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Context of production engineering in management model of Value Stream Flow according to manufacturing industry

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Abstract
The popularity of visual management in the lean concept is caused by the possibility to apply it in solving different kind of issues related to reduce waste or process planning. The adaptations of VSM is focused on stream flow, identifying waiting and productive times in accordance to material and information flow. In this paper five basic areas of value stream flow management have been presented and characterized. Discussion under the 5 areas on the VSM process included identifying the dominant stream in the area and the range of factors affecting the flow of the stream. Based on an observation of processes in the manufacturing industry and a literature review, the graphic model of mutual cooperation between value stream areas (1- 5) has been presented.

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1. Introduction

One of the methods of designing production processes is the proper value flow analysis in accordance to the whole production cycle of the product (Haefner et al., 2014). Regardless of the production activity type it is possible to use one of the tools included in the group of instruments in Lean management - Value Stream Mapping (VSM) (Ali et al., 2016; Andrés-López et al., 2015; Bevilacqua et al., 2013; Ingaldi and Jagusiak-Kocik, 2014; Klimecka-Tatar, 2017; Womack and Jones, 2008). The Value Stream Mapping (VSM) is an element of Lean management concept, and its main purpose is to present a current state map (CSM) and a future state map (FSM). The process big picture is one of the options to present the flow of an existing process or process that is under development (Haefner et al., 2014). The adaptations of VSM is focused on artifact flow, identifying waiting and productive times in accordance to material and information flow. The visual management tools and technique can provide consistent benefits in *muda* reduction and elimination (Klimecka-Tatar, 2017; Kurdve et al., 2015). In the case of waste of production processes it is called *muda*, and refers to prodigality, extravagance, mismanagement as well as quality defects, loss of time, excessive number of operations, unused potential of people and equipment etc. (Ali et al., 2016; Borkowski and Knop, 2016; Klimecka-Tatar, 2016; Morlock and Meier, 2015). The popularity of visual management in the lean concept is caused by the possibility to apply it in solving different kind of issues related to reduce waste or process planning (Romero and Arce, 2017; Kowalik and Klimecka-Tatar, 2018; Ulewicz and Kucęba, 2016; Werner and Cruz, 2013) and application of VSM has been expanded to many industry sector. The based Lean production principles could be referred to as:

Principle 1: Define the value - the value is the required need, which process is able to realize. The value is defined by the customer.
Principle 2: Identify the flow of value - as value is a meeting customer requirements, so the value of the stream is determined by the sequence of actions that allow them to requirements met.
Principle 3: Flow optimization - focuses on optimizing continuous stream through a sequence of activities that create value.
Principle 4: Enter the pull system - providing only what the customer actually needs.
Principle 5: Striving for excellence: in accordance of the customer requires it is the knowledge of customer needs (what, where, when, how?).

The main purpose of the paper is to identify areas and create the mutual model of value streams flow in accordance to the universal model of manufacturing processes.

2. Experimental

In order to properly analyze the flow of both the physical stream (raw materials and semi-finished products) and the intangible stream (information and knowledge), it is necessary to be widely recognized in the scope of the company's operations (Araujo and Queiroz, 2009; Womack and Jones, 2008). Normally (in manufacturing industry), the evaluations of the company's activity and the efficiency of the process are prepared on the basis of general input-output parameters.

3. Results and discussion

The proper design of the value stream flow depends on the recognition and collection of information on the 5 main areas included in the process map (Jereb and Rosak-Szyrocka, 2014; Liker and Hauseus, 2008; Morlock and Meier, 2015; Resta et al., 2015; Romero and Arce, 2017).

Area 1. The specification of customer requirements:
- the object for analysis determination - the output effect of the process identification (the final product indication),
- the customer requirements determination, the standards specification (specifying the criteria for accessibility and compliance with the requirements, quality, quantity, frequency of deliveries, packaging method, delivery dates, quality of deliveries etc.),
- detailed analysis of the inventory level in every stage of subsystems, availability of materials supplies.

Area 2. Identification of information flows:
- development of forecasts regarding the volume of orders,
- current analysis of order fulfillment,
- specification of information recipients regarding order fulfillment and production process,
- researching the time of information flow (it can be expressed by the time of waiting for information to be processed),
- identification of persons responsible for order processing, scope of information exchange between suppliers and recipients.

Area 3. Identification of material flows:
- defining the enterprise's requirements as to the raw materials and products of the planned deliveries (i.e. the size of deliveries and the number of suppliers), packaging
- identification of the constituent elements of the process, determination of the type of operation, their duration,
- defining the technological portfolio necessary for the implementation of the process,
- identification of fault locations and waste of resources - embedding quality into the process,
- determining the size of production batches,
- analysis of the workloads.

Area 4. Relationship between material and information flows. This stage merges the previously obtained data and allows to determine what kind of information is necessary in the individual phases of the production process and what actions should be taken in the event of disturbances.

Area 5. Analysis and estimation of added value. This stage is a summary and at the same time complementing the previous areas. The full analysis determines the total duration of the production cycle in accordance to the formula (1).

$$VA + NVA = L/T \tag{1}$$

where:
VA – summarized time of the value adding operations,
NVA - summarized time of the no value adding operations,
L/T - lead time of a process.

As it is well known (Klimecka-Tatar, 2017; Kuhlang et al., 2013; Romero and Arce, 2017; Rother and Shook, 2008; Tyagi et al., 2015; Womack and Jones, 2008), in Lean Management all the activities occurring in processes (in the aspect of the importance for the client) are distinguished between two categories (to effectively distinguish them one should look at the process through the eyes of the client). These two categories are: value adding activities (VA), no value adding activities (NVA).

While designing the entire production process, it is important to determine the relationship between the indicated areas. In Fig. 1 the graphical model of mutual cooperation between areas 1- 5 has been presented. The course of the process shows that its initiation begins at the stage of determining customer requirements - determining and identifying product criteria, as well as packaging and delivery criteria. At this stage, information is exchanged between the client (the contracting entity) and the enterprise (process owner) - the flow of information stream between area 1 and area 2. The stream flow in area 2 is slightly more complicated, as it requires synchronizing the information flows between areas 3 and 4 and additionally takes into account and start the flow of materials in area 3. Undisturbed flows of the stream between the areas 3 and 4 are presented in area 5. Area 5 is a very specific area, because it is a supplement in the metric parameters of the entire process. However, the area 5, mainly represents the flow parameters of the material stream - it refers to material management, supply and all subsequent technological operations (basic and auxiliary operations).

In the design of the production process, it is necessary to determine who is the decision maker on the parameters applicable in all areas of the stream flow.

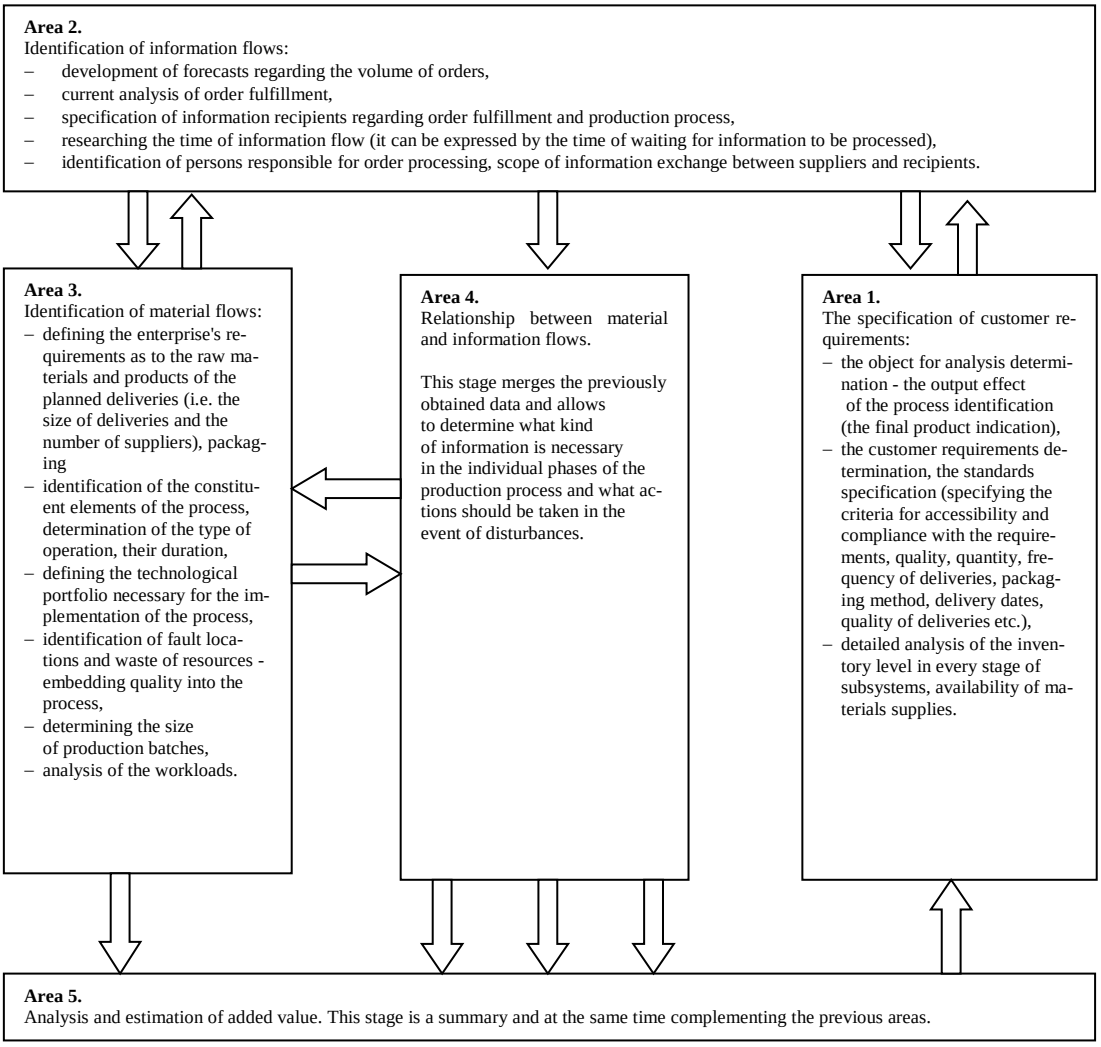

Fig. 1. The graphical model of mutual cooperation between value stream areas 1- 5.

In area 1, client decides about the requirements for the finished product, guided by the quality criteria, sets a set of parameters. The entire process should be conducted in such a way that the product will meet the requirements in terms of parameters set by the customer. Area 1 is the area where the flow of information from the customer plays a key role.

The stream (information) flow in area 2 is fully controlled by the owner of the process and depends mainly on the organizational structure of the enterprise, management systems in the enterprise, the operating procedures and the competencies of employees in the engineering project management centers.

Area 3 and 4, as well as area 2 is highly dependent on organizational structure and management systems but an additional element of this area is the element of logistics management, logistics systems, storage and a possible material management system. In this area, in addition to the flow of the information stream, process also deal with the flow of the material stream. In consequence, it means that the decision-makers are also the cooperators - suppliers of materials and components - which requires sustainable development and knowledge management (Ulewicz and Blašková, 2018).

Area 5 is fully dependent on the technical capabilities of the company. The material flow in this case is determined by the technological portfolio of the company as well as the technologies used. In this area, there are mainly physical (material) flows, as all information flows reaching the components of area 5 are treated by flows occurring in area 4. In area 5, it is additionally necessary to collect information about value adding activities (VA) and do not value adding activities (NVA) - as components of the process full flow (L/T - lead time of a process). Determining technical, product and organizational capabilities, how to reduce NVA time without loss for process correctness.

4. Conclusions

The design of technological processes based on the planning of the value streams flow (material stream and information stream) requires a thorough knowledge of the organizational structure and technological portfolio of the company. The graphical model of mutual cooperation between value stream areas presented in the paper correctly indicates the most important information collection points In gathering basic information, which will be the foundation for further activities of the process development and/or improvement, a practical model of stream flow areas interaction of can be helpful.

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管理中的生产工程背景　根据制造业的价值流模型

關鍵詞
生产工程
流程管理
大图
工艺设计
价值流图

摘要
废物管理在废物管理概念中的普及。 VSM的改编主要集中在流媒体流上，它专注于流程。 在本文中，已经提出并描述了五个有价值的领域。　关于VSM过程的5个方面的讨论包括在流的流程中。 基于价值流区域（1-5）之间相互合作的图形模型的概述已经呈现。