Barriers to Eliminating Waste in Production System

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Abstract

The paper is based on a case study conducted in a large-sized production service company, manufacturing plastic products. The presented research concerns the efficiency of project implementation encompassing lean manufacturing concept. For this aim the scope of the implementation of such tools as 5S, SMED, TPM, Hoshin Kanri, Kaizen and Kanban, and their meaning in the elimination of different types of waste were analysed. Afterwards, within the context of the company's goals, due to the implementation of lean concept, the possibility of elimination of particular types of waste was assessed. The obtained results were fairly limited. The unsatisfactory functioning of lean manufacturing tools was not only related to the ways of the implementation of particular tools but also other circumstances such as lack of the fundamentals of the implementation of lean philosophy or lack of culture change and continuous improvement. As a result a dedicated procedure facilitating the application of lean manufacturing tools was elaborated. Its implementation can also enable to broaden the scope of elimination of particular types of waste.

Keywords: implementation efficiency, lean manufacturing, lean tools, project efficiency, waste elimination.

Introduction

The concept of "lean" was first introduced by a research group at MIT after studying Toyota Production Systems in Japan in the 1980s (Womack et al. 2007). Since then it is one of the most often promoted methods in contemporary management, particularly in production industry (Vogel 2008, Dombrowski 2011, Fischer & Stowasser 2013). According to the National Institute of Standards and Technology Manufacturing Extension Partnership's Lean Network it is "a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection." It should result in creating pro-saving work culture not abandoning quality improvement and good relations with client, adjusting to new surrounding requirements. Being lean means using: „…less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products" (Womack et al. 2007). However, it is worth to emphasize that the fact of minimization of the number of defects results from the elimination of their causes in the preparation, planning and manufacturing stages, not after monitoring. It is an effect of a complex, pro-quality management in all areas of enterprise activities (TQM), which is often perceived as a basis for the application of this concept

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(Pfeiffer & Weiß 1992, Hopej & Szeloch 1994, Rzeszotarska 1994, Wyrwicka 1997, Wyrwicka 1999). The significance of time factor (defined as labour intensity, durability, timeliness) as a determinant of competiveness should be also emphasized. In addition to fast customer service, it is vital to strive for the minimization of production preparation cycle (time to come to the market). The examples of the expected effects of the lean concept are presented in Table 1.

Table 1. The effects of application of lean concept

Lean management inside enterprise (technical-organizational sphere)	Lean management with reference to enterprise relations with surrounding (tactic-strategic sphere)
Shortening time of production preparation and manufacturing cycles	Limiting the scope of own basic activity to the key branch
Shortening product life cycles	Selecting independent units from the enterprise structure (outsourcing, spin-off, spin-out)
Improvement of production stream flow	Delivering supplies right on time (just-in-time)
Simultaneous engineering	Suppliers are also responsible for quality
Searching for standard solutions	Involvement of suppliers in the realization of changes and development planning
Creating small entities	Creating networks and chains between suppliers, producers and customers
Flattening organizational structure (decreasing the number of decision levels)	Concept of self-learning enterprise, building human capital
Organization focused on group and team work	Exporting production to low wage regions
Delegating decision-making (decentralization)	Incorporating cooperation agreements and strategic alliances
Employee regrounding	Relation of collaboration and partnership

Source: (Wyrwicka 2003, p. 28)

A lean system is represented as two pillars: the first is ‘jidoka’ (stop and notify of abnormalities, separate man’s and machine’s work) and the second is ‘just-in-time’ (continuous flow, tact time and pull system). Its main goal is to produce products of higher quality at the lowest possible cost and in the least time by eliminating wastes (Dennis, 2007). In the lean manufacturing implementation it is possible to differentiate the following steps (Gupta & Jain 2013):

- identification of wastes in the system,
- recognition of types of waste and their causes,
- finding the solution for the root causes,
- finding and testing the solutions first for the system.

Contemporarily, the implementation of lean manufacturing is methodically elaborated under assumptions that waste elimination, which can be divided into nine categories[1], can be guaranteed by the application of a few organization techniques in a defined sequence (Wyrwicka 2009, Zasada 2011). Among them the following can be distinguished:

- organizing work stations – 5S – the appropriate application of this tool supports the realization of continuous flow and assures visual manufacturing control (Cyplik & Hadaś, 2013),
- fast refitting – SMED (Single Minute Exchange of Dies) – all methods focusing on reducing changeover and set-up (it should be no longer than 10 minutes),
- complex maintenance – TPM (Total Productive Maintenance) – based on all employee involvement to identification, monitoring and eliminating losses caused due to: breakdowns, equipment setup and adjustment, idling and minor stoppages, spills and process upset conditions or not satisfactory quality,
- cascade and decomposition of the organization's goals between all levels of employees, which means strategy development at different levels of the organization – Hoshin Kanri,
- continuous improvement towards perfection – Kaizen,
- a "pull" production system which improves material flow in a separate production process – Kanban.

All these tools have its own implementation steps which are widely described in the literature (Weber 1994, Charron 2015).

The application of the lean tools, such as: 5S, SMED, TPM, Hoshin Kanri, Kaizen or Kanban, allows to eliminate: overproducty transport, waiting, inventories, over-processing, repairs and defects. 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".

Materials and methods

The investigated company was founded in 1986 and now it employees 310 people (including 270 production workers). It offers a wide range of plastic products in three product lines: (1) – most numerous for gardens, (2) – kitchens and bathrooms, (3) – less numerous for decoration of gravestones. With internationally oriented sales program, these products are not only sold in volume on Polish market, but also in the European Union and in some eastern markets. Since a few years a number of its clients is stable.

The implementation of Lean Manufacturing has started in 2008 and its aim was to improve enterprise performance, increase its market and competiveness. In the first step a company, which was responsible for conducting trainings about basic techniques and tools of lean management: 5S, value stream mapping and problem solving, was chosen. These trainings were organized for the significant part of the staff. In the next steps, one employee was chosen for a coordinator of tool process implementation.

In order to better acknowledge the reality of the situation the participant observations were carried out in the period of two months. Moreover, seven production employees, who occupied different posts and had different points of view about the need of lean implementation, participated in the interview. They were mechanics (3), injection moulding

[1] There are usually overproduction, unnecessary motions, delays (waiting time), unnecessary transportation, inventories, defective products, over-processing, unutilized employee skills and un-ergonomic working conditions (Wyrwicka 2009, Golińska 2012).

machine workers (3) and production supervisor (1). All of them worked in this company for many years. The interview consisted of questions about lean tools implemented in the firm, barriers identified during their implementation and also benefits resulting from their application.

For the further investigation it should be emphasized that just before lean implementation a robot line was bought and the second production floor was built. Thus, not all activities undertaken to improve enterprise performance and efficiency can result from Lean Manufacturing. In the investigated enterprise the following tools are used: 5S, SMED, TPM, Hoshin Kanri, Kaizen and Kanban.

Results and discussion

The most common answers indicated the introduction of order and arrangement on worksites to decline time for searching items. The employees also mentioned reduction of production supply to the amount required by customers and decrease of failure frequency. According to the respondents such benefits were also noticed as elimination of faulty products, which were produced on not properly working machines, decrease of needless movement, elimination of waiting resulting from the lack of material and decrease of time of exchange of die which used to last half of the shift.

When the respondents were asked to list benefits of Lean Manufacturing, which were not achieved, they were all united in indicating time of exchange of die. The assumption is that all changeovers and start-ups should take less than 10 minutes. It was also possible to find responses that in spite of introducing TPM, machines often waited for repair for a few days.

According to the condition of the end of 2014, the implementation of the Lean philosophy in the investigated enterprise allowed to: order worksites, reduce time of exchange of die, supply decrease and improve machine availability in a small degree.

In order to identify the scope of implementation efficiency of Lean Manufacturing implementation procedures were identified and they were confronted by the enterprise reality, determining percentage levels of implementation of particular Lean tools. Its results are presented in Figure 1.

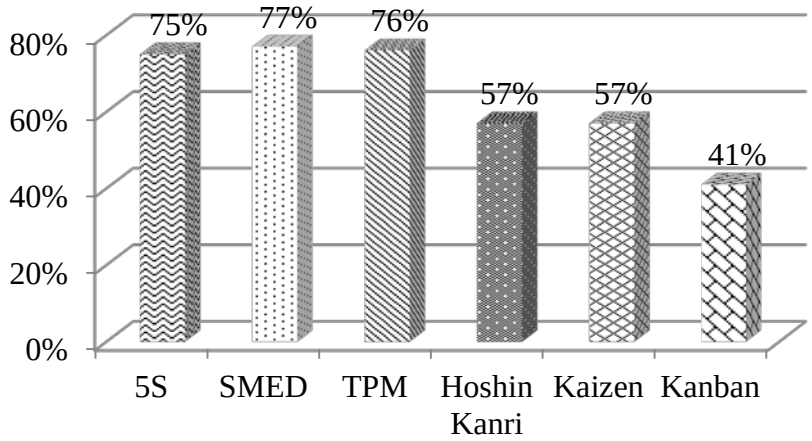

Figure 1. Level of implementation of Lean Manufacturing tools in the enterprise

As it can be noticed such tools as: 5S, SMED or TPM were implemented in the greatest scope according to the procedures described in the literature and thereby they should provide the most efficient solutions for the enterprise. The plan of the implementation of Hoshin

Kanri and Kaizen was done only in 50% what may result in their not full activity. As far as Kanban is concerned even a half of assumptions was not put into life, and also very important issues were omitted. As it was mentioned before it can be the result of a limited application of this tool.

Implementation barriers

The results of the study based on the interviews (with 7 people) and participant observation showed that neither common training for project coordinator and employees directly responsible for preparing the lean implementation nor enterprise strategy for implementing lean guarantee concurrent progress in all areas of waste elimination. The most often implementation barriers were: concentration on production results, not understanding lean philosophy, lack of communication between supervisor and their employees, problems concerning contemporary activities, poor motivation system, people mentality, wasted human potential (unused competences), workers' fluctuation and lack of ability to work in team. All these barriers are typical for Polish and European reality (Neuhaus 2013).

The influence map, which allows system analysis of barriers in the implementation of Lean Manufacturing in large Polish production companies, proposed by B. Zasada (2011), is depicted in Figure 2.

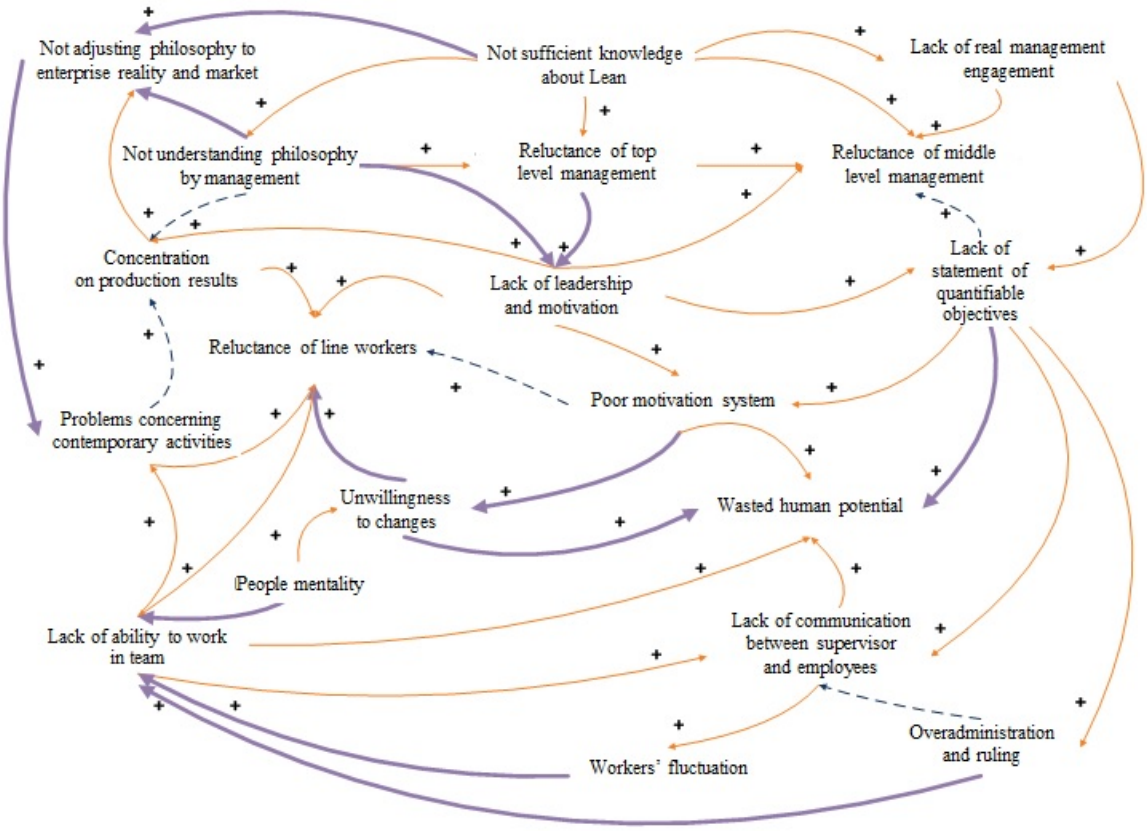

Figure 2. Network thinking in analysis of lean manufacturing implementation (Zasada 2011, p. 122).

Effects of waste elimination

The application of six lean tools was supposed to eliminate each type of seven wastes in the enterprise, however, in practice it turned out that it was only possible to reduce (Jasińska, Żurek, 2015): overproduction (50%), unnecessary motion (100%), unnecessary transport (75%), waiting (40%), inventories (67%), over-processing (100%), repairs and defects (0%). The detailed results of this study are presented in Table 2.

Table 2. Effect summary of waste elimination using Lean Manufacturing tools.

Tool / Type of waste	5S	SMED	TPM	Hoshin Kanri	Kaizen	Kanban
Overproduction						
Unnecessary motion						
Unnecessary transport						
Waiting						
Inventories						
Over-processing						
Repairs and defects						

Description	Symbol
The effect of waste elimination assumed in the concept of the method	
The effect of waste elimination assumed by the enterprise	
The effect of waste elimination not achieved by the enterprise	
The effect of waste elimination achieved in 50% by the enterprise	
The effect of waste elimination achieved in 100% by the enterprise	

Source: (Jasińska & Żurek, 2015)

In the case of the enterprise, which produces plastics, zero effect on decreasing the number of defects or repairs is not perceived as a problem as the faulty or unusable product can be recycled. Much more alarming are low effects in elimination of overproduction and inventories. The activities undertaken to reduce inventories and unnecessary transport produce noticeable results, however, they are still not the results of enterprise goals. In spite of the application of so many lean tools, it was not possible to eliminate waiting waste. The full efficiency (100% of effect) was achieved for activities concerning reduction of unnecessary motion and over-processing.

The reason of unsatisfied functioning of some lean tools is likely to result not only from the manner and scope of the implementation, but also other factors influencing their efficient action. For example, one of the reasons can be the lack of fundaments for implementing lean philosophy and culture of change and continuous improvement. It is also possible that the employees do not cooperate, feel that they belong to the enterprise, and thereby they do not identify with its problems and needs, have psychological barrier between them and managers. Moreover, their knowledge about lean philosophy can be also negligible as well as awareness of basic aims, rules and effects which are possible to be achieved due to its implementation.

It can also result from managers' approach to lean manufacturing philosophy only as a solution for lowering operating costs.

Improving actions for the enterprise

On the basis of the diagnosis in the analyzed enterprise 40 improving actions were suggested to facilitate the efficiency of the implementation of lean manufacturing tools. Their order of the activities is shown on Figure 3.

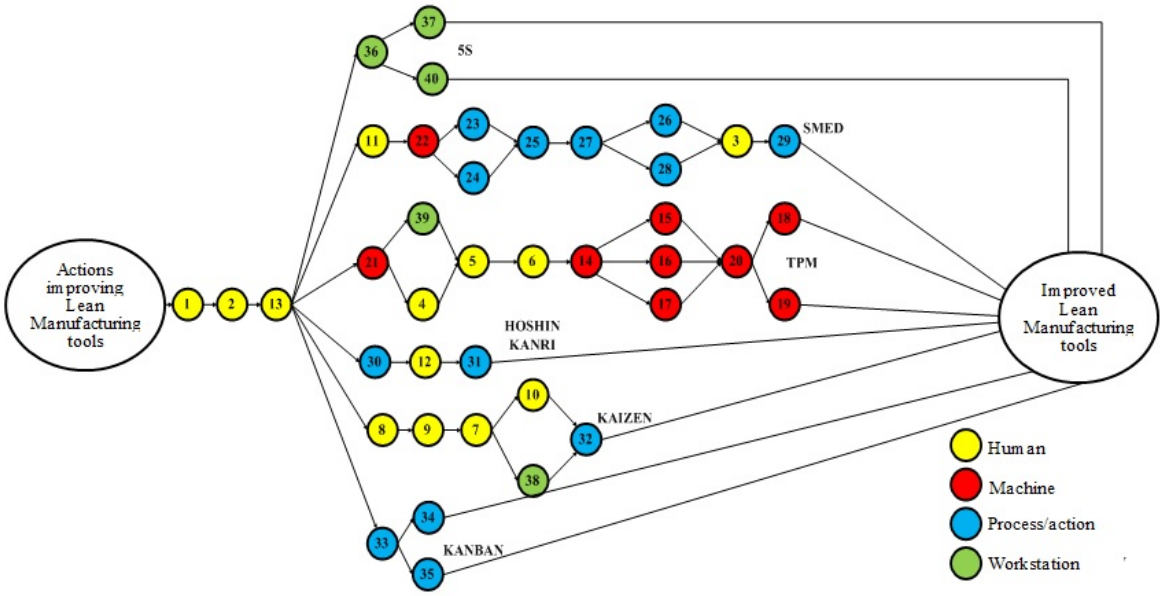

Figure 3. Scheme of introducing improvements to the implementation of lean manufacturing tools (Source: Jasińska & Żurek, 2015)

As it can be noticed the colours indicate the activities referring to human (1-13), machine (14-22), process/action (23-35) and workstation (36-40). The same order was applied in Table 3 which presents improving actions for machines.

Table 3. Suggestions for implementation of chosen lean manufacturing tools in the investigated enterprise

No.	Improving actions	Goal	Remarks
		MACHINE	
14.	Pre-cleaning and inspection of machines with participation of operators and maintenance workers.	Training of operators so as to enable them to repair small failures without maintenance workers. Maintaining machines in a good condition before introducing any improvements.	Activity can be done on Saturday. However, it will increase additional costs, for example the double wages for the employees.

15.	Analysis of machines and equipment with regard to frequency of their use, lack of replacement of bottlenecks, cost of service and work safety.	Division of machines into three groups: strategic, crucial and others. Organization of short weekly meetings for operators of strategic machines in order to discuss current issues and present factors which can improve the efficiency of these machines. In a case of key machines it is advisable to create a reaction service system, and for the rest of them, additional prevention, periodic inspections.	Activity will require time for organization of meetings.
16.	Maintenance schedule and different guidelines for monitoring all three groups of machines.	Determining time, tasks and people responsible for their maintenance and monitoring.	
17.	Analysis of the most often appearing problems during machine operations in the period of 5 years and preparing procedures.	Decreasing machine failure frequency and finding solutions faster to the problem.	
18.	Precise describing, making photos and creating the best solution for each new failure.	Not allowing to appear the same failure or its repairing in the shortest time.	
19.	Application of „5Why?”	Exploring the cause-and-effect relationships, determining the root cause of a defect/problem, and focusing on effective solution.	
20.	A list of places difficult to control and cleaning and also	Determining actions which aim at their cleaning.	

	a list of sources of contamination.		
21.	Installation of system monitoring machines parameters such as: level of temperature, pressure, wear of lubricating medium, changes in resistance etc.	Earlier detection of problems with machine.	Activity requires high financial expenditures; however, it brings a lot of benefits for the enterprise such as more efficient working of machines.
22.	A list of tools necessary to refitting.	Verification of their usefulness. It may appear that the application of some tools can be unjustified.	The change of fitting of key components will enable faster performing of operations in more ergonomic way by operators who do not have specialist tools. In order to fit components it is possible to use: thumbscrews, taps, fasteners, electric clamps and quick-fits. The indication of control points, introduction of Polish symbols and unification of screws could also facilitate this process.

Source: Adapted from (Jasińska & Żurek 2015)

Conclusions

The presented case study indicates difficulties in the implementation of Lean Manufacturing in the enterprise and emphasizes the synergic character of lean tools. Such an unsatisfactory effect of elimination of some waste categories can rely not only on the implementation of particular tools. There are many other factors influencing efficient system activity of loss elimination. For example, it can result from lack of fundamentals for lean philosophy implementation or lack of culture change and continuous improvement. It is possible that the employees do not work in a team, have a sense of belonging to the enterprise and thereby, they do not identify with its problems and needs or have a psychological barrier between them and management. Their knowledge about lean philosophy or basic goals, rules and effects were also not diagnosed. The situation may also result from management attitude which only emphasizes the need of lowering operating costs.

The presented case study of well-functioning enterprise, which implements Lean Manufacturing, shows the need of profound system research concerning searching determinants of efficient implementation and also consequences during long-term project realization.

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