VALUE STREAMS MAPPING IN THE IMPLEMENTATION OF PROCESS INNOVATIONS – IN THE CASE OF SINGLE–UNIT PRODUCTION

doi:10.2478/mape-2018-0082
Date of submission of the article to the Editor: 04/2018
Date of acceptance of the article by the Editor: 07/2018
MAPE 2018, volume 1, issue 1, pp. 649-655

Dr. inż. Dorota Klimecka-Tatar
Czestochowa University of Technology, **Poland**

Mgr inż. Katarzyna Kapustka
University of Technology, **Germany**

Abstract: The visual management technique used in process improvement, i.e. value stream mapping (VSM) has been presented in the paper. Value stream mapping is one of the basic management tools in the context of Lean Management or Lean Production. It allows to visualize the flow of decision, information, material and their connections in the full production cycle (from the order, through planning, production, to shipping to the customer). VSM is a lean tool that gives the ability to create flows in the process before implementing changes. In this paper, the possibilities of changes planning based on the current and future status maps have been discussed. On the basis of the current state map (CSM), the areas requiring improvement and operations which efficiency is decisive and for the process have been designated. Particular attention has been paid to the possibilities of using VSM in unit production processes. In the paper has been proposed the two possibilities for company development in terms of the improvement technique in line with the Kaizen philosophy as well as the implementation of process innovations. Which means balanced development through the improvement of the existing process or an acute development strategy through the implementation of process innovations (which involves significant costs).

Keywords: value stream mapping, process innovation, process improvement, lean management, Kaizen philosophy

1. INTRODUCTION

The revolution in the methods, techniques and concepts of management was the introduction of the word Lean in the manager's dictionary. It took place in the late 80's and is still the most valued strategy for the development of enterprises in both the production and service industries (Womack P. J. et al., 1990; Klimecka-Tatar, 2017; Kleszcz, 2017). The basis for this concept was the graphically illustrated Toyota Production System (TPS), which is a compilation of tools, activities and dependencies aimed at improving production (in the Lean concept, improvement is perceived as a leaning of production) (Sieckmann et al., 2018; Rosso and Saurin, 2018).

1.1. Lean philosophy – principles and their application

It is a management philosophy that focuses on the reconstruction of processes in order to constantly reduce and eliminate waste, thus contributing to efficiency and creating value for the client (Roriz et al., 2017). Lean conception is based on five basic principles (Womack and Jones, 1996; Lendel et al., 2015c; Lendel et al., 2015b):

1) Defining the value of a product or service from the customer's point of view. In this case, the value is related to the identification of the customer's requirements and is not always associated with the liquidation of the waste itself – regardless of whether the concept is implemented in a service or production enterprise, it is necessary to meet client's

requirements and expectations, etc. (Nowicka-Skowron and Ulewicz, 2016; Midor and Kucera, 2018).

2) Identify the value stream individually for each product and service. The value stream is perceived as a variable information and material system that aims to meet customer needs. The source of such a stream of values is the moment of the appearance of a new order, ending with the receipt of products/services in accordance with the customer's expectations (Abdulmalek and Rajgopal, 2007; Klimecka-Tatar, 2017).
3) Organizing the process in such a way that the flow of the stream is not disturbed. The continuity of the value stream flow guarantees minimizing the creation of indirect losses (waste of time, unnecessary movements, unnecessary transport, etc.). In this respect, it is worth thinking about process standardization and optimization – it is necessary to know the consequences of breaking the flow (Bialy and Ruzbarsky, 2018).
4) If it is not possible to ensure the continuity of the stream, focus on the customer's needs. It is worth introducing a pull system, which guarantees that the stream will start when the customer's order appears. The process is worth organizing in such a way that, despite the lack of continuity of flow, in the event of a client's request, it is easy to carry out the tasks (Kim and Kim, 2014; Chiarini, 2017).
5) Continuous efforts to improve the value stream and to improve its flow. This principle applies to minimize losses, improving in small steps in accordance with the philosophy of Kaizen (Kumar et al., 2018; Cheser, 1994).

The application of these principles is easily observed in companies that want to be lean. In addition, in the world literature, there are a lot of information about techniques, rules and framework for implementation of the Lean Management / Manufacturing / Production tasks (AlManei et al., 2017; Alpenberg and Scarbrough, 2016; Bitkowska, 2017; Brad et al., 2016; Dombrowski and Mielke, 2014; Dombrowski et al., 2012; Hoellthaler et al., 2018; Kadarova and Demecko, 2016; Lendel et al., 2015a, 2015a; Klimecka-Tatar, 2017). Lean gives the impression of a very easy concept for implementation in an enterprise, however, despite many advantages, it also raises a lot of controversy. The commencement of the Lean implementation procedure for the enterprise faces many barriers that fall into seven categories: management, resources, knowledge, conflicts, employees' experience, finances and the past (Lodgaard et al., 2016). And depending on the situation in which the company is located, these barriers can be seen as an obstacle, but in some circumstances they can also be the driving force of action – e.g. the management of the enterprise, due to the diversity of behaviors and relationships in the enterprise, can act as a inhibitor or driving force for Lean initiatives (Bitkowska, 2017; Alefari et al., 2017).

1.2. Process innovations in service and production enterprises

Innovation and innovative activity in the aspect of enterprise development are key determinants of intensive development of the region and the country. The numbers that speak of the number of implemented innovations and the financial resources allocated to their implementation are indicative of the speed and direction of economic development. All innovative activities are aimed at improving the process and organizational, process or product innovations are helpful here. It is important for the company to implement the innovation with regards to process approach, realizing each of the steps carefully (Fig.1).

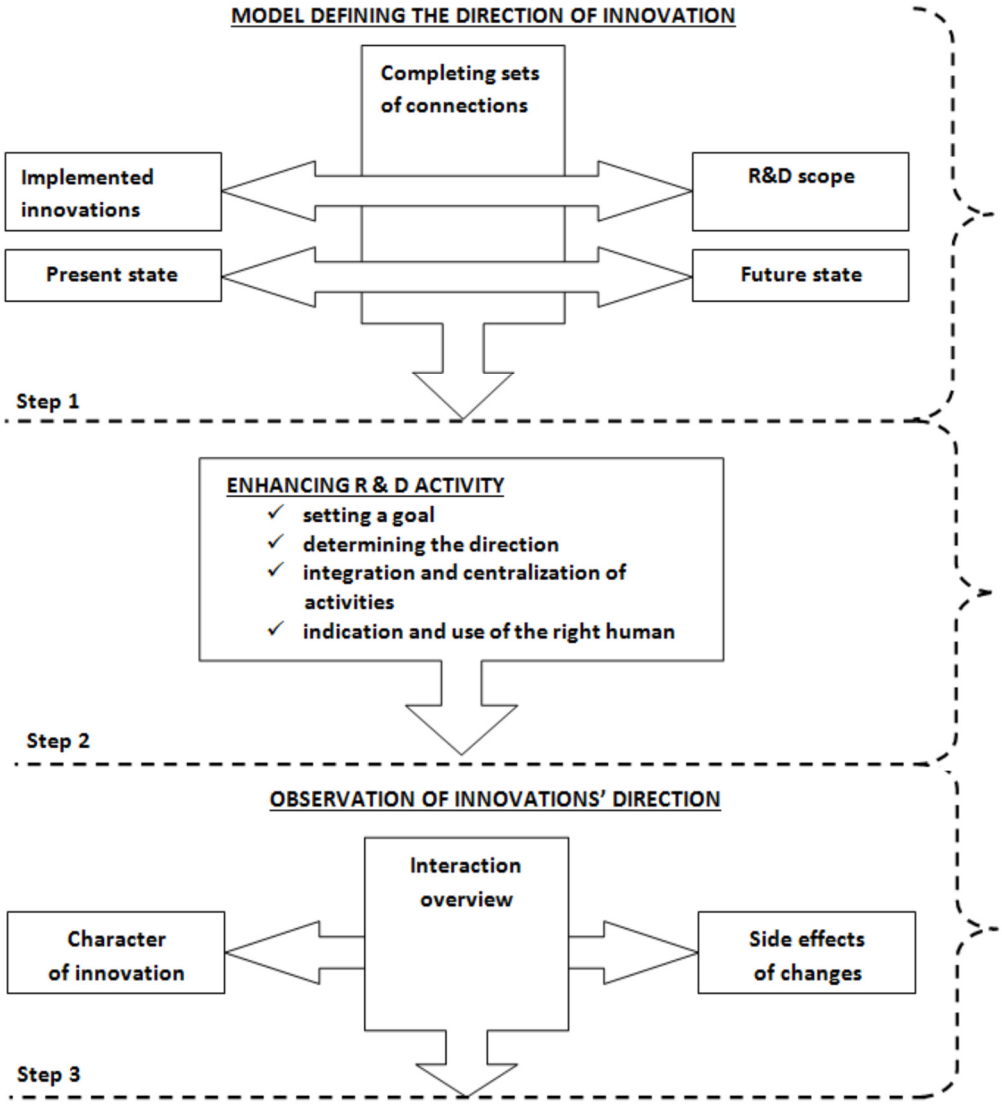

Fig. 1. A general scheme of innovative activities – in three steps

The process of implementing innovations is very often related to the implementation of Lean Management principles. Despite initially relatively large amounts of money demand, the company can significantly reduce the formation of losses (losses from the point of view of the customer – reduction of not adding value activities for which the customer is not able to pay). Process innovation in general is aimed at: increasing production capacity, increasing flexibility, the ability to quickly respond to market needs, reducing cost-efficiency (materials, energy, time, operations, etc.), improvement of environmental and work safety.

2. METODOLOGY

This paper presents the possibility of using one of the most important Lean tools, which is Value Stream Mapping (VSM). Process mapping was used to illustrate the current state of the process and to design the process after the implementation of process innovation. Value Stream Mapping (VSM) is a very effective method for illustrating and redesigning of process flow. This method consists two main phases: the value stream analysis, in which the current state of process is visualized by the current state map (CSM) and the stream of values according to the future state map (FSM) or stream design with Value Stream Design.

The mapping has been carried out for a small enterprise, which is a subcontractor for the specialist services provider – a prosthetic laboratory preparing prosthetic restorations based on orders given from a dentist.

3. RESULTS AND DISCUSSION

The current state map shows the existing state of the value stream. Each VSM map consists of five areas on which distinguishes key customers or groups of recipients of the value (materials and information) stream, specifies providers of the stream and also shows the status of the value stream at a given moment for the representative and average demand. In Fig. 2 the current state map (CSM) is presented.

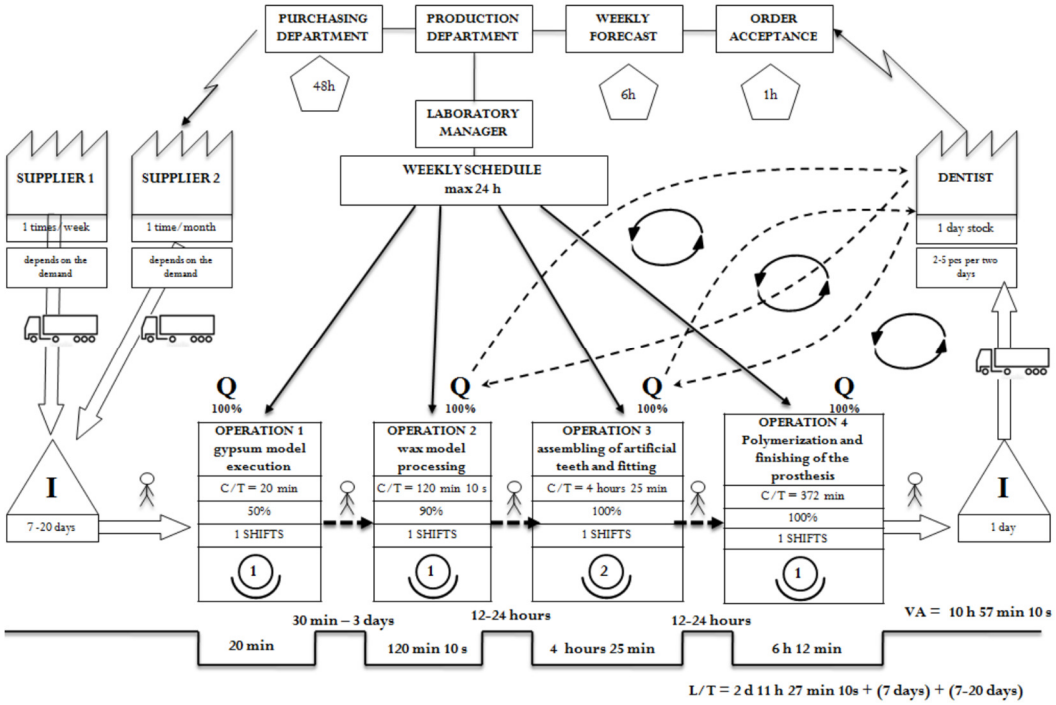

Fig. 2. The Current State Map of the ordering and production of single-unit dental prosthesis

The first area of the map presents the customer's requirements – in this case the customer is the dentist as a middleman between the prosthetic laboratory and the patient. The dentist places an order for an individual prosthetic restoration, transmitting the impression from the patient's oral cavity and presenting the specification regarding the aesthetics of the finished product. This type of order is difficult to plan, which results from the specifics of prosthetic services.

The second area concerns the internal flow of information. The enterprise receives orders 3 times a week (in a different number – usually 2 to 5 impressions from the oral cavity). Due to the durability and the ability to reproduce dimensions of the impression, it is very important to prepare a gypsum model from the obtained impression within 24 hours. Information between employees about order processing is passed manually. During observation of the process, at this stage, the largest number of negligence has been observed. Despite direct contact between employees, information is often omitted, which causes delays and the quality problems in the finished product. In the case of the company, a significant amount of material was found in the warehouse. The flexibility of the company's operation requires a wide range of materials.

The fourth area combines physical and information flows. In the fourth area there are all the key elements of the process, along with the time devoted to the various stages of the service

and the number of people involved in the procedure. The elements that have been also presented on the map are: stowage control, and relatively frequently occurring return loops. During the observation, it was pointed out that the frequency of the secondary workflow (return loop) results from negligence at the commissioning stage – gypsum model prepared too late. The time line completes the analysis. At the bottom of the map there is an axis indicating the total duration of the production cycle and time spent on value adding operations (VA). In the case of the selected product, the time devoted to value adding operations is 10 hours 57 minutes and 10 seconds, while the time from the moment the order was accepted until the moment of transport to the customer – the total duration of the service – L / T (leadtime – time of transition) is 2 days 11 hours 27 minutes and 10 seconds – with addition time of delays (7 days) and waiting (7-20 days). Information included in the map allowed to define areas where it is worth considering the implementation of process innovation.

A map of the current state (CSM+Kaizen) with ideas for improvement is the next stage of creating a project of production process (Fig. 3). At this stage, Kaizen's improvement proposals are used. The aim is to reduce the flow of the value stream, free from any disturbances. Among Kaizen's proposals, there was a need to apply 5S practices both in the area of the materials warehouse and at work positions. Employees devote a considerable amount of time to finding the right material and the necessary tools. Another proposal related to the creation of an information board about pending orders – however, this requires a large consequence towards the person responsible for accepting the order.

The Fig. 4 presents the map with indicated areas that need greater commitment on the part of management. A map that indicates the places of process innovations implication. The first idea is to introduce a system / systems which in activities will be similar to the ERP system (Enterprise Resource Planning). One of the systems aims at planning the company's resources. The second system will be responsible for overseeing the process of order fulfillment. With this approach, all departments and functions in the company can be integrated. The assumption is that all employees of the company have access to one and the same database. The entered data are visible on the positions of all employees. The system informs about the acceptance of the order and designates the person responsible for the preparation of gypsum model from the delivered oral impression.

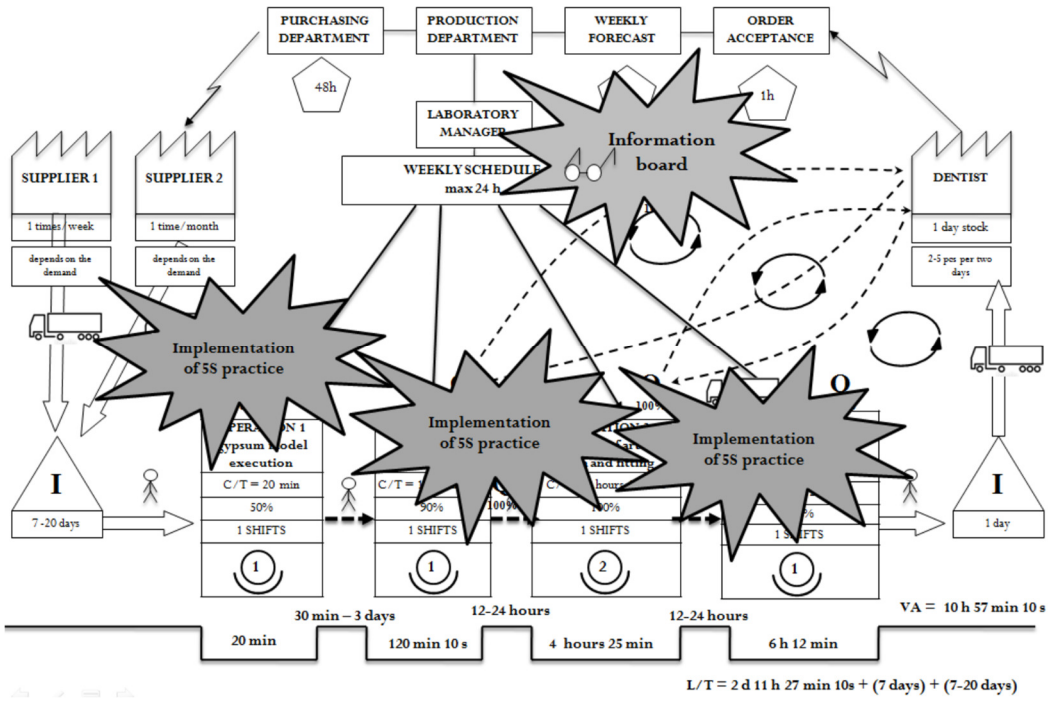

Fig. 3. The model of process design based on improvement according to the Kaizen philosophy

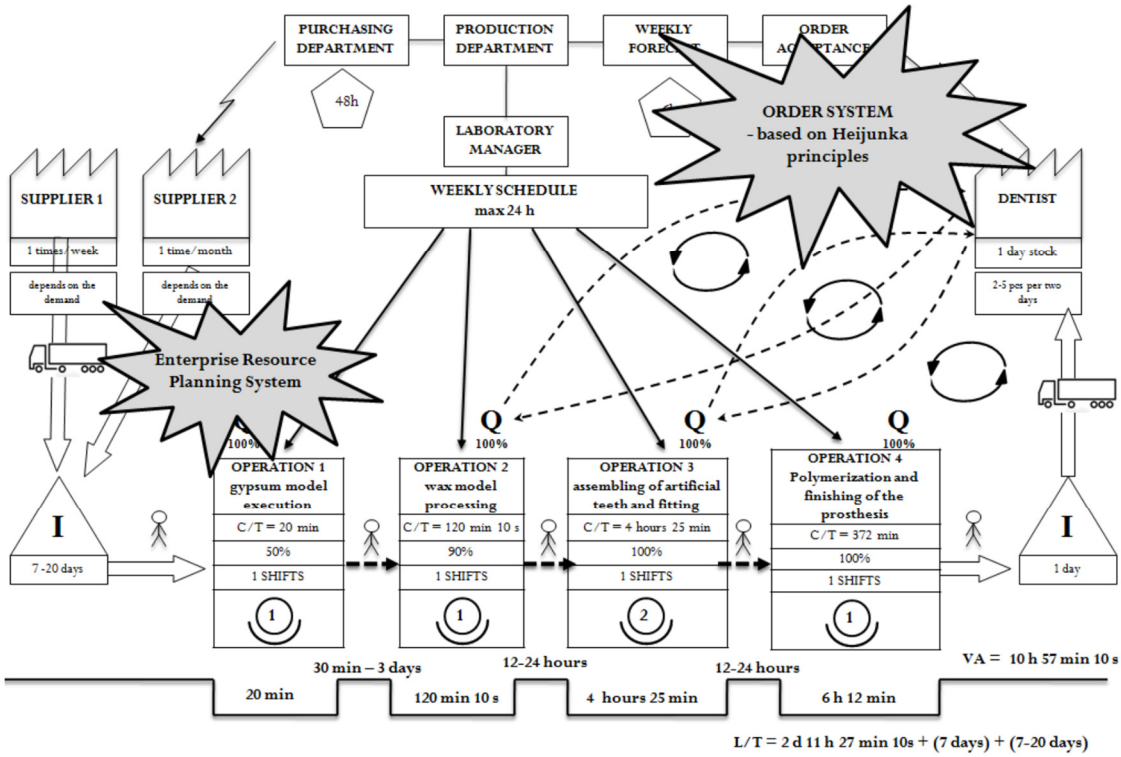

Fig. 4. The model of process design based on process innovation implementation

With this system, the work leveling (Heijunka) it is also possible. This is accomplished by creating a queue of orders and allocating further orders to the person least busy at the moment.

4. SUMMARY

Based on observation of the process flow and map analysis, areas that may affect on errors and delays occurrence in the production of a single-unit specialized product (in tthis case a dental prosthesis) have been indicated. Furthermore, two models of the process redesign have been proposed. One model referred to the principles of Kaizen, that is improvement through small changes – changes that do not result in significant financial outlays, and bringing spectacular effects to the consequences in action. The second model, proposed a redesign of the process based on the implementation of process innovations – the implementation of a specialized system of accepting orders, setting the queue of employees, as well as a material resources management system. This case study determines the importance of value stream mapping as an ideal way to highlights the need for changes in process management, and it also allows to visualize alternative solutions.

REFERENCES

Abdulmalek, F.A. and Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: Aprocess sector case study. International Journal of Production Economics, 107 (1), pp. 223-236.

Alefari, M., Salonitis, K. and Xu, Y. (2017). The Role of Leadership in Implementing Lean Manufacturing. Procedia CIRP, 63, 756-761, DOI: 10.1016/j.procir.2017.03.169.

AlManei, M., Salonitis, K. and Xu, Y. (2017). Lean Implementation Frameworks: The Challenges for SMEs. Procedia CIRP, 63, pp. 750-755, DOI: 10.1016/j.procir.2017.03.170.

Alpenberg, J. and Scarbrough, D.P. (2016). Exploring communication practices in lean production. Journal of Business Research, 69 (11), pp. 4959-4963, DOI: 10.1016/j.jbusres.2016.04.059.

Bialy, W. and Ruzbarsky, J. (2018). Breakdown cause and effect analysis. Case study. Management Systems in Production Engineering, 26 (1), pp. 83-87, DOI: 10.1515/mspe-2018-0013.

Bitkowska, A. (2017). Knowledge management in production enterprises. Production Engineering Archives, 15, pp. 23-26, DOI: 10.30657/pea.2017.15.06.
Brad, S., Murar, M. and Brad, E. (2016) Methodology for Lean Design of Disruptive Innovations. Procedia CIRP, 50, pp. 153-159, DOI: 10.1016/j.procir.2016.04.204.
Cheser, R. (1994). Kaizen is more then continuous improvement. Quality Progress, 27 (4), pp. 23-26.
Chiarini, A. (2017). An adaptation of the EOQ formula for JIT quasi-pull system production. Production Planning & Control, 28 (2), pp. 123-130.
Dombrowski, U. and Mielke, T. (2014). Lean Leadership – 15 Rules for a Sustainable Lean Implementation. Procedia CIRP, 17, pp. 565-570, DOI: 10.1016/j.procir.2014.01.146.
Dombrowski, U., Mielke, T. and Engel, C. (2012) Knowledge Management in Lean Production Systems. Procedia CIRP, 3, pp. 436-441, DOI: 10.1016/j.procir.2012.07.075.
Hoellthaler, G., Braunreuther, S. and Reinhart, G. (2018). Digital Lean ProductionAn Approach to Identify Potentials for the Migration to a Digitalized Production System in SMEs from a Lean Perspective. Procedia CIRP, 67, pp. 522-527, DOI: 10.1016/j.procir.2017.12.255.
Kadarova, J. and Demecko, M. (2016). New Approaches in Lean Management. Procedia Economics and Finance, 39, 11-16, DOI: 10.1016/S2212-5671(16)30234-9.
Kim, S.-C. and Kim, Y.-W. (2014). Computerized integrated project management system for a material pull strategy. Journal of Civil Engineering and Management, 20 (6), pp. 849-863, DOI: 10.3846/13923730.2013.802743.
Kleszcz, D. (2017). Assessment of application of 5S practices in ceramic industry. Production Engineering Archives, 16, pp. 47-51, DOI: 10.30657/pea.2017.16.10.
Klimecka-Tatar D. (2017). Process Management and Leveling of Service Quality in a Global Dental Product Management System. Globalization and its Socio-Economic Consequences 2017 (red.) KLIESTIK T. University of Zilina, pp. 961-967.
Klimecka-Tatar, D. (2017). Value stream mapping as lean production tool to improve the production process organization – case study in packaging manufacturing. Production Engineering Archives, 17, pp. 40-44, DOI: 10.30657/pea.2017.17.09.
Kumar, S., Dhingra, A.K. and Singh, B. (2018). Process improvement through Lean-Kaizen using value stream map: a case study in India. International Journal of Advanced Manufacturing Technology, 96 (5-8), pp. 2687-2698, DOI: 10.1007/s00170-018-1684-8.
Lendel, V., Hittmár, Š. and Latka, M. (2015c). Application of Management of Innovation Processes in Enterprises: Management Approach, Problems and Recommendations. Procedia Economics and Finance, 34, pp. 410-416, DOI: 10.1016/S2212-5671(15)01648-2.
Lendel, V., Hittmár, Š. and Siantová, E. (2015a). Management of Innovation Processes in Company. Procedia Economics and Finance, 23, 861-866, DOI: 10.1016/S2212-5671(15)00382-2.
Lendel, V., Hittmar, S. and Siantova, E. (2015b). Identification of the Main Levels in the Management of Innovation Processes. Procedia Economics and Finance, 26, pp. 1108-1112, DOI: 10.1016/S2212-5671(15)00937-5.
Lodgaard, E., Ingvaldsen, J.A., Gamme, I. and Aschehoug, S. (2016). Barriers to Lean Implementation: Perceptions of Top Managers, Middle Managers and Workers. Procedia CIRP, 57, pp. 595-600, DOI: 10.1016/j.procir.2016.11.103.
Midor, K. and Kucera, M. (2018). Improving the service with the servqual method. Management Systems in Production Engineering, 26 (1), pp. 60-65.
Nowicka-Skowron, M. and Ulewicz, R. (2016). Problems in the implementation of lean concept in the metal industry companies, METAL 2016: 25th Anniversary International Conference on Metallurgy And Materials, pp. 1962-1967
Roriz, C., Nunes, E. and Sousa, S. (2017). Application of Lean Production Principles and Tools for Quality Improvement of Production Processes in a Carton Company. Procedia Manufacturing, 11, pp. 1069-1076, DOI: 10.1016/j.promfg.2017.07.218.
Rosso, C.B. and Saurin, T.A. (2018). The joint use of resilience engineering and lean production for work system design: A study in healthcare. Applied ergonomics, 71, pp. 45-56, DOI: 10.1016/j.apergo.2018.04.004 (eng).
Sieckmann, F., Ngoc, H.N., Helm, R. and Kohl, H. (2018). Implementation of lean production systems in small and medium-sized pharmaceutical enterprises. Procedia Manufacturing, 21, pp. 814-821, DOI: 10.1016/j.promfg.2018.02.188.
Womack J.P. and Jones D.T. (1996). Lean thinking: Banish waste and create wealth in your corporation. London: Touchstone books.
Womack P. J., Jones D. T. and Roosc D. (1990). The machine that changed the world. Toronto: Collier MacMillan Canada Inc.