quantity of product can be produced only when the production process will be smooth and not carried out at the expense of other products. In order to ensure the harmony of production processes, cooperation between company departments must be described as impeccable.

Among the identified disturbances, attention should be paid to disturbances related to the state of in-process inventories regarding the production capacity of machines used in production. A significant role is also played by the problem of poor knowledge of production processes by people working in non-production departments.

Proposals for solving the problem include training systems for employees in departments related to production processes and a department that has an impact on setting deadlines for orders. In improving the subject of stocks, the most important role is played by the correct way of completing orders during the planning process, as well as investments in the development of the machine park of the enterprise. Investment in additional machinery and equipment will allow to increase the possibilities where machines are not able to ensure smooth flow of materials, and ultimately cause delays in the delivery of products to customers.

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Abstract. The sales market requires both the highest quality of offered goods and satisfactory prices for the buyer. In addition to the reliability of the important aspects are also the time of order fulfillment, reliability, readiness to act around the clock, and service of sold goods after their sale. In the production and confection of conveyor belts, the priority is a customer who, having strictly defined product requirements, also has individually focused goals. To meet these aspects, you need to look after the product both during its production and after. The products of this industry are specific, so that they can be used, after sales service is often required to be installed at the customer and possible actions to maintain their good condition during operation. The article analyzes selected production processes of transmission belts to identify disturbances. The analysis uses the value stream mapping method. Then, improvement methods were proposed.

Keywords: value stream mapping, production process