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## Barriers and opportunities in implementation of Lean Manufacturing tools in the ceramic industry

 Daniel Kleszcz<sup>1</sup>
<sup>1</sup>Ceramik Sp. z o.o., 42-200 Częstochowa, Poland, e-mail: [danielkleszcz@go2.pl](mailto:danielkleszcz@go2.pl)

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### Abstract

The concept of lean management in an organization, improving products and processes using the Lean Manufacturing concept, is discussed in this paper. Striving for excellence is the key factor in maintaining competitiveness on the market. Only organizations able to adapt to changing environmental conditions faster than others achieve an advantage, and the management in line with the Lean Manufacturing philosophy is de facto change management. In this paper, important factors in the ceramic industry, which should be taken into account when implementing Lean Manufacturing are characterized. Important factors affecting the implementation of lean tools include, such as: the size of the enterprise, involvement of employees, knowledge about the Lean concept, technological factor, type and variety of the product line, as well as the specificity of the ceramic industry. The greatest opportunity associated with the implementation of Lean is to increase the competitiveness of the company obtained through: meeting the quality and economic expectations of customers. The greatest opportunity associated with implementation of the Lean is to increase competitiveness of the company obtained through: meeting the quality and economic expectations of their customers. Practice shows, however, that despite the simplicity of rules and tools, few organizations manage to achieve the level of excellence of the pioneer of this concept, the Japanese Toyota Corporation.

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## 1. Introduction

In the literature on the subject, the Lean management concept is mainly applied in the context of large enterprises implementing this concept. Whereas, the possibilities and limitations of its use in small and medium-size enterprises are not described and analyzed very often. If we still refer to the situation in the ceramic industry, it turns out that there is a large gap in the field of good lean implementation practices in small and medium-sized enterprises producing functional ceramics. Against the background of many available methods and concepts of work such as: Controlling, Reengineering, Outsourcing, TQM, Lean is characterized by a way of thinking aimed at increasing productivity and manufacturing products in line with the expectations of customers (Szatkowski, 2014). Currently, more and more organizations associate (integrating) the Lean concept with the Six Sigma concept (Urbaniak, 2010). The Lean concept reduces activities (various manifestations of waste) that do not add value to processes and products, and the Six Sigma concept improves the quality of activities (processes) creating added value in these products by removing various errors (George, 2002).

Improvement projects conducted as part of Six Sigma can be used to support the improvement goals of the Lean concept. The Lean concept is widely described, e.g.: among companies representing the automotive industry (Womack and Jones, 2002; Liker, 2005, Rother and Shook, 2009, Aoki, 2013), IT industry (Pernstal et al., 2013, Bortolotti et al., 2015), or service activities (Locher, 2012). In the ceramic industry, there are very few publications in which the authors (Bhamua et al., 2015; Bonavia and Marin, 2006) refer to general information related to the elimination of waste and increased work efficiency. Whereas, in the case of Polish ceramic plants, descriptions of implementations of individual Lean tools can be found, for example 5S or standardization (Predoń et al., 2008; Chomicz, et al., 2006).

By implementing individual Lean Manufacturing tools, enterprises attach considerable attention to the implementation of all preparatory and implementation activities included in the procedures, so that a given tool can start functioning as soon as possible. Elements that seem to be irrelevant and not included in the implementation procedures of Lean Manufacturing tools are often overlooked, but in fact they create the basis for the effective operation of Lean philosophy in the

enterprise. It should also be remembered that when implementing lean manufacturing we use the process approach and the organization activities must focus mainly on:

- the sequence of activities, and not on selected aspects of functioning of an organization,
- "from outside to inside" analysis of the organization based on the acceptance of clients' expectations,
- analysis and improvement of all relations among the sub-systems of the organization, and not within particular functions,
- making use of inter-functional teams, including representatives of individual organizational units involved in the process,
- description of the data feeding the process and the resulting values,
- adaptation of processes to external (customer needs, legal provisions) and internal conditions,
- taking into account all relationships so as to make sure that the balance of optimization of one of the elements of the organization causes positive changes in other elements of the system.

## 2. Implementation of Lean Manufacturing

When analyzing the barriers and opportunities associated with implementation of the Lean concept in the workplaces of ceramic plants, it is necessary to recognize the situation and answer two basic questions:

- What effects will the implementation of the concept bring?
- What problems can be encountered during the implementation of the Lean Management in the production of ceramic products?

In order to be able to answer the above-mentioned questions, it is necessary on the one hand to thoroughly analyze the ceramic industry, and on the other hand, to thoroughly understand the Lean philosophy. To be adopted and used by a given company, Lean Management, like any other concept or method of work, must first be analyzed in terms of functionality, suitability, and expenditures incurred for the implementation to be economically justified. It is therefore necessary to analyze many important areas, which include:

- specificity of the industry (ceramics production technology),
- available resources (human, informational, material, financial),
- adopted production system,
- the size of the enterprise,
- infrastructure of the enterprise ,
- customer expectations,
- opportunities for business development,
- increasing competitiveness of the enterprise,
- reduction of operating costs,
- relationship of the enterprise with the environment.

The areas listed above should be analyzed in the context of the Lean philosophy.

J.P. Womack and D.T. Jones defined 5 Lean principles (Womack and Jones, 1996):

- defining what constitutes value for the customers, i.e. determining what properties of a product or service are important to them and makes them willing to pay for it. The concept of value for the client is of key importance in the Lean concept (Hines et al., 2004). This knowledge is necessary to eliminate all the activities that do not add value (wastage). Application of this principle requires keeping close contacts with clients, systematically obtaining information from them and quickly translating information into actions,
- identification of all activities in the so-called value streams for all products manufactured and services provided (or groups of them). The value stream is the flow of materials and information through all the company's cells, from the moment the order is placed by the customer to the delivery of the product. Each of the successive activities performed by departments, teams or individual employees should add value. All activities in the stream which do not add value must be identified, and then eliminated as a result of lean activities,
- Optimizing activities in all value streams in such a way as to achieve a stable flow, i.e. the highest possible liquidity and the speed of delivery of the ordered product or service required by the customer. This requires eliminating all distortions, "bottlenecks" and limitations of variability in processes.
- Creating of the so-called pull system, that is linking the product manufacturing process or providing the service to satisfy the declared demand. This principle allows to produce only what the customer will buy at the required pace and quantities required by the customer,
- striving for excellence, or continuous improvement of all "slimming" processes in the organization.

## 3. Identifying factors affecting implementation of the Lean in the ceramic industry

The ceramic industry focuses around the ceramic plants dealing with the production of various types of assortment (building, sanitary, functional and technical ceramics), and each of these plants is characterized by a different production profile, which causes a problem in the development of one pro-lean solution for the entire ceramic industry. One of the elements common for the entire ceramic industry is the main production processes, without which a ceramic product could not be produced. The production profile of ceramic products varies depending on the type of product range produced and the size of the ceramic plant. There are different sizes of ceramic plants and their production is of individual, serial as well as mass character.

**Size of the enterprise.** The first major barrier to the Lean transformation may be the size of the enterprise. The results of research carried out in ceramic plants (Kleszcz and Ulewicz, 2010) correspond with what has been widely described in the literature on the subject and noticed in research on companies from various industries (Nowicka-Skowron, and

Ulewicz, 2016; Pacana and Ulewicz, 2017). Implementation of lean tools in large enterprises is a conscious, well-planned and long-term undertaking. Large production facilities have adequate resources (financial, material, human, information), allowing them to undertake activities related to the implementation of new solutions.

Whereas, in the case of small ceramic plants, there are such barriers as, for example:

- limited personnel resources, especially the instability and variability of employment,
- problems with planning, especially strategic planning, implementation costs, training and consulting, problems with the preparation and maintenance of documentation.

Small and medium-sized enterprises also have negative features affecting the organization and functioning of the enterprise: the managers (owners) of small companies quite often do not have sufficient management knowledge, are distrustful of organizational innovations, do not have the necessary time or formalized methods of data collection.

However, in the case of small and medium-sized enterprises, we are faced with opportunities related to the transparency of material flows (products) by the company, transparency of organizational structures (which results from their simplicity), speed of information flow and decision making (short information paths, a small number of levels of management, centralization of basic decision-making powers), lack of anonymity of employees and functions, personal contacts and strong personal relationships, high motivations of employees and managers), which also translates into quick and flexible response.

**Location** – of a ceramic enterprise is associated with high costs of raw materials. Occurrence of clay deposits occurs in some regions, and many ceramic plants are located at a long distance from clay mines and processing plants. The delivery of the raw material often takes place in larger batches and causes accumulation of the inventory of the ceramic plant for a longer period of time.

**Customer relations** - business terms (the size of the assortment, the quantity of ordered products in one delivery, short delivery time, returns of goods) have a direct impact on the functioning of the company. In order to provide reliable and timely delivery of orders to customers, ceramic plants collect products in the finished goods warehouse. This state of affairs is an obstacle in eliminating waste and implementing a tool responsible for leveling production (Heijunka).

**Production system.** The company type of production system in force determines the flow of materials and semi-finished products during production orders. Characteristic feature of the production environment in which many ceramic plants currently operate is the organization of a continuous production system. The production system is determined by the firing process taking place in roller or tunnel kilns. The continuous production system forces the planners responsible for production to the appropriate prior preparation of the batch. The continuous heat treatment process is extremely demanding and can be a real cost problem associated with extinction and restart of the kiln. Another, additional problem is the fact that ceramic factories producing ceramic galletry or build-

ing ceramics are exposed to fluctuations in the sale of products due to seasonality. The barrier associated with the continuous maintenance of production affects the storage of inventory. Losses caused by overproduction or shortage of products are an obstacle in eliminating wastage.

According to the Lean concept, the company should adjust the production volume to the sales volume. However, it is difficult to predict trends in demand for particular assortment groups. Sales data from previous periods do not always correspond to the current market situation. In this situation, it is difficult to implement a suction system based on the actual customer demand and thus it is difficult to maintain the actual efficiency of the production line. Manufacturing bottlenecks are another problem. A small number of machines and devices as well as uneven demand from customers leads to high, not always desirable warehouse stocks, which may turn out to be a big problem after the end of a given season. Therefore, the type of production system, bottlenecks and seasonality are major barriers to the implementation of production based on the actual demand of customers in line with the Lean philosophy.

**Labor market** - employee market causes problems with employing people possessing appropriate qualifications. The skills that people working in ceramic plants possess, are an essential element of the company's operations. Work hygiene, diligence, pro-activity on the part of employees have a direct impact on the quality of manufactured products, maintaining cleanliness in the workplace (5S), compliance with standards (Standardization), work flexibility (SMED), improvement of the enterprise (employee suggestion system).

**The assortment and the degree of modernization of the company** - producers of ceramic products (ceramic accessories, ceramic tiles, clinker, tiles) compete with one another, offering their clients a modern, often changing design (changes in design and shape introduced several times a year). Customers are more and more demanding, and an enterprise that is attractive on the market must offer not only high quality and low price of products, but also products with an interesting design. A wide and dynamically changing assortment in relation to a limited number of machines and devices results in a situation in which managers must carry out production based on inventory.

#### 4. Surveys

The research was carried out in 2017 in a ceramic plant producing ceramic accessories. Surveys that were used to collect the research material were carried out among 36 employees. The respondents occupied various posts, but mainly production ones. Majority of the respondents were people with seniority of 6-12 years or more, which is significant in determining barriers and limitations during the implementation of lean manufacturing. The first lean management tools in the surveyed enterprise were implemented in 2010. The conducted survey has an exploratory character and requires extending the research to a significant group of plants in a given branch of the ceramic industry (e.g. producers of

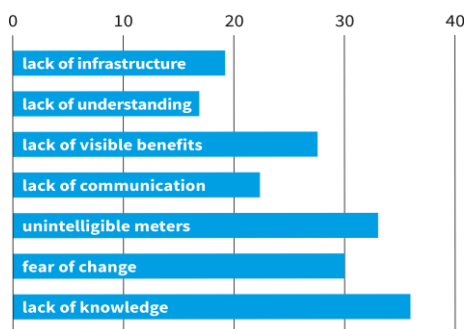
ceramic accessories). The questionnaire, in addition to the data identifying the respondent (s), included multiple-choice questions regarding:

- applied Lean Manufacturing methods and techniques,
- positive effects of the use of Lean Manufacturing,
- negative effects of the use of Lean Manufacturing,
- barriers and limitations during implementation of Lean Manufacturing, areas of implementation of Lean Manufacturing,
- methods of motivating employees.

On the basis of the empirical research, the following barriers and limitations occurring during the implementation of lean manufacturing have been identified:

- lack of knowledge, support and commitment to implementation of Lean Manufacturing displayed by company top management members,
- fear of change, insufficient knowledge about Lean and the objectives of its implementation, negative experience from previous implementations and initiatives,
- unintelligible measures used at the operational level – no feedback to the employees,
- lack of proper communication,
- no visible benefits from the implementation of Lean Manufacturing,
- lack of understanding for the continuous improvement process,
- lack of Lean support infrastructure,
- lack of Lean association with the company's strategic objectives.

The results of the survey are shown in Fig. 1.



**Fig. 1.** Barriers and limitations occurring during the implementation of Lean Manufacturing

In addition, the lack of appropriate management knowledge about the Lean concept, lack of belief in the rightness of action and the lack of proper communication led to the occurrence of negative effects, among which the respondents mention:

- lack of action plan, or plan of action not adapted to the conditions and possibilities of the organization,
- extending working time,
- increasing work control,
- introducing a large number of unintelligible meters,
- lack of clear understandable objectives of the organization,
- a large number of post-production documentation,

- lack of understanding of the need to change anything,
- building barriers between managers and employees.

## 5. Conclusions

The presented research results show the advantage of large enterprises in the application of tools related to the Lean Manufacturing methodology. However, there is a growing interest in the concept in small and medium-sized enterprises. Yet, there are barriers related to the implementation of the Lean concept. This condition results from the lack of management awareness and limited funds. Larger enterprises have diametrically larger financial resources, which allows undertaking activities related to the improvement of production processes. Building awareness of employees of small and medium-sized enterprises with the need to eliminate wastage may translate into an increase in production efficiency, and hence more effective functioning on the labor market and achieving better financial results. In the case of the ceramic industry, there are still organizational technological factors specific to this industry, which make the process of divination more complicated and demanding. Lean Manufacturing ideas are practically completely different from traditionally understood mass production. Starting from implementation of the continuous flow instead of production in large batches, through striving for a radical elimination of stocks, to continuous improvement and organizational culture.

Transformation of enterprises towards Lean should focus in a synergetic way on introducing technical and organizational changes, but first and foremost on developing an in-house culture. An important obstacle is lack of the Lean concept model in small and medium enterprises, which together with the relevant methods could be adapted not only to the specifics of the size of the company, problem situations arising therein and the existing organizational culture, but also taking into account the characteristics of the production industry itself. The implementation of "Lean Management" often faces workers' resistance. Its causes may be, first of all, fear of change and fear of employee layoffs as a result of implemented improvements. An important element is elimination of the barrier of misunderstanding the process of continuous improvement. One of the methods to identify problems with understanding the process of continuous improvement in the organization is to analyzing its strengths and weaknesses. An exemplary scheme for identifying disturbances in the improvement process is shown in Table 1. This approach includes other than Lean methods and tools, management instruments, the use of which is to allow improvement in the operational layer of the organization. Lean Manufacturing cannot be implemented in organizations that do not want to change their way of working. Achieving maximum benefits from the implementation of the Lean is conditioned by the so-called soft aspects of management, in particular the extensive use of knowledge and skills of regular employees, related to the humanization of work and by changes in the superiors – subordinates relations. Implementation of lean tools is necessary, but support for them must be

based on cooperation and continuous improvement of organizational culture. The presented barriers and limitations in the area of soft aspects can be eliminated through training and

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Kleszcz, D., Ulewicz, R., 2010. *Application of the FMEA method In The process of assurance of quality of ceramic ware*, Dnipropetrovsk, 9-25.

**Table 1.** Identification of barriers in the improvement process

<ul style="list-style-type: none"> <li>• unintelligible measures used at the operational level</li> <li>• low involvement of employees in the evaluation of activities and a small number of improvement notifications</li> <li>• labor-consuming presentation of results</li> <li>• data collected in a way that makes trend analysis impossible</li> </ul>	<b>WEAK POINTS</b>	<b>STRONG POINTS</b>	<ul style="list-style-type: none"> <li>• indicators focused on strategic and tactical goals</li> <li>• regular measurements of effectiveness and its evaluation</li> <li>• regular information for employees on results</li> <li>• friendly communication of results</li> </ul>
<ul style="list-style-type: none"> <li>• working out objectives of gradation and structuring the measures at all levels of the organization</li> <li>• introduction of uniform communication standards</li> <li>• verification of clear communication rules</li> <li>• verification of the method of data collection</li> </ul>	<b>DIRECTIONS OF IMPROVEMENT</b>	<b>EFFECTS</b>	<ul style="list-style-type: none"> <li>• target-oriented improvement</li> <li>• prioritizing actions</li> <li>• involvement of operational employees in improving activities</li> <li>• accelerating the pace of change implementation</li> <li>• analysis and evaluation of trends will increase decision efficiency</li> </ul>

workshops for managers and regular employees. The problem arises when it is necessary to adjust lean tools to the organizational structure and production specifics of, for example, ceramic plants.

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## 陶瓷行业实施精益生产工具的障碍和机遇

### 關鍵詞

精益制造  
精益管理  
陶瓷工业  
实施障碍  
精益工具

### 摘要

本文讨论了组织中精益管理的概念，使用精益制造概念改进产品和流程。追求卓越是保持市场竞争力的关键因素。只有能够比其他组织更快地适应不断变化的环境条件的组织才能获得优势，符合精益制造理念的管理是事实上的变革管理。在本文中，陶瓷行业的重要因素，在实施精益生产时应予以考虑。影响精益工具实施的重要因素包括：企业规模，员工参与，精益概念知识，技术因素，产品线类型和种类，以及陶瓷的特殊性行业。与实施精益相关的最大机会是通过以下方式提高公司的竞争力：满足客户的质量和期望。与实施精益相关的最大机会是通过以下方式提高公司的竞争力：满足客户的质量和期望。然而，实践表明，尽管规则和工具简单，但很少有组织能够达到这一概念的先驱 - 日本丰田公司的卓越水平。