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Assessment of application of 5S practices in ceramic industry

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Abstract

Results of research connected with determining the degree of implementation of 5S practices in ceramics industry are discussed in this paper. Direct survey with employees of companies plus expert interview was used in the research. A 21 point scale was used to assess the degree of implementation the 5S practices at individual stages of the manufacturing process. The specificity of production in ceramics industry enforces maintaining the regime of cleanliness during production. The research revealed that the level of conscious implementation of the 5S practices in companies depends on the culture of organization and the degree of involvement of employees in the improvement actions in their company. The presented results are a part of the research aimed at determining reference requirements for companies in terms of implementation and making use of the Lean Management (LM) instruments.

1. Introduction

The ceramics industry covers a wide range of products which have become a part of everyday functioning in communities around the world. They include ceramic articles used in building industry, electronic industry and universally used every-day ceramics. Important processes in manufacturing ceramic articles include:

- Preparation of raw material,
- Shard formation
- Burning
- Decoration depending on the type of an article (KLESZCZ D., ULEWICZ R. 2010)

Methods of manufacturing ceramic articles have evolved over the recent years. It was partly the result of changes which were caused by development of the industry, and partly the result of the requirements of the customers themselves. The development of knowledge resulted in improvement of properties of ceramic materials in terms of both quality and functionality. Yet, the constantly growing demand of the market resulted in the necessity to implement new technologies as well as technical and organizational solutions. It allowed to offer customers items meeting their high standards. At this stage managers play the key role in the development of a company, as they choose what technol-

ogy and concept of management will be implemented in their working conditions. In case of the ceramic industry, the choice of an appropriate model of management based on the Lean Management it is also a very important element of correct functioning of the company (ULEWICZ R., KUCEBA R. 2016, GRABARA J. 2017).

2. Lean Management in the ceramic industry

The concept of Lean Management makes use of a number of management instruments comprising tools, methods and systems of work. According to J. Womack and D. T. Jones, Lean Management is based on five basic principles: precise definition of value of each product, determination of the stream of value for each product, achieving uninterrupted flow of value, enabling the customer to draw the value from the manufacturer, and a constant pursuit of perfection (WOMACK J., JONES D. 2008). The idea of the LM, characterized in 1998 by J. Krafick (KRAFICK J.F. 1998) specifies in detail the core of the concept naming this methodology of work a "lean" method of action, eliminating any wastage. Acceptance of these ideals by companies results in creation of the organizational culture serving a continuous improvement. The objective of the management tools and principles of acting implemented by the LM concept is to achieve such a system of

work in which companies will use less resources, manufacture articles according to schedules, according to the specifications supplied by their customers (internal and external), while maintaining respect for people and protecting the natural environment. Such a system of work leads to a situation in which Lean companies assume a different system of manufacturing articles than the one that takes place in case of the mass production companies. The difference between the abovementioned systems of production are illustrated in Figure 1.

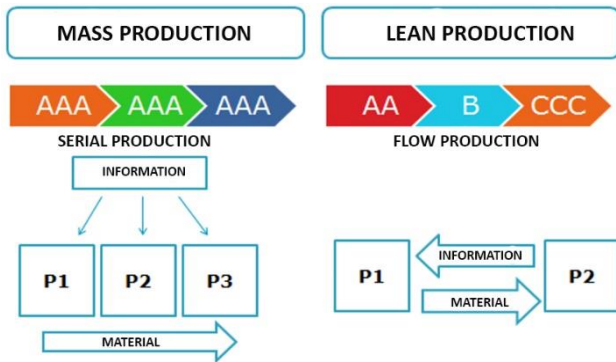


Fig. 1. Diversification of production with the use of Lean concept

Dynamically changing market conditions cause a situation in which ceramic industrial companies must continually fight a battle aimed at meeting expectations of a customer in the field of quality, prompt completion of work, prices and other important product attributes.

The target of many ceramic companies is to achieve a system of work in which there is a possibility to diversify production within one working day. It is, therefore, necessary to create conditions for effective implementation of lean instruments (KLESZCZ D., ULEWICZ R., NOWAKOWSKA-GRUNT J. 2013). One of the first solutions of the LM type in Polish ceramic industry was the implementation of the 5S practices (PREDOŃ B., BADURA L., SOBCZYK M., NOWACKI M. 2008). 5S is a helpful tool used in organizing the workplace, which contributes to elimination of wastage and improvement of the company, which, consequently, results in lower consumption of resources and faster reaction of the operating workers to customers' needs. A properly implemented system of work based on 5S provides a real opportunity to gain competitive advantage, e.g. in the field of production leveling, which an essential element of meeting customers' needs concerning complete and prompt the implementation of delivery (KLESZCZ D., ULEWICZ R. 2011, ABDULMALEK F.A ET ALL 2006). Lean management is a relatively young concept of management. For many years lean methods of work were disregarded because they were considered to be obsolete and not revolutionary enough. Furthermore, it should be emphasized that, initially, the Lean concept was mostly used by Japanese motor industry, and the knowledge of instruments used by lean practices was very limited. Western companies pinned their hopes upon fast changes of innovative nature. Effectiveness of the lean tools applied in automotive industry made managers of other fields

of industry try to transfer practices used in lean production to their own plants. This phenomenon caused the necessity to propagate knowledge in this field among employees and creating the culture of lean production. It should be emphasized that these are mainly big companies with large resources (human, financial) which benefit from the implementation of innovations, especially when the latest solutions become first available. A similar phenomenon occurs in the case of ceramic industry, where there are no developed solutions as to how the LM instruments should be used. It appears from the conducted research that in Poland Lean practices were first implemented in large industrial companies, such as Ceramika Paradyż, Wienerberger, Opoczno S.A. (CHOMICZ J., GOŁUZZ M., PARTYKA J., ŻECHALUK P. 2006), and were based on the solutions taken from automotive industry. The objective of the research conducted in ceramic industry companies was finding the answer to the following question whether and to what extent ceramic industry implements the instruments of the Lean Management concept.

3. Adopted research method

There were five research facilities representing the ceramic industry qualified for the research. The range of research covered the main production processes (preparation of raw material, throwing, heat treatment and decoration). A survey chart containing 21 questions was used in the research. The objective of the questions was identification of the range of implementation of the 5S practices. The questions were developed so as to allow evaluation of implementation of the practices on a scale from 0 to 1 points. The questions referred to areas connected with industrial safety, in-house communication and characteristics of the studied tool. In order to eliminate the expected problems connected with obtaining information resulting from lack of knowledge about the 5S tool of some of the respondents, a simple and comprehensive compendium to follow by all the respondents was developed, based on the following rules:

- explaining and defining the topic of the research to the respondents,
- defining the range of the research,
- checking a given problem on site,
- conducting an expert interview among the lower and higher level staff,
- asking questions that are always easy to understand by the respondents,
- explaining unknown terms in order to avoid mistakes,
- asking mostly closed questions,
- allowing maximum 4 possible answers (no, probably not, yes, probably) and avoiding measure with the use of a scale (e.g. 0-10) in order to limit disparity in interpretation by respondents on a given phenomenon,
- determining the maximum number of points possible to obtain, resulting from the number of questions asked and the applied grading scale,
- making synthetic analysis of data,

- on the basis of the number of awarded points, making a descriptive assessment of the range of the applied 5S tool,
- graphic presentation of data,
- drawing correct conclusions, which will serve the need of continuous improvement,
- making use of the output data from the research for modeling more effective methods of work.

Table 1 shows the first adopted grading scale for a given tool.

Table 1. First adopted trading scale for the 5S tool in ceramic industry.

No\Probably not	Probably	Yes
0	0.5	1

Table 2 shows the criteria of assessment in the research on implementation of the 5S in ceramic industry.

Table 2. The criteria of evaluation of implementation of the 5S practices in the ceramic industry

Points	Description
20-21	Model implementation of the tool
15.5-19.5	Advanced implementation of the tool
10.5-15	Medium level of implementation of the tool
0-10	Lack of implementation of the tool

On the basis of the presented rules of conduct, there was a comprehensible compendium of questions prepared for the respondents and used in the survey questionnaire. Examples of the questions about the 5S practices are presented in the second part of the article.

- **Sort:** Is the production area (the area around the workplace) well-ordered?
- **Sort:** Are all the things (tools, instruments, other elements) which can be found in the workplace necessary?
- **Set in order:** Are the following present: passageways painted in the workplace, shield, barriers, an array of shadows, pictograms, fire extinguishers, clean area?
- **Shine:** Is your workplace systematically cleaned ?
- **Standardize:** Are there the following documents printed and available for the employees: industrial safety instruction book, operating manuals, procedures?
- **Sustain:** Are the employees well-disciplined and observe the applicable rules (procedures, instructions, regulations (standards)) in terms of keeping order?

When preparing the survey questionnaire, theoretical basics described in papers of the following authors were used: (JOANNA CZERSKA 2014, J.K. LIKER, D.P. MEIER 2005, J., KOVACS G., KOT S. 2016, MASA AKI IMAI 2006, J.K.LIKER 2003).

4. Results

The research group consisted of 5 companies in which consent was granted to verify the existing state.

Table 3 shows a list of the obtained results in five ceramic industrial plants:

- Company A – a large manufacturer of ceramic tiles,
- Company B – a manufacturer of flower/plant pots and ceramic casings,
- Company C – a producer of ceramic raw materials,
- Company D - a producer of ceramic casings.

Table 3. The obtained grading for implementation of the 5S practices in the chosen companies expressed in points

Process/company	Grading				
	A	B	C	D	E
Throwing	21	11	8	1	8.5
Burning	21	12	7	1	8
Decoration	21	10	None	None	9

Implementation of the 5S practices in Company A was assessed in the grading scale in individual departments: throwing department 21 pts., burning 21 pts., decoration 21 pts. According to the assumed criteria, the awarded grading allows to qualify Company A to the reference group (model example) of implementation of the examined tool. Company B is a plant, which took the challenge aimed at implementation of the 5S. The obtained results of research indicate an average level of implementation of the tool. The producer of ceramic plant pots and casings was awarded the following number of points: throwing department 11 pts. , burning 11 pts., and decoration 10 pts. In the case of the producer of building materials (Company C) and producer of ceramic raw materials it was possible to make an assessment only in reference to the process of throwing and burning. The process of decoration is not applied in these companies. Results of the research in these objects are as follows:

Company C was awarded 8 pts. In the throwing department and 7 pts. In the process of burning, Company D was awarded 1 pt. in both throwing and burning. The last object of research was the E Company – the producer of ceramic casings. As in companies A and B, all the researched production processes can be found in this plant. The obtained results are as follows: throwing 8.5 pts., burning 8 pts., decoration 9 pts. The obtained results of implementation of the 5S practices in the chosen stages of production are collectively presented in Fig. 2.

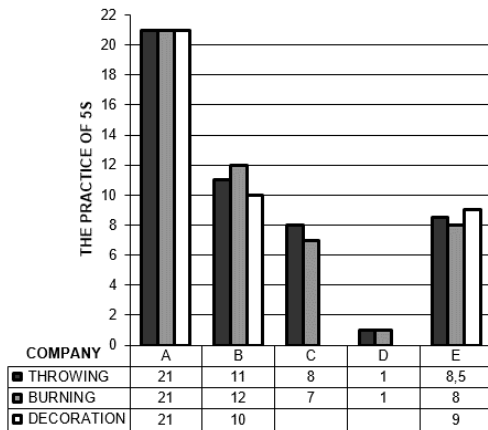


Fig. 2. The evaluation of 5S practices at various stages of production

5. Discussion

Due to the production technology characteristic of the ceramic industry, the research was carried out in the area of the main processes generating the highest surplus value (throwing, burning, decoration). These processes are the key production stages, in which most of the technical operations connected with shaping, changing physico-chemical properties and giving the products their esthetic appearance. Representatives of the plants were reviewed directly in their workplaces, which allowed to assess the actual situation. In cases where the respondents did not have enough knowledge about the 5S practices, the survey questions in the questionnaire were explained as they arose. Another important stage during the study was making an assessment of the obtained answers according to the assumed criteria. The developed questions were phrased in such a way as to enable the respondent to make a precise, explicit assessment of implementation of the 5S practices. Depending on the number of obtained points, there was an assessment of practical implementation of the examined tool made in different research facilities. During implementation of the research, there was a lack of sufficient theoretical knowledge concerning the 5S practices identified among employees. A few of the questions in the questionnaire concerning the examined tool concerned general rules of industrial safety connected with the current regulations (arrangement of fire-extinguishers, assessment of occupational risk, instructions for use) and the generally accepted law and order of acting (communication lines, pictograms, workplace instructions, standards of performed job). The rest of the questions concerned methodology of conduct (use of red cards, 5S audits, golden flag, corresponding courses of training connected with 5S). It allowed to gain deep insight into the situation as to in what way the examined objects interpret maintaining order in their workplaces. In the case of the large ceramic tile producer, apart from basic rules of action concerning performance of duties resulting from the regulations of the law, there is a clearly visible implementation of the rules of conduct characteristic for the 5S tool. Particularly, the use of red cards, 5S audits, systematic sur-

veys, designated places for storing various things (components, raw materials, equipment used when working in clean places). The company gained high assessment of implementation of 5S practices fluctuating at the level of 20 to 21 at 21 points total possible. Yet, it should be noted that the company has appropriate human and financial resources, which certainly helps in efficient implementation of different LM tools, including the 5S tools. Another example of a conscious attempt at implementation of the 5S practices is a small company manufacturing useful ceramics (ceramic plant pots and casings). As in the case of the producer of ceramic tiles, the producer of ceramic plant pots and casings is an example of a company which consciously made an attempt to implement the LM instruments. In the case of the 5S tool the obtained results were – depending on the production process – from 8.5 to 14 pts. According to the assumed criteria, the number of the awarded points falls into an intermediate level of implementation. The reason is mainly dictated by lack of sufficient human resources, which could fully coordinate activities in favour of the idea of lean management. Apart from the necessary requirements connected with the regulations of the law, the company conducted several red card campaigns, implemented clean workplaces, saw to marking places dedicated to storing specific objects. An array of shadows was also applied in a few places in the plant. The relatively low assessment in relation to the actions taken is caused by the lack of implementation of 1 of the 5S practices – regularity, e.g. in carrying out audits, which results in stagnation of the program and lack of its development. It also results from the interview that in spite of lack of the 5S audits, on the workplaces, where everyday tasks are implemented by highly qualified, responsible staff with long-term experience, the initially implemented rules connected with the researched issues keep functioning according to the assumed objectives. The third researched company was a brickyard. In case of this company, the research was limited mainly to satisfying all the rules of safe and responsible work in compliance with the regulations in force. Lack of knowledge about the 5S methodology and dynamic development of the company cause that activities connected with the 5S tool were practically abandoned. The other two research sites include a German producer of ceramic casings and a (micro) company producing ceramic raw materials for the needs of the ceramic industry. Company E – producer of ceramic casings, observes all the legal regulations, which earned him points in such areas as industrial safety and internal transport. Any machine and device markings, storing the necessary tools in designated places as well as any instructions of use and workplace instructions justified awarding a positive grade. The company producing ceramic raw materials is an example of a company which has been active on the market for a relatively short time (one year). In a short time of its functioning, the company was unable to implement the system of work corresponding to the 5S practices. An average grading of implementation of the 5S practices in the researched plants is presented in Figure 3.

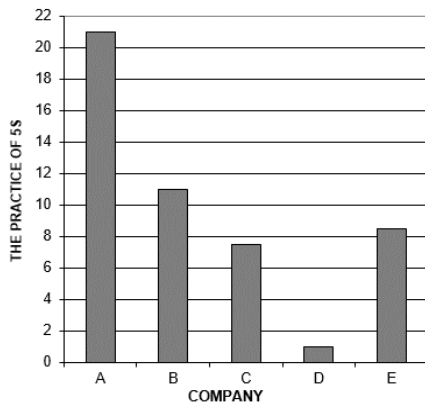


Fig. 3. Grading of implementation of the 5S practices in 5 examined research facilities

The next stage of the research was further interpretation of the obtained results involving determination of average values of implementation of the 5S tool in chosen production processes. The average level of implementation of the 5S from the completed research is shown in Fig. 2. One of the researched companies does not make use of the process of decoration in its production profile. Therefore, the chart contains averaging data obtained in the other ceramic plants.

6. Conclusion

Literature review confirmed a research gap in the field of assessment of implementation and effectiveness of the LM instruments in the ceramic industry. The assumed method of research, confirmed by an expert interview allows reliable assessment of implementation of the 5S practices in the ceramic industry. The obtained results of the survey research in the research facilities are presented in Fig. 1 and in Fig. 2. The average result obtained by Company A was 21 pts. Average values obtained in the research facilities indicate that companies A and B are characterized by the highest implementation of the 5S practices. The actual state of affairs is dictated, among other things, by the long term presence of the abovementioned producers on the market, taking continuous refresher steps, which eventually translate into stable production and high organizational culture.

This in turn results in a desire for further development and implementation of solutions increasing operational effectiveness of the company, an example of which is implementation of the 5S practice. The conducted research indicates that in many cases ceramic plants unconsciously make use of practices corresponding to the 5S rules. Taking deliberate action aimed at implementation of the 5S program increases its success and speeds up the time of implementation, which definitely lowers the cost of running a business, which is confirmed by the scale of action of the A producer. Ceramic industry, especially small and medium size companies need substantive support in the field of implementation not only of the 5S practices, but making use of the new LM instruments.

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陶瓷工业5S实践应用评估

關鍵詞

5S
精益管理
陶瓷工业

摘要

本文讨论了确定陶瓷工业5S实践程度的研究结果。研究中使用了与公司员工进行的直接调查以及专家面试。使用21分尺度来评估制造过程各个阶段的5S实践的执行程度。陶瓷行业生产的特殊性在生产过程中强制维持清洁制度。研究发现，公司5S实践意识水平依赖于组织文化和员工参与公司改进行动的程度。提出的结果是研究的一部分，旨在确定公司在实施和利用精益管理（LM）仪器方面的参考要求。