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Towards Lean Production in Industry 4.0

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Abstract

Lean Production is widely recognized and accepted in the industrial setting. It concerns the strict integration of humans in the manufacturing process, a continuous improvement and focus on value-adding activities by avoiding waste. However, a new paradigm called Industry 4.0 or the fourth industrial revolution has recently emerged in the manufacturing sector. It allows creating a smart network of machines, products, components, properties, individuals and ICT systems in the entire value chain to have an intelligent factory. So, now a question arises if, and how these two approaches can coexist and support each other.

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1. Introduction

Lean concerns a production system that is oriented on learning of organization through continuous improvements. It has its origins in the Toyota Production System and has been recognized as doing more with less. Therefore, it aims at reducing unnecessary variations and steps in the work process by the elimination of waste which is perceived as any action that does not add value to the product or services. Originally, it was focused on the elimination of such wastes as defects of requiring rework, unnecessary processing steps, movement of materials or people, waiting time, excess inventory, and overproduction. Nowadays, it covers diverse aspects of the manufacturing starting from the initial stage of product life cycle such as product development, procurement and manufacturing over to distribution [1]. It is implemented as a philosophy and a set of tools and practices to achieve the highest quality, lowest cost, and shortest lead time. It is an effect of a complex, pro-quality management in all areas of enterprise activities [2]. It can be also considered as an extended just-in-time including all parties involved in supply chain, intra and inter-

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organization [3, 4]. Thus, it is a multi-dimensional approach that can work synergistically to create an efficient, high quality system to deliver products in accordance with the pace of customer demand with minimum waste [5, 6].

2. Lean Implementation

Generally, the successful implementation of any management practice often relies on organizational characteristics. However, it should be emphasizes that not all organizations can or even should implement the same set of practices. The most often revealed practices commonly associated with lean production are: bottleneck removal (production smoothing), cellular manufacturing, competitive benchmarking, continuous improvement programs, cross-functional work force, cycle time reductions, focused factory production, just-in-time/continuous flow production, lot size reductions, maintenance optimization, new process equipment/technologies, planning and scheduling strategies, preventive maintenance, process capability measurements, pull system/Kanban, quality management programs, quick changeover techniques, reengineered production process, safety improvement programs, self-directed work teams, total quality management [5]. However, it should be emphasized that these tools create a system so they contribute to the elimination of a particular type of waste and they should be applied together. The following approaches are often treated as “lean toolbox” [2].

As far as the implementation process of lean production is concerned there are discussed diverse frameworks. According to Ålström [7] it is evident that improvement activities appear in the sequence in manufacturing, however, continuous improvement should be introduced late during the process to allow it to benefit from the earlier established other principles. Storhagen [8] suggests that continuous improvement and change can be supported by job rotation and teamwork which only in the beginning of lean implementation allow taking the advantage.Moreover, it is suggested that employees’ attitudes to quality should be changed to get material flow which contains only value adding operations [9]. Following Womack and Jones’s “lean leap process” [1] there is a need to identify a change agent to create a new lean organization. Such person should be the first one who acquires lean knowledge to be able to share it with the rest of organization before mapping value streams. After creating a lean function and strategy, business systems should be fixed. Lean thinking can be recognized as completed when it is applied to suppliers and customers, a global strategy is developed, and continuous improvement programme is transitioned from a top-down to a bottom-up. Furthermore, Hobbs [10] proposed a step-by-step implementation of lean which hypothetically can reflect the five lean principles (Table 1).

Table 1. Lean steps and principles.

Step	Lean principle
Establish strategic vision	-
Identify and establish teams	-
Identify products	Value
Identify processes	Value stream
Review factory layout	Flow
Select appropriate pull strategy	Pull
Continuously improve	Perfection

Source: Author elaboration on the basis [1, 10].

It can be noticed that steps three to seven are linked to the five lean principles, whereas it is difficult to assign the original lean principles to steps one and two. Therefore, Hines [11] proposes to extend the classical principles to “people” and if it is added the second step can reflect it. Finally, the first step can be suggested to be a starting point for any strategic implementation project, and thus it can be considered as “a pre-step”. An alternative approach was proposed by Bicheno and Holweg [12] who perceived the implementation of lean hierarchically as presented on Fig. 1.