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PRESENT AND FUTURE OF THE PRODUCTION: INTEGRATING LEAN MANAGEMENT INTO CORPORATE FORESIGHT

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The present paper describes a combined approach to corporate Foresight and lean management. When companies implement lean management, they are often faced with a broad range of barriers such as top-management resistance, slow response to market change, etc. Due to the shift to new technological paradigm (Industry 4.0) planning horizon gradually changes. To overcome the new challenges at the company level, we propose to use the combined approach Foresight and lean management. It will allow companies to set goals not only for a period of 10-15 years, but also to bring all the details to the operational level, therefore every employee will aware of in which direction the company is moving. Based on a review of theoretical and methodological approaches and the investigation of the implementation experience of lean management and Foresight approach taking into account conditions of trends in Industry 4.0, human and time resources. The present paper intends to provide the conceptual basic for testing the developed model later.

JEL Classification: M11; O32

Keywords: lean management, Foresight, strategy, Industry 4.0, production management

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Introduction

Currently, companies tend to work in conditions of expansion of economic processes and increased international competition. At the same time, risk factors of external and internal environments have significantly impact on the operational results. Consequently, management of the company moves on the prioritization of long-term development of its business, or experiences a different loss of its assets. Strategic competitiveness of enterprises is based on analysis of long-term trends forecasting models of consumer behavior and demand [Ahmedova, 2015].

The last years can be described as a new stage of planning, characterized by the need to create and use in enterprises integrated production systems, bringing together the entire range of tasks to improve operational efficiency, increase productivity, and reduce downtime [Leitão, 2009; Crompton, 2016]. One such system is the system of "lean management", which is the most successful symbiosis of market principles of management (only produce what is claimed) and the administrative team (strategic planning and management by objectives) solutions. Thanks to the lean management, the effective management of resources of the company is a powerful tool, allowing increasing the efficiency of the enterprise, to obtain positive results and indicators. However, companies that implement lean manufacturing, are often faced with the strategic and organizational nature of the problem, for example lack of top/senior management involvement or resistance on different level [Staudacher & Tantardini, 2007; Hagstrom & Wollner, 2011].

For the conservation and rational distribution of resources companies often use a different techniques and methods for the better understanding and modelling the future, setting goals for the next 5-10 years and methods to achieve these goals and objectives. To justify strategic and tactical decisions in a rapidly changing environment are widely used Foresight studies [Vishnevskiy et al., 2014; Gokhberg et al., 2016; Meissner, 2016; Vishnevskiy et al., 2016; Gershman et al., 2016]. In this regard, for enterprises that deploy lean management, these methods are necessary for effective strategic planning, reduce uncertainties, identify opportunities, and adverse outcomes [Popper, 2012; Calof et al., 2015].

It should be noted that the main purpose of the corporate Foresight is an analytical forecast of the company's development, tailored to the available resources and conditions of the external and internal environment. Companies rarely use a combined approach of corporate Foresight and lean manufacturing. However, recently there has been a tendency to increase in terms of planning the development of the industry or business in the long-term. This is due to necessity of company owners realize its potential and the role of business development in the context of future development scenarios. In order to answer to the new challenges and barriers, we propose to combine two approaches to the development of the company: Foresight and lean manufacturing. The new approach is able to prepare the company for future trends, and organize knowledge

not only in the company's management, but also to bring it up to an operational level so that every employee in the company knew its place and its role in development. Thus, the researchers should perform the following tasks:

• What are the limits of this integration in the field of lean management and strategic management research, corporate Foresight?

• How Foresight and production techniques aimed at management mix can be combined to affect the strategy of implementing the philosophy in companies?

The work aims to answer these questions and elaborate fields for future research.

Literature review

Due to the complexity of analyzing concepts, methodology is divided into two sections: Lean management, corporate Foresight.

Lean management

A few decades ago, the lean production concept was viewed as an unreasonable alternative to traditional manufacturing models offered by Womack et al. (1990), Shingo (1989) and Krafcik (1988). The scholars Fullerton et al. (2013) claimed that today this system may be a paradigm for operation and it is one of the steps to success for achieving world-class performance. Lean is a well-known manufacturing system; however, some scholars argued that for achieving success in the any industry the implementation of more than a complete business system is required [Womack & Jones, 1991; McVay et al., 2013].

Lean production (LP) can be described at two level of abstraction: as a philosophy, which has a set of principles and tools and as bundles of practices. For example, Womack et al. (1996) characterized lean production philosophy as system, which reduce time between order placement and product delivery by eliminating "bottlenecks" in product's value chain. Spear (2004) and Womack and Jones (1996) set out the essence of lean manufacturing as a process that includes five phases. However, the dominant view in describing and measuring Lean production rests on a set of practices and tools used in eliminating waste [Narasimhanet et al., 2006; Shah & Ward, 2007]. Although the most scholars disagree with exact practice and their number, there is four aspects of LP and related together into bundles. It associated with quality management (QM), human resources (HR), pull production and preventive maintenance [Cua et al., 2001].

The main essence of the lean management is defined as integration in one single comprehensive system all business - processes with aim of using the lean principles and methods, lean philosophy for providing better value to the final customers through continuous improvement and eliminating "bottlenecks" [Shingo Prize, 2010]. This issue has been dealt with by leading scholars and some provided sufficient explanation that since all business - processes are inter-

linked, lean system cannot operate in isolation to realize its potential [Maskell & Kennedy, 2007].

Lean manufacturing is aimed to improve internal quality at work and satisfy needs of the end customer. Many companies started implementing Lean concept and the number of Lean tools, techniques and technologies available to improve performance are growing. It is suggested that it is important that companies practice most, if not all, of the following (Table 1).

Tab.1. Frequent tools and methods of lean management

S. no.	The frequent tools and methods of LM	References
1.	Continuous improvement/Kaizen	Lillrank & Kano, 1989; Robinson, 1991; Bessant, 2003; Suárez-Barraza, 2007
2.	Cellular manufacturing	Yoon & Lee, 2000; Davis & Mabert, 2000; Weiss, 2002
3.	Kanban	Donald, 2003; Kumar, 2010; Bhim et al., 2010; Antony, J. 2011
4.	Process mapping	McManus, 2005; Jafri Rohani & Seyed Mojib Zahraee, 2015
5.	SMED	Shingo, 1985; Melton, 2005 Alves & Tenera, 2009, Desai & Warkhedkar, 2011
6.	Supplier development	Spekman et al., 1998; Kannan & Tan, 2002; Choi & Krause, 2006; Mitrega & Pfajfar, 2015
7.	Total Productive Maintenance (TPS)	Kodali & Chandra, 2001; Chan et al., 2005; Rodrigues & Hatakeyama, 2006; Pinjala et al., 2006

Source: HSE

In the philosophy of lean production, every transaction is invited to consider in terms of adding value to the end user. The emphasis should be laid on the question: « If the manager eliminates a definite operation of production, will it decrease the product's value for the end-user? ». It is noteworthy that loss is overhead and includes time and costs. M. Vader noted that only 2-5% of the time by the total time add value to the client. The production of lean on pre-acceptance distinguish seven main types of losses: overproduction, waiting, over-processing, inventory, motion, defects, and transportation.

For a long time, the renowned scholars addressed the question of practical implications on lean implementation and their effects on performance. In-depth study of the key types of operations in the lean systems, Bender & Slump (2009) acknowledged that this system has both beneficial and problematic impact on the financial situation of the company. They considered lean manufacturing as a long, arduous process depending on external contextual factors. However, their theory did not provide sufficient explanation of what and how factors can influence different aspects of the enterprise. Nonetheless, analyzing different sizes of factories in different countries, the scholars Camacho-Minanoet et al. (2013) recognized that evidence about relationship between lean practices and financial performance is unconvincing. In addition, Sila (2007) reckoned that there is no difference among subgroups distinguishing five contextual factors –

totally quality management implementation, International Organization for Standardization registration, country of origin, company size, and scope of operations.

It is significant to measure the effects of implementation of principles and tools of lean production. This subject has inspired a great deal of interest among professionals. Many models and systems have been developed by researchers to assess the performance of lean implementation. The renowned scholars investigated the effectiveness of manufacturing lean by assessing the efficiency of productivity and operation [Leung & Lee, 2004; Marvel et al., 2009]. In general, many researchers measured the effectiveness of lean performance using the value stream mapping or financial and nonfinancial indicators. It appears that it is not impossible to evaluate the cost-effectiveness of measures for the introduction of lean production. Wan et al. (2007) made an emphasis on the costs, time and output values, however the scholars did not raise question about effectiveness of production. Moreover, they determined three methods, which could reasonably evaluate lean systems, namely qualitative, quantitative and graphical methods.

Quantitative surveys of research provide better leanness score compared to qualitative metrics. Thus, Wan & Chen (2009) indicated a web-based approach of lean performance including three components, namely lean training, value stream mapping and lean assessment. As claimed by many, the process of performance evaluating can be significantly improved.

Corporate Foresight

Search market trends and new technology take the form of activities, which is commonly referred to as corporate Foresight. Activities of corporate Foresight facilitate companies to maneuver in certain, complex and unstable conditions [Rohrbeck, 2008], the uncertainty and unpredictability is reduced [Tsoukas & Shepherd, 2004]. Corporate Foresight activities include scanning environment, interpretation of the data and initiatives as the basis of the context and the problems of the company.

It should be noted, that sectoral leadership and cross-sectoral collaborative play significant role in corporate Foresight. For instance, according to Rohrbeck and Gemünden (2008) Foresight need to have strong internal and external network, wide interest; that in the area of network must be clearly defined and managed network with internal and external partnerships of the Foresight. Moreover, taking into account small and medium-sized enterprises (SME's), partnership between companies and external stakeholders can be used to improve Foresight's activity. External sources can provide regional scenarios with a time horizon of five to ten years and companies can adapt it to their specific [Gershman et al., 2016].

Currently, there is a growing trend towards the use of approach of partnerships in Foresight's activity at the micro level. Corporate Foresight studies emphasize that participation is crucial in this activity [Meissner D., 2016]. To ensure the success of the Foresight, it is necessary

to involve all the stakeholders, experts, decision makers into the process [Barker, 2013; Daheim & Uertz, 2008]. In addition, it is alleged that the dominant logic in organization prevents the recognition of changes and difficult to take of alternative ways the company's development. Consequently, the challenge of corporate Foresight would be to appear doubt concerning the basic assumptions in the company by perform involvement Foresight exercise [Blackman & Henderson, 2004].

Some scholars founded that the process brings additional advantages in the analysis of the future. The researchers argue that the process of scenario planning can play a strategic conversation and improve organizational learning [Chermack et al., 2006; Rohrbeck, 2010; Vishnevskiy et al., 2014; Khripunova et al., 2014].

Corporate Foresight can help an organization to qualify for leadership in any sector, taking into account the communications organizations of all its stakeholders and cross-sectoral effects. Furthermore, Foresight is able to form a common vision problem and solve it with the consensus of stakeholders, which greatly affects the speed of decision-making and the availability of the company's competitive advantage in the industry. Thus, the novelty of the results of the present study may lie in the combination of cross-sectoral partnership, sectoral leadership and corporate Foresight.

Integrating lean management into corporate Foresight

Strategic view of lean management

In the 1990s, lean management considered as a manufacturing level, in which managers can use a set of operational tools and techniques in the process of identification and elimination of waste, improving quality and reducing costs. However, there were differences when working with this concept. Therefore, Hines et al. (2004) argue that two approaches have appeared over time. The first level is operational and second is strategic level. These organizational levels have distinguished in aspects, for instance goals, the degree of assessment of results, etc. [Sturdy, 2004, Shu & Shi, 2010] (Table 2).

Tab. 2. Types of production strategies and competences

Levels	View of value	View of philosophy of lean	Task and objectives	Organizational participation	Techniques and tools	KPI
Operational level	Satisfaction on the specific customer's requirement (quality, quantity, etc.)	Comfortable tools and techniques to eliminate waste	Eliminate waste and improve operational activity	Manufacturing	Tools that can apply in the production (5S, Value stream mapping, etc.)	Specific indicators such as OEE, time of cycle

Levels	View of value	View of philosophy of lean	Task and objectives	Organizational participation	Techniques and tools	KPI
Strategic level	Deep knowledge about market's requirement and how it is possible to satisfy it	Building the lean thinking	Implementing lean philosophy on the all organization's level and making "lean company"	The all levels of company	Continuous improvement	Only financial indicators

Source: HSE

In this case, it makes an emphasis on the strategic level because it has straight-line relationship with it. So, in strategic level lean management consider in view as running the company, forming the corporate culture inside company. It is not only tool but also a way of thinking, going beyond product's quality and satisfying customer's needs. Implementing lean management only manufacturing level, company does not create long-term success for a business [Wang & Huzzard, 2011]. Womack and Jones (2005) identify the main objective of this philosophy is to build not just a "lean organization" but also "lean solutions" to achieve long-term success.

A few number of companies outside of Japan which introduced this philosophy, has been successful [Kadri, 2010]. Scholars argued that the frequent obstacles to implementation of LM are factors related to culture, finances, time and the necessary skills [Baglee & Knowles, 2010]. Moreover, Benton and Shin (1998) noted that the main implementation problems related to the cultural, human and geographic factors. Therefore, implication of lean system is a difficult task. The main barriers that companies usually faced are described below.

1. Organizational barriers. Often, enterprises implementing lean production occur organizational culture that directs employees to think that the time spent on the improvement of the process is more precious than time spent on the usual "real job." In this regard, there are various barriers of an organizational nature. At the end, participants in the process are not aware of the benefits of the improvements, which means that not all employees are involved in the process of improving and do not understand its necessity. The most common are listed below:
   1.1 Top management resistance [Sohal & Egglestone, 1994; Axelsson et al., 2005; Staudacher & Tantardini, 2007; Hagstrom & Wollner, 2011]
   1.2 Lack of top/senior management focus leadership [Shingo, 1989; Suh, 2001; Ducharme & Lucansky, 2002; Houshm & Jamshidnezhad, 2006; Sim & Rogers, 2008; Urban, 2009; Veiga et al., 2011]

1.3 Lack of top/senior management involvement (commitment and support) [Tracy, 2007; Scherrer-Rathje et al., 2009]

1.4 Lack of formal training for managers [Schein, 2004; Wan & Chen, 2009; An & Kodali, 2010; Wong & Wong, 2011b]

1.5 Lack of supplier collaboration or lack of mutually beneficial strategic partnership with suppliers and customers (supply chain members) [Forza, 1996; Shah & Ward, 2003; Taj, 2005; Wong et al., 2009]

1.6 Absence of a sound strategic action/logistical planning system [Bhasin & Burcher, 2006; Muslimen et al., 2011; Hagström & Wollner, 2011]

1.7 Lack of logistic support [Gulyani, 2001; Srinivasan, 2004; Gubbins, 2007; Hagström & Wollner, 2011]

1.8 Lack of consultants and trainers in the field [Tracy, 2007; Scherrer-Rathje et al., 2009; Cudney & Elrod, 2010]

2. Communication barriers. Implementation of lean manufacturing requires not only the using of the instrumental approach, which gives results only in the early stages of implementation, but also working with the corporate culture. Management of enterprise directive sets new rules, which are subject to all the staff, and employees do not understand the main point and purpose of these changes. The following are common barriers:

   2.1 Lack of communication between management and workers [Scherrer-Rathje et al., 2009; Cudney & Elrod, 2010]

   2.2 Lack of cooperation and mutual trust between management and employees [Staudacher & Tantardini, 2007]

   2.3 Cross-functional conflicts [Upadhye et al., 2010]

   2.4 Lack of information sharing or communication with suppliers and customers [Karlsson & Ahlstrom, 1996; Tracey & Flinchbaugh, 2006; Brown et al., 2006b; Oduoza, 2008; Hines et al., 2010; Cudney & Elrod, 2011]

3. Motivation. The company's employees are especially slow down the implementation process as well as the overall picture of implementation. Moreover, the desired results do not reach up to the operational level or it cannot motivated to reduce costs and increase value. The following are common barriers.

   3.1 Lack of empowerment of employees [Cheung & Podolsky, 1993; Barrett & Fraile, 2005; Carroll, 2005; Barrett & Fraile, 2005; Jones et al., 2006]

   3.2 Workers' resistance [Franklin, 2004; Buesa, 2009; Wong et al., 2009; Eswaramoorthi et al., 2011]

3.3 Lack of perseverance [Su, 1994; Emiliani & Stec, 2005; Wong et al., 2009; Camagu, 2010]

3.4 Lack of formal training for workers [Hurd, 2004; Houshmand & Jamshidnezhad, 2006; Eswaramoorthi et al., 2011]

3.5 Incompatibility of lean with the company bonus, rewards or incentives systems [Cudney & Elrod, 2010; Upadhye et al., 2010]

4. Supply chain management. With the introduction of lean production, the use of outdated methods to manage stocks has a negative character. Emerging issues have a negative impact on the work of the whole enterprise, because the more inventory is in stock and production, the more money is "frozen" in these stocks. Stocks do not add value to the product. The following are common barriers.

4.1 Lack of cooperation from suppliers [Salaheldin, 2005; Liker & Meier, 2006; Wilson, 2010]

4.2 Lack of influence over suppliers or lack of involvement of suppliers in the actual implementation [Ward et al., 1995; Liker, 2004; Liker & Meier, 2005; Dahlgaard & Dahlgaard-Park, 2006; Moyano-Fuentes & Sacristán-Díaz, 2012]

4.3 Quality problems with supplied material [Forza, 1996; Shah &Ward, 2003; Taj, 2005; Wong et al., 2009b]

5. Other. With introduction of lean production, management should take into account the intricacies of doing business, in a particular, staff attitudes, mentality, and technology. The following are common barriers.

5.1 Cultural difference [Lloyd et al., 1994; Dyer & Nobeoka, 2000; Sako, 2004; Herron & Hicks, 2008; Robinson & Schroeder, 2009]

5.2 The lack of resources to invest [Bateman & Rich, 2003; Achanga et al., 2006; Pedersen & Huniche, 2011a; Eswaramoorthi et al., 2011]

5.3 Slow response to market [Wan & Chen, 2009; Cudney & Elrod, 2010]

5.4 Problems with machines and plant configuration [Heragu, 1997; Wong et al., 2009]

Lean management and Industry 4.0

Nowadays, more and more elements of the industry focused on the interaction of components in the production and the final product without human intervention. In many research centers, researchers put the emphasis on the concept of Industry 4.0, which is one of the key future paintings [Kempf, 2014]. When modeling the future, it is assumed that the effect of a new industrial revolution in the development of the economy would be enormous, as the Industry 4.0 promises a significant increase in operational efficiency, as well as the emergence of entirely

new business models, products and services (Fig.1). However, without the use of modern techniques and production management practices in the current stage of development of production is impossible to present a complete picture of the implementation of Industry 4.0 [Kagermann et al., 2013; Kagermann et al., 2014]. New industrial revolution will have a significant importance in the implementation of lean manufacturing practices. Its techniques and tools are able to overcome the currently existing barriers. However, some scholars argue that management style can depend on the specific complexity of a project. Therefore, new challenges can appear in implementing a lean management. Moreover, when it is possible to combine lean management with other techniques, different barriers can impede the integration, for example technological variables [Hertogh & Westerveld, 2010; Chiarini, 2014; Pampanelli et al., 2014].

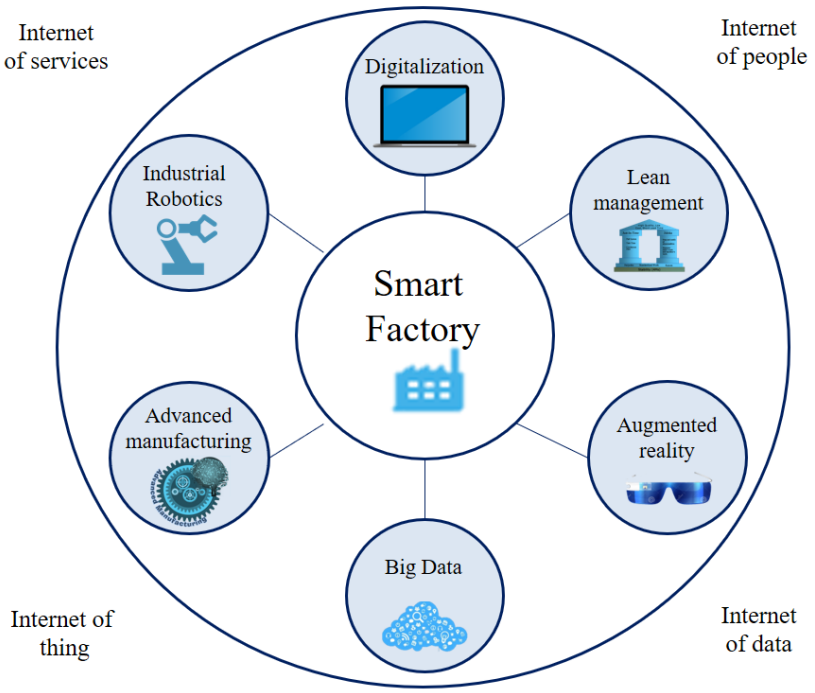

Figure 1. Components of Industry 4.0

Source: HSE

With the advent of the fourth industrial revolution, the applicability of lean management philosophy will acquire special importance. Its principles, its methods are likely to become more relevant and important as new industrial revolution makes it possible to better understand the structure of consumer demand and significantly speed up the process of data exchange and information throughout the value chain [Kagermann et al 2013; Kagermann et al., 2014]. It should be noted that also new industrial revolution could change the nature of lean. It called new challenges as well as manufacturing production technology will also be changed, because the emphasis in production will be placed on customized sector [Abdallah et al., 2009].

Smart Factory will be able to produce the required amount of product, while spending fewer resources than at present. On the other hand, with the rapid changes in both the external

and internal environment of the organization, namely the advent of robotic technology, the replacement of human labor and other technologies, traditional methods and tools of lean management can significantly knowledge-undergo changes. For example, it is expected a significant decrease in the area of imaging techniques such as Andon system or use Whiteboards. Nevertheless, one of the important aspects of the new industrial revolution is the ability to share-and act on-real-time information in a coordinated end-to-end supply chain, which will direct the production to a significant reduction in the time form of instant just-in-time pull production [Martínez et al, 2013; Mostafa et al., 2016]. In addition, there are significant challenges associated with the investment and the necessary resources, such as infrastructure. It keeps in mind not only the purchase of technology, but also the ability to integrate them into the supply chain and internal environment of the organization. High initial investment might become an entry barrier [Andersen et al., 2016].

Any improvement is the most cyclical process that begins with the initial idea and ends elaborated strategy actions for its implementation and the establishment of a permanent habit of employees. It is known that any improvements are logistical certain sequence, and continuous improvements make to repeat these cycle periodically. One of the most famous and best working practice is the Deming cycle or PDCA cycle. In other words, this cycle is P-plan, D-do, C-check, A- act and it displays the correct sequence of the implementation of improvements. Moreover, it is demonstrating one of the main principles of lean manufacturing [Witcher, 2002].

Today, vast amounts of data are used in large enterprises in the analysis and the person cannot process it at the same rate as the machine can perform. It becomes appropriate to give the machines, equipment the opportunities to interact with each other in the production and the environment. Most processes can be significantly improved for efficient, flexible and cost-effective operation due to using medium that can be equipped with appropriate equipment [Lee et al., 2015].

In the fourth industrial revolution, it is assumed that the production facilities will occupy an integral part of the whole system and will be equipped with cyber-physical systems, which is a single whole of the Internet and the real physical objects. Moreover, it has the positive features: the interaction with the environment, adapting a rapidly changing environment, rapid reconfiguration, self-optimizing. Using a variety of sensors and built-in mechanisms have a significant impact on the structure optimization of the company, as well as it can lead to a substantial conservation of resources of the enterprise. This approach can further convert the production system into an environmentally safe, efficient advanced manufacturing [Lee et al, 2015].

Thus, the possibility of applying the fourth industrial revolution in the system of lean production, namely, the use of the Deming cycle, is possible to observe the following modification (Fig.2)

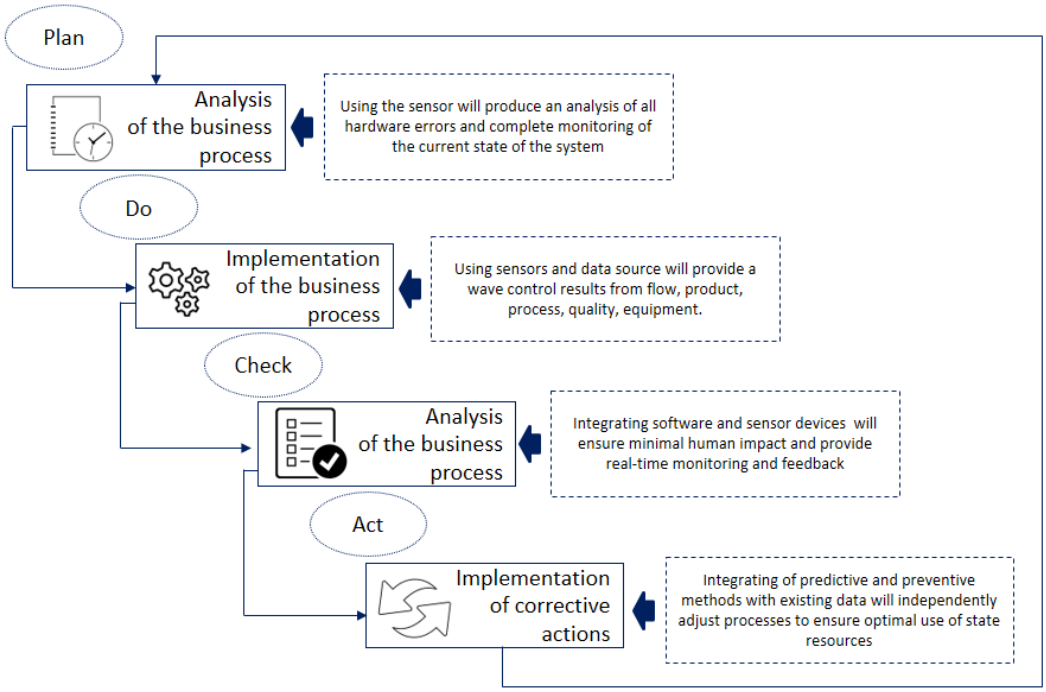

Figure 2. PDCA cycle and Industry 4.0

Source: HSE

Plan. In the classical sense, this step is the initial step on the road to improvement. The company's management proceed to the identification of the problem, its description, as well as to the collection of information characterizing the problem of past failures in the system and formulate the next targets. In the new industrial revolution, it becomes possible to use the sensor, which is able to review and diagnosis system to provide full detailed information about the current operation of the system. The program will answer these simple questions: what and how often there were errors in the recent years. It also responds to more complex issues, such as the statistics data, and can analyze all the hardware errors.

Do. This step is aimed at realization of the work plan, and monitoring the activities taking place. Using sensors and data source will provide a wave control results from flow, product, process, quality, equipment. Tracking performance will occur as often as necessary, which will also be determined by the system itself.

Check. This is one of the most important stages of the cycle. However, managers often miss it. At this stage, it is necessary to analyze the results. If manager has found deviations from the defined parameters, it is advisable to return to the planning stage and make the cycle anew. In the context of the fourth industrial revolution, manager can focus efforts on software integration

of sensor devices that provide minimal human impact on the operation of the equipment. It should be noted that the impact on system operation personnel is one of the most serious barriers to enterprise resource optimization. Furthermore, the possible integration provides monitoring in real time and the system will give timely feedback.

Act. At the final stage of the cycle, there is a confirmation of the results of this work, which can later be standardized. Management of the company start the implementation of new ideas to improve the production process. Integrating of predictive and preventive methods with existing data will independently adjust processes to ensure optimal use of state resources. It should be noted that at this stage, new ideas to improve the process appear and the interaction the sensors with the external environment can provide data on the company's consumer demand, to predict changes in consumer desires, and perhaps yourself restructure processes to changing conditions.

To date, there are few studies on the combined approach of lean manufacturing and the new industrial revolution. However, it is worth noting the study of Dennis Kolberg and Detlef Zühlke, who attempted to determine the place and the role of lean technology in next industrial revolution. The authors identify four aspects, where the tools of lean manufacturing can express themselves sufficiently. They allocate smart operations, smart products, smart machines and smart planners. Scholars show that the integration of innovative technologies in the automation system of the enterprise is relevant and promising topic. Now there are gaps in their integration, such as the lack of necessary infrastructure. However, the authors note that both systems can bring added value to each other. Thus, gradually, with the help of the Deming cycle, companies can get closer to the new trends, responding quickly to various difficulties [Manufacturing Industry Perspectives, Deloitte Industry 4.0. Challenges and solutions for the digital transformation and use of exponential technologies].

Mixed approach: lean management and Foresight

Integration method of Foresight studies and lean production is not particularly gained relevance and interest from researchers. Since most Foresight studies carried out under conditions of forecasting the development of the country or some area, but not at the level of the company. There are a number of reasons, for example, the lack of a specific methodology, the introduction of restrictions on the company level, the specifics of the business, as well as high cost.

Lean manufacturing can act as a link between the current states of the company and work in the new industrial revolution. The first step is describing the general characteristics of the impending changes regarding the production. It includes a review of aspects related and modification of the production chains. In addition, it includes changing the corporate culture related to the transition to robotics, and with the advent of new technologies to reduce costs, and challenges

arising from the replacement of human labor in artificial intelligence. Moreover, many researchers noted that the new industrial revolution unlike previous characterized by close integration of information and communication technologies with the classic industrial processes. In this form it so-called as cyber-physical systems. The above facts are put before the management system of the new challenges, the solution of which causes some difficulties when using traditional methods. Thus, the introduction of lean production systems at the enterprise can help facilitate the transition of modern enterprises to new conditions and to help them better adapt to changing environmental conditions.

The use of Foresight sessions in the industrial sector reveals for the company's ways of optimal using the resources of the enterprise and it can significantly reduce costs, which is especially important for the company that implements the methods and tools of lean management. In addition, the methods of Foresight include a multi-level and multi-disciplinary work of experts, aimed not only at the image of the desired future state, but also to propose measures and techniques to achieve it. Figure 3 demonstrates a conceptual diagram of Foresight research and its impact on the implementation lean tools.

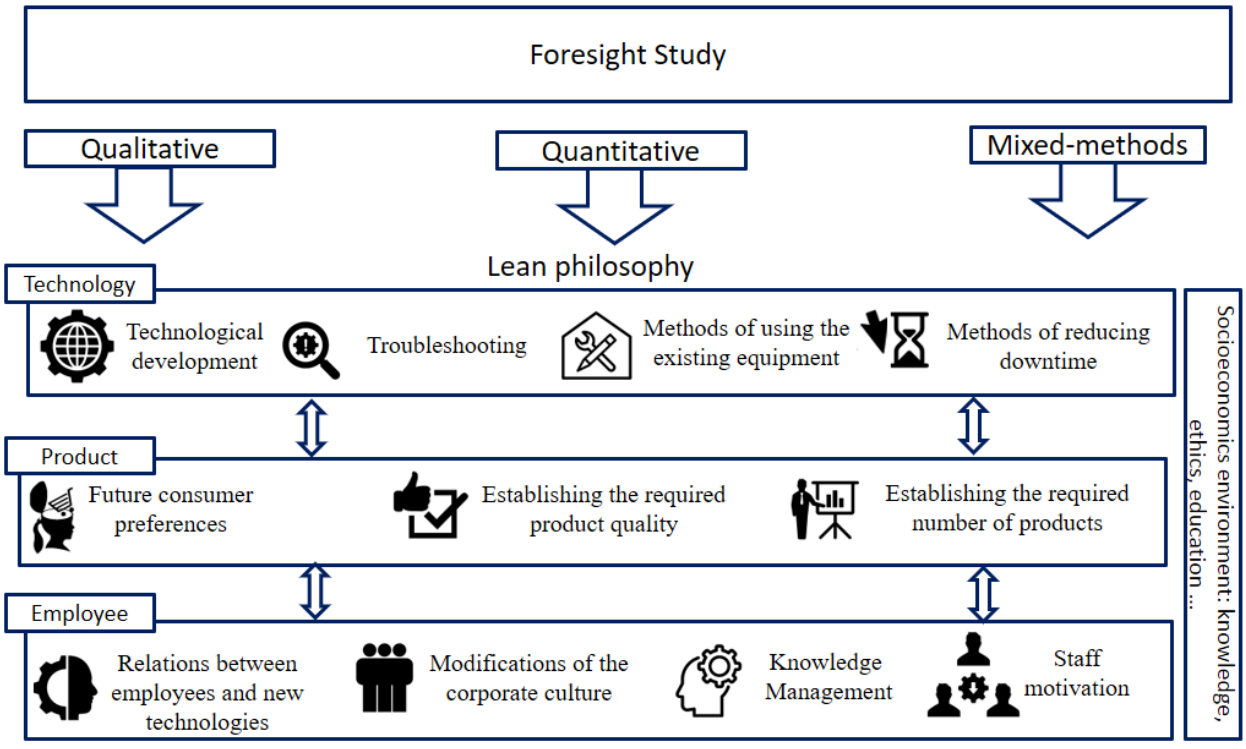

Figure 3. Combining approach of lean management and Foresight to support long-term development of the company.

Source: HSE

In modern conditions of growing competition in the markets it appears the need to use the methods of long-term forecasting and planning, which is based not only on the extrapolation of

trends, but also takes into account the possible radical changes of products, markets and technologies is gaining popularity. Such studies have become an integral part of the organization, as it contributes to management focus and optimize efforts on the priority area of the company's future [European Commission, 2010]. Methods of Foresight studies are also an excellent tool for long-term analysis of the development of industrial enterprises introducing lean production. Currently, more than 30 known methods of this tool. It includes quantitative methods (Benchmarking, Bibliometric, Modelling, Patent analysis, etc.), qualitative (Brainstorming, Expert panels, Scenario writing, Literature review, etc.) and semi-quantitative methods (cross-impact/structural analysis, Delphi, Roadmapping, Stakeholder Analysis, etc.). Through implementation of Foresight based on the condition of the company, taking into account the development of the industry trends, it is clear and understandable, what changes can relate to the internal environment of the organization. Thus, the conduct of Foresight modifies the implementation of lean management on such key aspects as technology, products and employees [Vishnevskiy et al. 2015].

Corporate Foresight includes 4 phases: Preparation, vision, analysis and prioritization system. At these stages are formed of experts from the test subject area, the development of the key trends and create a conceptual vision of the future, as well as the assessment of market opportunities and development priorities and possible competitive advantages. Further, it should be the development of roadmaps, which are aimed at the implementation of the selected priorities, visualize them on a suitable time interval. This stage also consists of four phases: preparation, analysis, prioritization system and further implementation. Thus, the main purpose of the first phase is to create four special groups of experts with a focus on technology, markets, cross-industry issues, and independent experts. The next phase aims to assess the requirements of consumers. At the stage of drawing up a priority system, the basic idea is to assess the combination of the identified group of innovative technologies and the market demand. In addition, the last stage is dedicated to the development of the plan, as well as recommendations on building innovative strategies and trajectories. Thus, after the preparation of the roadmap the company can choose the most appropriate path of development, taking into account the impending trends in technology and in market demand changes. In order to achieve the desired state of the future, it is necessary step ghosts of the current state of the company in the form of suitable, ready for the new changes [Vishnevskiy et al., 2014, Vishnevskiy et al., 2015]. Lean management is just able to fully meet the needs of the consumer, and the introduction of this philosophy takes the same amount of time as the majority of Foresight studies. It is about 10-15 years old [Vishnevskiy et al., 2014; Vishnevskiy & Karasev, 2016].

Lean management can act as one of the possibilities to accelerate the transition to the fourth industrial revolution. With the ability to use systems that are able to communicate and in-

teract with the environment, the company can make optimal use of their resources with zero losses, release staff from unnecessary work and fully adapt to the needs of consumers. Companies that successfully integrate the Internet, computing technology, big data with a strategic vision, are at a more advanced level of the lean implementation.

Conclusion

Every company has special conditions of the internal environment and its interaction with the environment. There are barriers to implementing lean management, which contributed both domestic and foreign scholars. The authors of the present study have been identified these barriers. Firstly, it barriers which include changes due to the higher resistance of personnel and lack of involvement in the process and support. Often, managers are faced with a lack of motivation to achieve the set goals. It be due to the lack of opportunities of successfully implementing system, which significantly discourage staff. In lean manufacturing strong emphasis placed on the efficient use of production capacity, due to which there may be barriers associated with on-servicing equipment wear and its technological obsolescence. Moreover, this concept involves building long-term relationships with suppliers, based on trust. However, there can also be barriers such as the lack of impact on the suppliers or their lack of involvement.

The new industrial revolution affects all lean management; its corresponding trends have a positive impact. For example, major information technology trends such as big data, advanced analytics, social technologies, and the Internet of Things all can be harnessed in supply-chain management and other aspects of manufacturing. In particular, Big Data has impact across manufacturing value chain on implementing lean manufacturing, model and optimize production, develop dashboards. Lean is about eliminating waste, variability, and flexibility in the value chains. Moreover, the lean movement is far from finished, and shifting demand to developing economies raises the need for productivity improvement. Manufacturers may need to devote as much effort to resource optimization, as they have to lean and other performance improvement initiatives in the past.

Further, the connection was built between Foresight and lean production. The combination of these technologies, lean manufacturing can act as a bridge between the current state of business and the new industrial revolution. Quantitative, qualitative and mixed methods of Foresight studies produce recommendations, following which the company will be ready to meet new challenges. It is worth noting a positive thing: Foresight studies are guided by the perspective of 10-15 years. This period is the best for the implementation of lean management systems in the enterprise. This fact shows the need for companies to think seriously about the prospects of cooperation between these two concepts. Next, a modification has been considered PDCA cycle in

the new industrial revolution. This cycle is the basis of the philosophy of lean production and plays an important role in the implementation of continuous improvement.

The results of this study suggest of further research: for instance, preparation of the roadmap in a particular company and the development of practical measures for the long-term development. Moreover, future papers can focus on the following topics:

- What are the limitations of the combined approach?
- What competencies might be necessary for successful implementation of the proposed approach?
- What barriers can appear when using the proposed approach?
- What are the results of the proposed model will show in practical terms?

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