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USE OF THE METHOD VSM TO THE IDENTIFY MUDA

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Abstract: Managing the enterprise by Lean Manufacturing concept consists in eliminating the errors and limiting the 3M (muda, mura, muri) but also increasing the efficiency of the processes which adds the value and shorting the duration of activities which are necessary but not generate the added value. Implementation of the solutions of the lean area gives measurable results, that is why lean toolbox is implemented in many economic branches. First phase of the efficiency improvements in the enterprise is the analysis of the actual status. The article presents an example of the value stream mapping method usage (VSM) for the chosen product.

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1. INTRODUCTION

The rules of the Lean Manufacturing reflect to the optimization of the tasks and processes in the production and service industries. This optimization is multi-criterial and multi-dimensional. That is why resolving this kind of the problem takes long time and is hard but also ambiguous. Enterprise is an example of complex system which is dynamic and differs in the time showing instability due to the environmental changes. Quite often organizations are trying to make a lot of the same products and after that there is a long process of reorientation for different series of production. This kind of organization imposes the usage of the magazines between operations which leads to increasing the level of the work in the process – WIP (Nyhuis, 2009). Gathered stocks are blocking the assets, take place in the magazine and make the whole process longer. In result the production system is limp and indisposes fast reaction for the market situation. Moreover – the time between the start of the process and its' finish is very long.

Idea of the "thin" approach according to lean is the change of the muda (Womack, Jones, 2001). Muda is the Japanese word which means waste. All kind of actions which require the work but do not create the added value are waste. There are two muda types: first which are the actions which do not add the value to the client but are indispensable and impossible to eliminate and second which are the actions which do not add the value but it is possible to remove them and those should be removed in the first place. There are seven different types of the waste which are named 7M: (1) overproduction, (2) redundant stocks, (3) outages (like waiting for the next step of the production process because of the people's inactivity, (4) unnecessary transport, (5) not valid methods of production (like using the wrong methods or tools), (6) redundant motion (like non-ergonomic management of the space or wrong organization of the workplace), (7) production of the defective products (Womack, Jones, 2008).

There are two different groups of losses which can appear in the enterprise: mura and muri. Mura affects the losses which appear because of the variability of the processes. This variability affects the quality of the product, quality of delivery, changes of the cycle's times and changeable costs. Muri affects the losses which are connected with the overuse of the stocks and human resources. Effect of the planning and scheduling of the tasks which exceed the abilities and possibilities of the individual is the bigger amount of the accidents and greater frequency of the failures of the devices. Muri affects the wrong exploitation of the human resources as well. Minimization of the losses of muda, mura and mudi (3M) types is the rational solution which limits the tasks generating costs of the whole production system. Lower production costs, flexibility of the crafting system and the stability and the repeatability of the processes and crafts make the enterprise competitive on the market with good products and low cost (Imai, 2006). However it is important to set the value from the client's perspective and identify the areas of the 3M losses. To do it properly,

it is necessary to identify all the operations of the process and the Value Stream Mapping method (VSM) is a tool which is really helpful (Rother & Shook, 2009). The main purpose of the thesis was the usage of the VSM method to present the chosen process of production and identification of the wastes in the efficiency and quality areas. The actual status map which has been created is a first step in the process of the project based on the Deming cycle (also known as PDCA – Plan-Do-Check-Act). This method consists in planning the recovery actions and then applying those and checking the results and pointing potential benefits. If the new actions bring the benefits – it is important to implement them as a standard in the future endeavors and just monitor the progress.

2. VALUE STREAM MAPPING

The mapping of the value stream is a tool which is easy in use and easily available as well – both for big and small enterprises. It does not require the use of complicated and expensive software. To create the map you need only pen and paper. The mapping process is about going through the way between the client and the supplier. The map is made using the idea of "go and see" (The Productivity Press Development Team, 2013) which enables the direct contact between production employees and the operators. Managers tend to forget that the employees, their knowledge about the process is crucial whilst identifying problems and their causes. The knowledge of the operators is really important whilst planning the changes and improvements of the production processes. Extremely valuable is also the use of the mapping of the values' stream. It has a crucial meaning to the improvement process in terms of the enterprise. We can divide the mapping process to four phases (Rother and Shook, 2009):

1. Value Stream Analysis (VSA),
2. Value Stream Designing (VSD),
3. Value Stream Work Plan (VSP),
4. Analysis of the effects.

There are some relations between phases and going through all the steps makes the process the most efficient. Making a map of the current status is not enough and it is really important to prepare the map of the upcoming status as well. Working on the VSD map is a required phase. About it there is a place to introduce the project. Time needed to achieve the predicted effects is dependent on the amount and the level of advancement of the planned Kaizen or/and Kaikau changes. This kind of the algorithm is a base of regular improvement. Continual improvement of the processes with the use of the values' stream maps is an algorithm of processes based on the Deming cycle. After the fourth phase there is a need to evolve the current map of the

actual status which will be the first step in the process of the development of the map of the upcoming status and the plan of the improvement tasks.

2.1. VSA – Value Stream Analysis – case studies

Enterprise which has been analyzed produces high quality skis, snowboards and kiteboards. This firm produces it using its' own brand but also as a outsourcer for other companies. First step of the efficiency improvement processes is to analyze current status of the enterprise. It is important to choose the products which will be analyzed. After choosing it, the firm is able to create the production process scheme. It is important to gather all the information about the stocks, pauses, deliveries, etc. It is also necessary to identify all the waste. The company has to set the fundamental parameters which describe the process but also set the exact chronometers of time predicted for particular actions. After gathering all necessary data the firm is able to create the map of the current status.

Due to the fact, that majority of actions is production of the skis, it has been decided to create the map for this products. The skis' models can be divided in a few different ways: by construction, fabric used, graphic and sideslip technique and the way of edit. Going along the value stream there has been created general scheme of all technological operations whilst producing the skis. Depending on the model or specification, the way of producing can slightly differ, but the basis of the operations is invariable for the whole family of products. First picture presents simplified scheme of the flow of the analyzed production object.

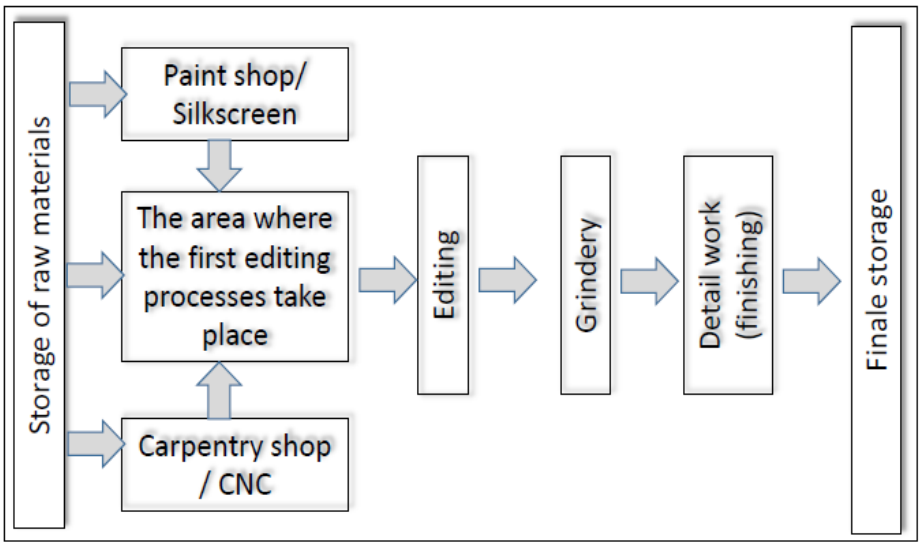

Fig. 1. Simplified scheme of the material flow

Going along the value stream enabled identification of the waste on the certain steps of the production process. The list of all kind of muda classified and enlisted below (according to the branches, not processes):

Carpentry shop – pending, unnecessary movement of the employee,

The area where the first editing processes take place – overproduction, pending, stocks, unnecessary movement of the employee,

Editing – stocks, pending, production of the defective parts, unnecessary movement of the employee,

Grindery – unnecessary transport and employee's movement,

Silkscreen – overproduction, stocks, production of the defective parts,

Paint shop – production of the defective parts, over-editing of the parts, unnecessary transport,

Detail work (finishing) – unnecessary transport and employee's movement.

Whilst stepping to the identification of the particular operations of the technological process there have been some parameters chosen. Those will be used whilst quantitative and quality analysis: Processing Time and Value Adding Time. For all the operations there have been created chronometers – for each the series of thirty repetitions or more. From the results there has been calculated the median which was the basis for setting the standard of the task. Median has been chosen because it is more accurate than mean average in case of the collection of the random events. Table 1 presents cumulated times of processing and adding the value for the main areas in which production processes take place. Value Adding Time and Non Value Adding Time are for the batch of 20 pieces (and clearing unit). Batch of 20 pieces is set accordingly to the maximum capacity of trolley track.

Table 1. Cumulated times of processes for the batch of 20 pieces

	Storage of raw materials [s]	**Carpentry shop [s]**	**First editing [s]**	**Assembly [s]**	**Grindery [s]**	**Paint shop Silkscreen [s]**	**Detail work [s]**
VAT	40	26 308	24 008	51 748	23 062	16 320	37 454
NVAT	7 240	37 476	36 628	67 586	31 460	$1.83*10^6$	6 116

It is impossible to set the exact, unified time for all departments on the analyzed production process. Each of them works differently and all operations is treated specifically. Lack of synchronization between certain departments impedes the planning of the production and implementation of the tasks within predicted time. That is why it is necessary to make changes all the time and also prioritize tasks and orders to be able to prepare the products for shipping on time.

Independent steering of all processes is quite complicated and time-consuming task which leads to errors. In the analyzed production process there is a "push-type" flow. In this type of flow products are pushed from one worksite to another and it causes queues and stocks which are as big as the difference of bandwidth of

particular worksites. It is easy to notice that the production process in convergent until the completing step. It means that the product is made of different components and the production system is a mixed set (serial-linear). Operations after the completing process create continued (linear) course in which some types of products have some branches. There is an information flow between the planning department and foremen. The data consists of the list of all orders, production dates and priorities. Foremen set the real production course, giving orders to the certain worksites. It is impossible to highlight the booster operation which imposes the rhythm of production in certain process. Each of steps is scheduled individually or liaised with the consecutive step. There is no place for any kind of pulling out because there are operational magazines between the steps. Between operations the products are retrieved and located on trolley trucks. Additionally, location of the machines and worksites is not the same as the course of the technological operations.

2.2. VSD – Value Stream Designing

Coming to the second step, there is a need to focus on elaborating possible changes in the system. Whilst planning, it is important to focus on customizing the production process to the frequency of orders and minimalizing of the stocks and production in process. Proposals of the improvements should be suggested and taken into consideration whilst preparing the upcoming state map. In the next step it is necessary to set exact tasks and prioritize it but also divide responsibilities among the human resources. Those procedures should lead to achieving predicted upcoming state. Then there is a process of consecutive verification which is needed to check whether changes that has been made brought predicted results or not. Control of the process is the last, four stage of the whole endeavor. Achieving good results should be a catalyst of further actions based on iteration of the phases by PDCA.

In the examined department a lot of streaming impediments has been revealed and defined. Process of the removal of those impediments is a priority. Significant discrepancies has been identified whilst executing the same operations (and the same time of processing) in certain departments. Technological chain can be divided into two parts (or phases). First is made of all the operations with completing of the order. In this part all the elements are crafted and edited in few different departments and all of them are unifying and making one piece on the assembler's table. On the further step skis, so complete product are under processing. All the operations are making a chain in which transport between departments is the only break. That is why, first step of the process should be steered due to current needs (completing). The rest of operations should be organized in the way which enables stream of the single element. This kind of actions should limit the necessity of scheduling whilst production process. Knowing how much time one needs to go through all the steps enable scheduling with safe anticipation. Due to the transpar-

ency of the Figure 2 there is only a piece of the map of the upcoming state. It considers the areas steered by Kanban cards and first part of the production process.

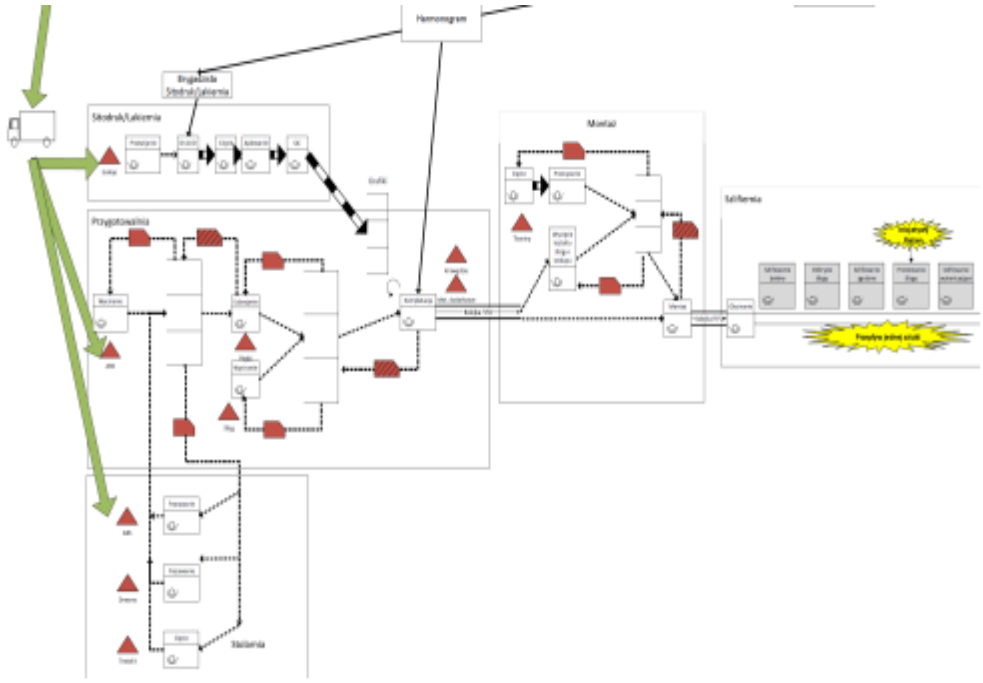

Fig. 2. Piece of the upcoming state map

It is impossible to use the constant stream in the top of the value stream. It is also impossible to use the FIFO lines. All those limitations are caused by the placement of the stands in the department. In such case supermarkets and Kanban cards are some examples of solution. Use of this tool guarantees delivery of the necessary elements of the products in the certain time. The rules of Kanban system are based on the circulation of production and transport cards between client's and supplier's processes (The Productivity Press Development Team, 2013). In this example suppliers from the completing process are the operations made in carpentry shop and in preparation room. That is why it is necessary to use two different supermarkets. First will be set before completing process, second will predate chock's arming process. Treating of all elements will be steered by the completion stands, which will have information from the planning department. All orders will be set in the FIFO queue and there will wait for the next step.

3. MODELLING OF THE REAL OBJECT

Data gathered on the certain steps of mapping process has been used in correlation and implementation of production processes to the IT language. Basing on the gathered information about the real object and being after analysis of losses, there has been created the model (with the use of the IT tool – Witness). The main purpose was to conduct the validation of the analyzed production system. Witness software enables modelling of the processes and precise analysis of those. This duality is desired because in the variety of the organizations it is important to use the human resources, devices (machines) and IT tools in the most effective way. Precision of optimization depends on the correctness of modelled real sets. Modelling in the first step has been based on the identification of the lacks of efficiency – in the lean philosophy it is identification of 3M (muri, mura, muda) wastes. This step is a diagnostic phase which is the basis to the optimization or the reengineering process. Proper rating of the actual state is crucial for the potential implementation of the improvement solutions. Figure 3 is a PrintScreen of the analyzed object (with the use of Witness).

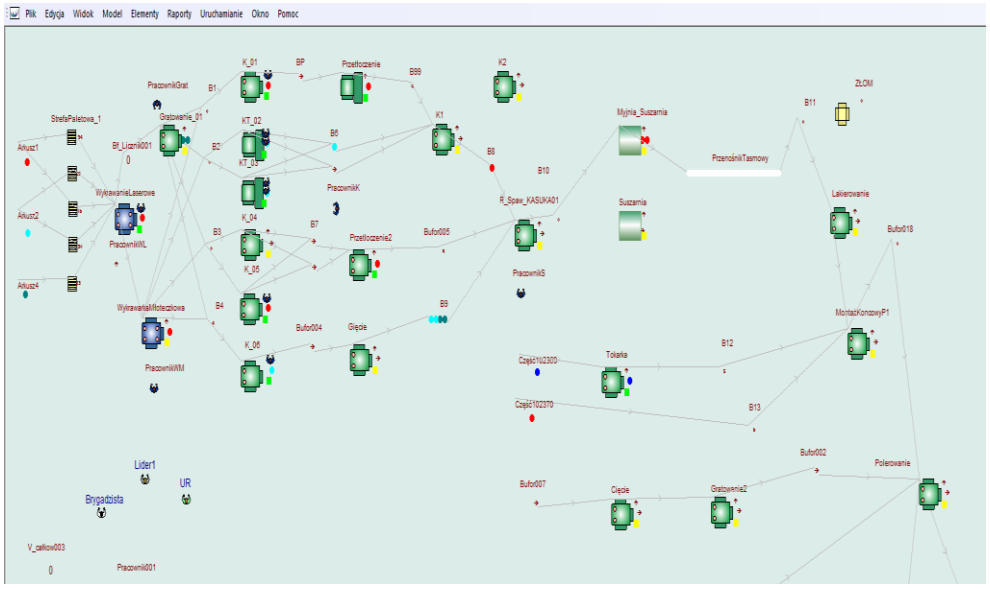

Fig. 3. PrintScreen of the model of the set created with Witness simulator

Validation of proposed changes is made on the virtual object (which is a proper reflection of the real system) can help with avoiding the risk of failures and automatically lower the costs of the reengineering. Moreover, using IT tools can help with assessing the possibilities and potential needs in personal, finance, material, machine or energetic resources. It is also possible to set the KPI (Key Performance Indicators) to the process and study the value for the assumptive input. All of those

advantages determined the use of the Witness simulator in creating the model of the studied production set.

4. CONCLUSION

VSM method is a standard in creating of the visual definitions of the flows and processes easily recognizable on the operational, tactical and strategic levels. In the article there are some steps presented as well as the advantages of using the Value Stream Mapping. VSM method enables identification of the places and causes of the wastes and also present the place where muda is generated. The purpose of creating the future state map is to work out the process which will be the canal for the value stream. It is a "one – piece – flow" – flow of one piece. Moreover, creating the map of flows and processes with the use of VSM icons and transforming gathered data into the IT platform enables conducting the simulation and monitoring.

In the analyzed case – going along the value stream accordingly to the predictions enabled the location of 3M losses which appeared on the certain steps of the production process. Thanks to the physical observation of the process there were some irregularities revealed on each and every step. Those irregularities caused the losses (unnecessary actions made by employees and use of the stocks and machines which did not add any values to the product). The most common "muda" was unnecessary movement of the goods, production of the defective parts and stocks which were directly connected to the overproduction of the semi-finished products.

Looking for the savings in the processing is highly limited with the technology. This approach generates small profits and firm is going out of opportunities. Moreover – there is a need of extra expenses for the investments. Further savings could be achieved by changing the way of production process. This change focuses on those elements of the process which do not add the value to the product directly. Giving the direction to the elimination of the wastes is the first step to the Lean Manufacturing which is an answer for the traditional approach to the production's organization.

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BIOGRAPHICAL NOTES

Bożena Zwolińska is a graduate of Faculty of Mechanical Engineering and Robotics at AGH University of Science and Technology in Krakow. She received her Ph.D. degree in Industrial Engineering from AGH in 2009. Her professional interests concern the area of production and revers logistics.