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Value Stream Mapping Demonstration on Real Case Study

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Abstract

The aim of this article is a practical demonstration of Value Stream Mapping method (VSM) for visualization and rationalization of processes and its use in the context of a real enterprise. Own philosophy of a method lies in a view of the value-chain “from doors to doors” among all important transportation and transformation processes flowing in a company since receiving of raw materials and semi-finished products from suppliers to final delivery of finished products to a customer. Processes within VSM are strictly separated in to the two groups: Value-Adding Processes (VA) and Non-Value-Adding processes (NVA). The outcome of a VSM method is a diagram presenting a value flow in a company. Trough VSM is possible to identify places of piling inventory, calculate a lead time and realize how many percent of a time are Value-Adding and how many are not. The VSM flow diagram and its calculated indicators are used in next step not only as a tool of communication in problem solving processes, but also as a clue for improvement, visualization and description of a future state. The importance of a VSM method is rising together with the level of management. With help of VSM it is possible to generate small and continuous improvements of operative character or to generate huge and capital intensive strategic projects which lead the company directly to fulfilment of all its stated goals and mission. VSM is primarily an analytical method which purpose is to identify bottlenecks and potentials for improvement at all levels of the process.

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1. Process management and its overlaps into strategic management

Nowadays successful companies commonly use methods of lean management with the aim to eliminate waste and find significant cost savings. There is no guarantee of maximum savings and efficiency in simple

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implementation of lean management methods for the company [2,7]. Maximum savings can be achieved only by long term process management. The process should be systematically measured, their performance analysed, there must be an adequate response to the identified anomalies and finally current set up of processes must be continually improved. In recent years the process management became one of the most effective tools used by enterprises to struggle with consequences of the last economic crisis, which resulted in decrease of consumers' demand and into change of consumers' behaviour [15]. Nowadays, surviving enterprises are heading to implement lean management methods. But only by implementing all of these techniques and methods into business processes and business culture we cannot ensure the bright future for our enterprise [1,7]. If we want to dramatically increase our chance to success it is important to standardize properly all important business processes, measure and analyse their performance, react correctly to detected anomalies and malfunctions and finally continually improve current process setup [6]. The last mentioned thing is also the main reason why the process management was developed.

From management point of view every important business process should have at least one performance indicator (so-called Key Performance Indicator, KPI) [12], which purpose is to assess real process performance according to its goals in real time. Identified differences between these two states (real vs. optimal) subsequently initiate a process improvement. There is no strict rule about an optimal manageable number of KPIs, but all of them have to be connected with strategic goals of a company, because they reflect company's connection with inner and outer circumstances and they set a direction to future state of company according to its mission. All of these strategic goals are usually transformed from their strategic level into operational level by sophisticated management methods like Balanced Scorecard, EFQM and more [1,3,4,6,9,10].

2. . Value Stream Mapping

2.1. VSM principles and its mission

The Value Stream Mapping (VSM) method was introduced in a second third of twentieth century by the Toyota Motor Company and after that promptly became one of the fundamental methods of the lean management [8,15,16]. Its philosophy stands on graphic presentation of value chain flow from door to door within a company – in other words from receiving customer's demand through all logistic and transformation processes to delivery of final product. The VSM method strictly divides all processes into two groups: Value Adding (VA) and Non Value Adding (NVA). The outcome of a VSM is chart presenting value flow across whole company, where is subsequently possible to identify a place of heaping inventory, find out a total manufacturing lead-time or realize how many percent of this time are VA in other words how long are inventory items inactive and stored in warehouse shelves. On the one hand the VSM map itself may work as a clue in following decision making and process-improvement processes. On the other hand it may be used as a future state visualization tool, see Fig. 1 [16].

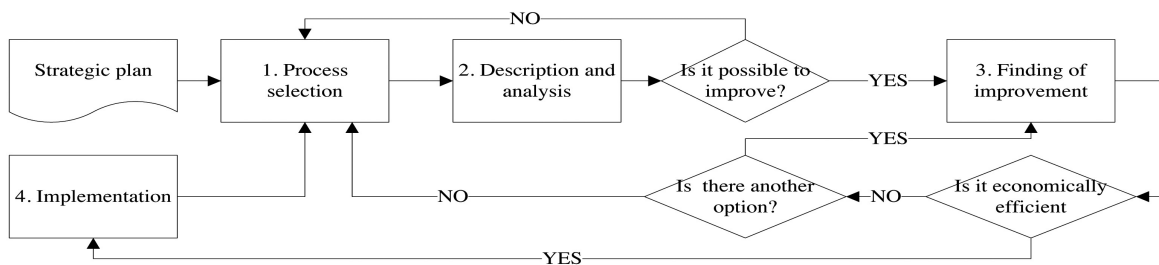


Fig. 1. Process improvement procedure [16].

The VSM is a graphic method using rich amount of icons presenting each important element within value chain. Whole procedure stands on realizing of customers' tact time (customer demand in time flow), which is subsequently compared with a current production performance. Calculation of VA time is simply done by sum of VA processes continually from the first to the last. Same procedure is also used in calculation of NVA time.

Purchaser Supplier	Department	Purchase	Warehouse	Electronic information	Operational communication	Process	Inventory
Transport flow	Consumption	Information	Signal supply	PUSH	PULL	Traffic kanban	Consumption kanban
Production Kanban	Batch to expedition	Lorry Transport	Mech. handling	Handling	Conveyor	VA line	Shift foreman

Fig. 2. Icons used in Value Stream Mapping from MS Visio.

The most important item of NVA processes are inventories. Their value presents the period of time when enterprise is overstocked according to its tact time. Value of this indicator may be calculated by dividing the number of stored items of product-material (according to its bill of material) by the number of their daily need (as a result of customers' demand). Mission of the VSM is to eliminate all these needless inventories and reduce finances allocated in them. In the next step these finances could be used for example to stabilize Cash-Flow, paying of extra dividends or to finance new projects. There are usually various hidden problems behind inventories, which make achieving of approved strategic goals much more difficult. The VSM method usually directly initiates finding of the appropriate solutions.

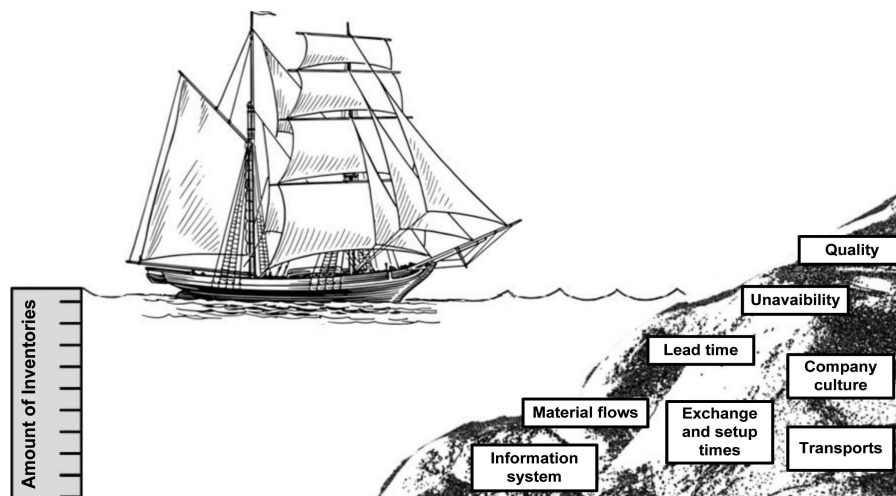


Fig. 3. Malfunctions hidden behind inventories.

2.2. Key performance indicators in real use

Studied enterprise is a manufacturer producing plastic products dedicated to pharmacy and health care industry. Company utilizes many of the modern project and process management methods (Six sigma, TQM, 5S, SMED, Kaizen and etc.)[2,7].

There are several approved strategic goals for years 2014 – 2018, which are divided into three main thematic groups:

“Q-group” - quality goals dedicated to manufacturing processes

“L-group” - logistic goals dedicated to logistic and storage processes

“C-group” - cost goals dedicated especially to personal costs

All strategic goals are more specified by using of the Balanced Scorecard method onto yearly/ quarterly/ monthly/ plans which contain several of KPIs. Results are mandatory for all levels of management to reach. Table 1 represents very simplified original KPI document used at studied company.

Table 1. Typical KPI document.

Quality		Affiliate		Affiliate XYZ		
Nr.	Cost	Responsibility	CTO, CFO	GOAL 2014	I. 2014	II. 2014
	Logistics	KPI 2014				
1	C	Added value / employee / hour	EUR	35,67	26,29	34,15
2	C	Personnel costs / revenue	%	14,5%	19,7%	14,3%
3	L	Inventory: RAW MATERIALS	Days	77	71	79
4	L	Inventory: SEMI-FINISHED PRODUCTS	Days	12	13	13
5	L	Inventory: FINISHED PRODUCTS	Days	7	7	6
6	Q	5S [Max Score = 4 points]	Points	2,97	2,73	3,02
7	Q	Rejection / revenue	%	1,83%	1,06%	3,20%
...

These KPI documents are often presented to the TOP management as a primary source of information about company's performance. The KPI values are often averaged to the level of whole company and differences among each product groups' performance are blurred among of thousands of stored items or between departments' costs. This arithmetic-average-trap makes its primary function fulfilment (identifying of waste and malfunction within a value chain) much more difficult.

2.3. Choosing of a representative value chain within an enterprise

Only the L-group of KPIs will be focused and analysed in this paper. First of all it is necessary to choose concrete product line and map its value chain from door to door. In this case, weakness of the VSM is impossibility to draw all product lines within a company at once into one map according to its potential illegibility of the final VSM map. It is not necessary to map all product lines separately – especially if all produced items share the manufacturing technology (in this case automatic plastic injection moulding machines and automatic montage). It is necessary to choose one etalon which could describe all VA and NVA processes of a company in as much accurate way as possible. In this case Pareto's 80/20 principle is used. Pareto's principle is implemented with method of differentiated management known as the ABC method [5,9].

Studied enterprise produces sixteen product groups where only three of them (A group) take together over seventy percent of all logistic costs. With regards to this phenomenon and shared manufacturing technology among all product lines one of the "A group" product lines to draw a VSM map was chosen.

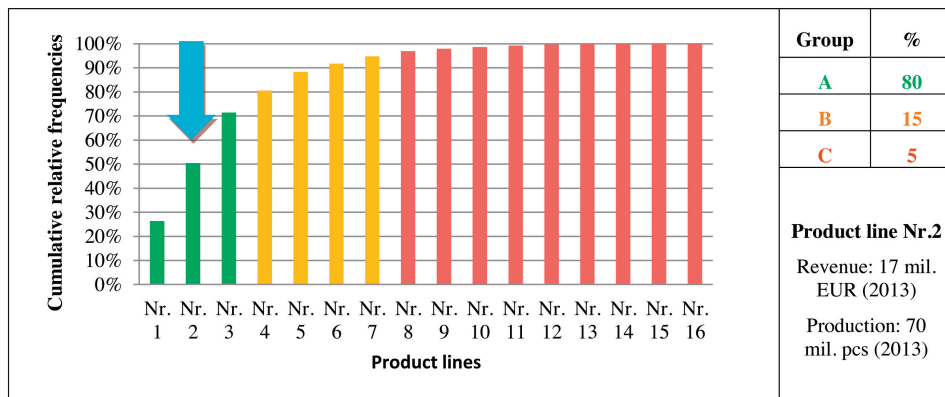


Fig. 4. ABC analysis [16].

3. Creation of the VSM current state map

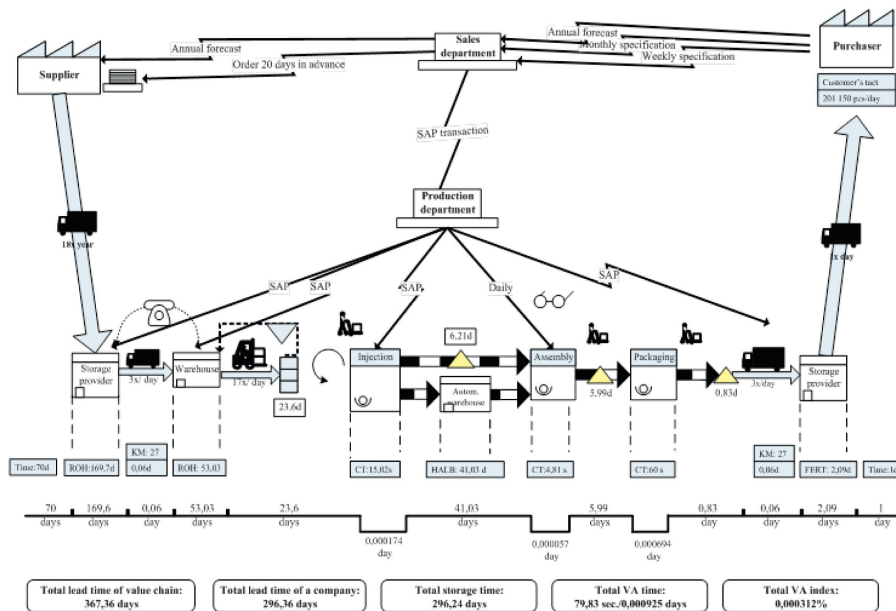


Fig. 5. Current state map.

3.1. Performance evaluation

Using the VSM method on selected value chain provides information about logistic conception which obviously depends on external outsourced storage capacities dislocated 27 km away from production facilities. At the first glance the VSM map indicates that current logistic conception is highly demanding on transports between manufacturing and warehouse (as a result of number of “lorries icons” located across value chain). Lead time takes about 296 days although it should take max 96 days according goals in table 1 (RAW 77 days + SEMI FINISHED 12 days + FINISHED 7 days + VA time 79 sec = 96 days). Figure 6 graphically demonstrates problem with this value chain.

The VSM map informs about non fulfillment of approved KPIs although the KPI document with real values claims opposite standpoint. At this point the arithmetic-average-trap at selected company arises. The reason is that there are fifteen other value chains next to the selected one for VSM analysis.

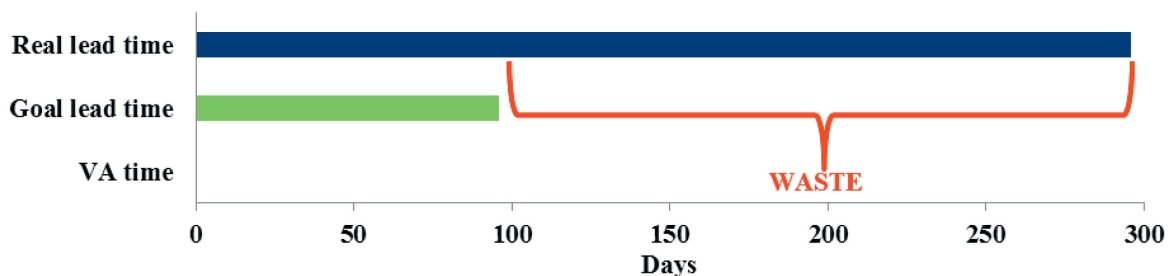


Fig. 6. Comparison of real total lead time with goal lead time.

In this particular case there is about 276 000 EUR of own financial resources bounded in these inventories. Unnecessary inventories demands 100 EP (palettes) of additional capacity at external storage. Financial loss due to this unnecessary inventories is combination of waste in form of not using disuse mentioned 276 000 EUR to better investment activities (for example investing into state bonds) and cost connected with storage. As a result we calculated these additional costs are 16000 EUR annually. It is important to mention that this number is connected only with one particular product line so there is a possibility that reality is even far worse.

3.2. Analysis and problem solving procedures

The VSM analysis gives an impulse for identification of particular root causes causing problems across value chain (i.e. by 5 Whys method, Ishikawa Chart, 5W2H, and etc.) [11]. The VSM method is only analytical method and does not removes the problems or root causes by itself. It is necessary to fix identified problems by other means for example by lean methods.

4. Creation of the VSM future map and identified problems, their causes and proposals for potential improvements

In general the majority of identified problems were hidden in an initial setting of current logistic conception which presents itself as too far administratively and logistically difficult to manage. There are way too many interactions between variable human factors on all levels of management with big amount of transports which leads to errors and waste. Solution is in suppressing the role of human factor within all purchase, quality and storage processes [13,14,17]. The table 2 presents all identified problems, their initial causes identified by method 5 Whys and possible solutions identified by brainstorming discussion with responsible workers of a company [11].

Table 2. Identified problems, its causes and potential solutions.

Identified problem	Initial causes	Proposals to improve
Inappropriate current logistic conception (high costs in future)	Insufficient setup of employees' competencies and controls	Reassessment of employee competences
Big amount of inventory across value chain	Implemented but not strictly required PULL system philosophy in company culture	Implementation of strict deadlines to solving of material blocking (quality acceptance processes).
Existence of old inventory items	Information system was not set up appropriately during its implementation 2 years ago	Creation of special VSM report informing about age and amount of inventories of each product line
Arithmetic average trap in KPI documents	Investment of company capital only in production facilities – lack of storage capacity.	Implementation of strict PULL system through the KANBAN system.
		Construction of own logistic center near production facilities

Suggested improvements could be divided into three main categories:

- Simple incremental improvement with small investment costs
- More difficult improvements within current logistic system
- Radical process reengineering improvement

Each proposed improvement helps to ensure fulfillment of L-category KPI, whereas a combination of several of them could affect more widely. For example an implementation of barely costless special VSM reports could reflect about structure and age of inventories more accurate than ordinary KPI documents and subsequently it would prevent arithmetic-average-trap from happening. On the other hand managing of inventory in that way will require additional administrative activities connected with creation and managing the VSM documents. All of these improvements somehow help to solve the most important problem of current state logistic conception – amount of transport and costs. According to the approved production plan for years 2014-2018 amounts of manufactured goods should rise for 59% and costs for transport and using of storage capacities should rise for 163% within this period. At this moment there is a discussion about possibility to abandon current state of logistic conception and construct own logistic center in the area of company and save annually about 1 million EUR of own financial resources.

For small projects simple term of recoverability (SToR) is enough. More sophisticated economical methods which operate with discounting and risks, such as NPV, IRR, EVA, MVA, CFROI, risk management principles and etc. are suggested for bigger projects. To determine which from suggested solutions are worthy to implement in terms of limited financial sources, a portfolio attitude together with mathematical optimization used for decision making processes is recommended. The final combination of projects would be as most efficient with regards on limited budget.

In a case of simple improvements (especially when administrative processes are improved) it is difficult to identify accurate investment costs. They may be seen for example in organizing of special workshops, paying of external specialists, paper, pens and in employees' work time. Almost the same situation occurs during identifying of improvement's Cash Flow (for example work time of employees preparing special VSM rapport versus its positive consequences within inventory management). This phenomenon makes economical evaluation of these simple improvements much more difficult and sometimes it is better to make decision based on the practical intellect of responsible manager than on hard numbers.

Paradox is that much simpler and methodically more accurate to evaluate bigger investment project based on cost calculation. In the case of construction of logistic center the identified investment costs are 4.5 million EUR with an assumption of project's implementation at the beginning of year 2015. Internal regulation of the company claims that all big investment projects (production facilities, warehouse halls, etc.) has to be profitable sooner than in eighth year of its existence. Proposed project of a logistics center accomplishes these criteria even in its discounted form DToR (discounted term of recoverability). Positive outcome is indicated also by values of NPV and IRR (own capital costs = 7.71%). For more information see table 3. The final appearance of a value chain improved by all suggested improvements is presented on the picture 7.

Table 3. Evaluation of economic indicators .

Investment	NPV (2022)	IRR (2022)	ToR	DToR
4,9 mil EUR	625 781 EUR	11,25 %	4,84 years	6,06 years

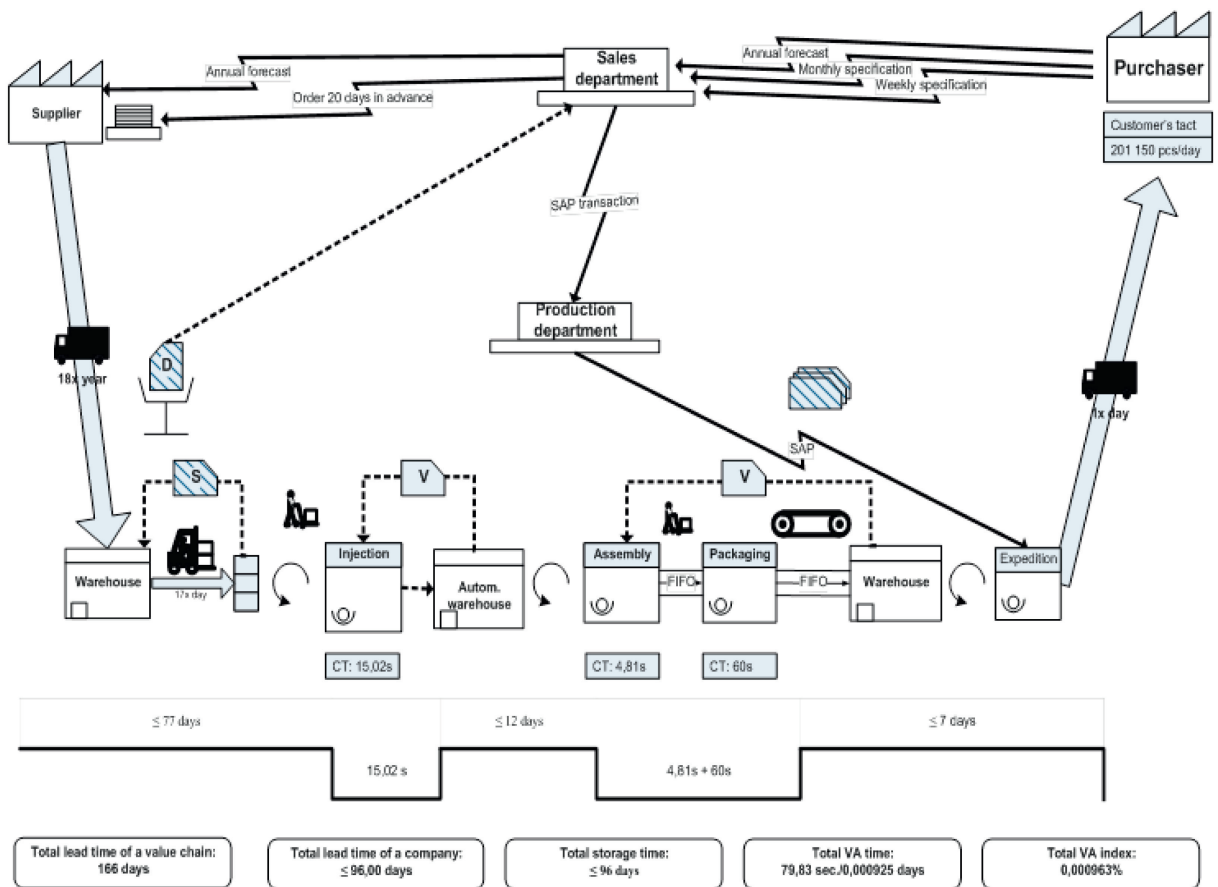


Fig. 7. Future state map.

Table 4. Comparison between current state and potential future state.

	Original value	New value	Improvement (%)
Total lead time	296,36 days	96,00 days	208,7%
Total VA time	79,83 seconds	79,83seconds	0 %
VA index	0,000312%	0,000963%	208,7 %

As shown in table 4, all suggested improvements have potential to fulfill approved KPIs and show three times higher efficiency in comparison to current state. The effect of using the VSM is in better functioning processes and therefore in better Cash Flow and the financial area of the company.

Until today all three proposed simple incremental improvements (assessment of employee's competencies, strict time deadlines for quality acceptance processes and preparing of special VSM reports) were implemented.

Conclusion

The goal of this article was to introduce the Value Stream Mapping method used for description, analysis and finding of suitable improvements within processes of a real enterprise. Responsible management representatives should always keep in mind the primary mission of their business and the strategic goals, because all of these elements (usually transformed into values of Key Performance Indicators) affect the way of future development of an enterprise itself.

Analyzed enterprise is a manufacturer producing plastic products dedicated to healthcare industry.

Key performance indicators in analyzed company are divided into three groups: cost, logistics and quality. In this article only L category of KPIs which informs about efficiency within logistic processes across whole value chain from door to door was analyzed. VSM method was applied onto one of the most logistically demanding product line. Particular problems which make efficient management of logistic processes much more difficult (as well as fulfillment of approved KPIs) were found. The lead time was 296 days which exceeds expected performance set up by top management (96 days) more than three times. Result of the difference between these 2 values is additional 100 EP of inventories dislocated at external provider and also additional 276 000 EUR of unusable financial resources tied up in the inventories. If there was no change in that state, it would take over 16 000 EUR annually as a result of inventory handling and management and consequence of lost opportunity costs. All these values are connected only to one from sixteen product lines. The real situation may be much worse. Another detected problem was a current logistic system based on external storage capacities as a result of lack of own storage capacities. This system is too far depended on transports and number of administrative processes and its usage in the future may cost another 1 million EUR of opportunity costs.

Application of VSM method uncovers number of problems and bottlenecks in company logistic processes and 5 improvements was suggested. All proposed improvements have an impact on effective KPIs fulfillment and process cost and effectiveness optimization. If the company will use VSM techniques repeatedly in future, it could result into even more positive outcome to business effectiveness and financial health.

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