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Implementation of the 5S lean tool at a laboratory station in the road industry

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Abstract: The concept of lean management is increasingly being adopted in all economic sectors around the world. The benefits of its use allow you to eliminate waste, save time, money and natural resources, while increasing the quality of the final product. Implementing lean tools into the organizational structures of enterprises improves the quality of work at each workstation, minimizes the level of accidents and increases the company's competitiveness on the industry market. The aim of the study was to identify existing problems at the workplace in the road engineering laboratory and to propose 5S to eliminate them. To this end, a survey was conducted among laboratory employees and a visual assessment was conducted before and after the improvements were implemented. Based on the results, it was concluded that the identified areas of waste were eliminated, primarily by reducing the time spent searching for tools, materials, and equipment by approximately 33.33 %.

Keywords: 5S, lean tool, lean construction, lean management

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Introduction

Lean Management is a concept of managing a production company, the main goal of which is to eliminate all types of waste in every area of the company's operation, while increasing the quality of the final product and the services provided. There are 7 areas of waste (Pereira et al., 2019), the minimization of which helps to achieve the best possible final effects of the entire enterprise.

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The Lean Management concept includes various types of Lean Tools, techniques and methods, including: Daily Kaizen, VSM, Just-in-time, 5S, which have recently been often adapted in various sectors of the economy, e.g. the production industry (Mazur & Momeni, 2018; Ribeiro et al., 2019; Roriz et al., 2017), medicine (Bertholey et al., 2009). Their implementation in enterprise structures allows, among others, better organization of the workplace, reduced operating costs, increased level of safety at the workplace (Czajkowska & Ingaldi, 2023), increased competitiveness on the industry market. In the context of the construction industry, the lean philosophy is known as lean construction. It is one of the key elements of the construction process in order to achieve the intended implementation faster, better and cheaper (Nowotarski et al., 2016) while achieving the assumptions of the sustainable development concept (Dębska et al., 2020). Eliminating areas of waste contributes to reducing CO₂ emissions, minimizing generated construction waste and saving natural resources, which is in line with the lean green strategy (Sá et al., 2023; Teixeira et al., 2022). This strategy combines Lean Management principles with ecological goals, focusing on eliminating “eco-waste” and negative environmental impact while improving the efficiency of production processes. The assessment of the usefulness of one of the lean methods (Kaizen) in a construction company is discussed in the study (Brycht, 2024).

Unfortunately, in addition to many advantages resulting from the implementation of lean methods, there are also certain implementation barriers, mainly in the form of insufficient knowledge of enterprise employees. Low awareness of the staff, as well as often financial and technological limitations, make it impossible to start the process of improving the organizational systems of companies. That is why it is so important to organize training and invest in the development of employee competences in the aspect of Lean Management.

The topic of 5S application discussed in this article is crucial for the construction industry. The Lean Management concept is widely used, primarily in the manufacturing industry, but it has not yet found sufficient application in the construction industry. Therefore, disseminating knowledge and raising awareness of the benefits of implementing management principles and techniques in an enterprise, or in the case of a road engineering laboratory, is crucial.

The aim of the article was to identify areas of waste in a road engineering laboratory and to propose corrective actions based on the 5S concept. Similar research on the use of 5S to improve workplaces was discussed in (Ingaldi & Pala, 2016; Jamróz & Pleskacz, 2018; Łopatomska, 2002; Wolniak, 2020). Therefore, the present study was designed as a single-case study of one laboratory workstation in a road engineering laboratory at University in Czestochowa, focusing on the identification of problems and the proposal of improvements.

1. 5S lean tools

The 5S is one of the lean management tools whose aim is to ensure an ergonomic workplace by applying five principles:

- Seiri – sort;
- Seiton – set in order;
- Seiso - shine;
- Seiketsu - standardize;
- Shitsuke – sustain.

The first stage involves identifying necessary and unnecessary tools or materials at the workplace and segregating what is useful in the workplace for the operator (sorting).

In the second stage, useful items are appropriately marked and put them back in their place. Similarly, useless materials and information are also assigned to their destination. Thanks to this, finding a given item will not take longer than the maximum 30 seconds. Maintained transparency at the workplace allows you to reduce wastage of time and unnecessary movement when looking for appropriate tools and materials, as well as to increase the level of safety during activities performed.

Taking regular actions to maintain order at the workplace, as well as its maintenance, is the next stage of applying the 5S. The cleaning stage also allows for identifying the causes of contamination and creating instructions and a schedule for cleaning works.

Standardizing the first three stages of the 5S provides the basis for their proper implementation and compliance. Thanks to this, any change in the scope of duties of a given employee will only require initial training. Creating procedures for the entire enterprise will allow for maximum unification of activities at work stations and its transparent maintenance.

The final step is self-discipline. This stage results in the development of certain habits, which will often be the result of a long-term implementation process. This is the most difficult stage because it requires fundamental changes in the organizational structure of the company and the involvement of all employees (Szczygieł, 2019).

By using the 5S, you can achieve many benefits for the entire enterprise. The 5S principles are universal and can be used not only in enterprise structures, but also in university laboratories (Jiménez et al., 2015), the automotive industry (Hąbek et al., 2023; Veres (Harea) et al., 2018), maintenance workshops traffic (Pombal et al., 2019), warehouses (Zimon et al., 2014) or the logistics industry (Wojtynek et al., 2018). The strengths of the method include facilitating the use of the work station while ensuring safety while performing individual activities (Muotka et al., 2023), improving the quality of manufactured products and services, shortening operational time (Shahriar et al., 2022), minimizing the risk of producing defective products, low cost and simplicity of implementation. The use of the 5S is also important in the ecological aspect. Following the 5 rules creates the need to segregate the generated waste and, consequently, minimize it. Improvements aimed at reducing the production of defective products can save natural resources.

Unfortunately, in order to obtain tangible benefits of using the discussed method, it is necessary to involve the entire staff in its implementation (Lizak, 2016). This involves the need to conduct periodic training and introduce an attractive motivational system. In order to check the correctness of the implemented activities and

the resulting effects, periodic audits should be carried out, presenting the current condition of the enterprise, and specialist supervision should be introduced. The studies (Kawalec et al., 2018; Omogbai & Salonitis, 2017; Pacana et al., 2014) discuss the possibilities of improvements in the implementation of the 5S in an example company, which can be used as a scheme for improvements in other enterprises (Sá et al., 2021).

2. Research methodology

Among the many lean tools, those whose implementation would be beneficial in the context of this research include 5S, Kaizen, Kanban, Poka-Yoke, TPM and VSM. Given the research goals of organizing the workplace, reducing tool search time, eliminating waste and unnecessary items, increasing workplace safety and efficiency, and offering low costs and ease of implementation, 5S was selected. A similar context of research using the 5S method in a chemical laboratory was discussed in the article (Gajdzik & Wyciślik, 2016).

Table 1. Questionnaire used to identify problems at the laboratory workstation (*own research*)

No.	Question	Answer	
		Yes	No
1	Are there unnecessary items in the laboratory (e.g. tools, materials) that should be stored elsewhere?		
2	Is waste collected in the laboratory?		
3	Is the laboratory kept clean?		
4	Is it possible to move freely in the laboratory?		
5	Does the search time (including the time of movement from the workstation and the search time) of tools/equipment/materials exceed 30 seconds?		
6	Is there difficulty locating tools/equipment/materials?		
7	Have laboratory technicians received training in the 5S lean tool?		
8	Are there dangerous items in the laboratory?		
9	Is there complete documentation in the laboratory?		
10	Is documentation properly stored and described?		

The research involved identifying problems at work stations in the road engineering laboratory. For this purpose, a questionnaire survey was conducted among laboratory technicians. By answering a set of Yes/No questions, they indicated the types of existing problems at the workstation. Table 1 presents the questionnaire used in this survey (10 closed questions with Yes/No answers). The questionnaire was used to systematically capture the technicians' perception of workplace problems and to complement the visual assessment. This made it possible to identify not only observable irregularities, but also issues experienced by the staff in their daily work.

Based on the answers provided and a visual assessment of the laboratory, the existing problems were identified, supported by photographic documentation. The visual assessment was carried out by a team of 5 people: the laboratory manager and laboratory technicians who had completed training in the implementation of 5S principles. The research also measured the time needed to search for sample equipment and material, both before introducing changes and after implementing improvements. For this purpose, a stopwatch was used, which was turned on when the employee left the workstation in order to find the necessary items. The stopwatch was stopped when the necessary items were found.

The next step was to implement the changes, which was documented with photographs. In the last stage of the research, the survey was again conducted among the same group of respondents to determine the effectiveness of the changes made. Laboratory technicians answered the same questions using appropriate symbols.

3. Results analysis

Based on the results of surveys and visual inspections, it was found that the main problems in the laboratory are: poorly managed desk and shelf for tools and materials, lack of free movement, storage of unnecessary items, accumulation of waste, lack of segregation of equipment used by laboratory technicians, lack of documentation that is not properly described and contamination of the floors, shelf, desk and table (Table 2).

Table 2. A summary of identified types of problems along with suggestions for improvements (*own research*)

No.	Type of problem identified	Proposal for improvements
1	Incorrect management of desk and shelf for tools and materials	Removing unnecessary items from shelves and countertops and arranging tools and materials
2	No free movement	Removing obstacles in the form of accumulated waste and poorly located equipment
3	Storing unnecessary items	Designating a place to store currently unnecessary equipment/materials/tools
4	Collection of generated waste	Disposing of accumulated waste in accordance with segregation rules
5	Lack of segregation of tools/equipment/ /materials	Designation a place for the necessary equipment/tools/materials
6	Lack of complete documentation in the laboratory	Preparing a place for documentation and moving it from another room
7	Failure to adequately describe the documentation	Creation labels for each binder with the name of the documentation
8	Dirty floors, shelves, desks and tables	Performing cleaning activities, i.e. vacuuming, washing floors, etc.
9	Lack of training of employees in 5S principles	Conducting training in the area of the 5S lean tool

The first visible problem during the inspection of the laboratory was a poorly managed tool shelf (Fig. 1a) and a desk (Fig. 1b). In addition to the empty shelves, there were unnecessary items on the shelf, just like in the case of the desk.



Fig. 1. Incorrectly managed: a) tool shelf, b) desk, before introducing improvements (*own research*)

As part of the improvements, unnecessary items were removed and tools and materials appropriately needed at a given position were arranged (Fig. 2a and 2b).



Fig. 2. Correctly managed: a) tool shelf, b) desk, after implementing improvements (*own research*)

As part of the improvements, unnecessary items were removed and tools were arranged. Difficult access to the shelf was also found, as well as a general inability to move freely around the laboratory due to incorrectly stored equipment and accumulated waste, which resulted in an increase in the time needed to search and perform activities. For this purpose, a new location was designated for the necessary equipment, tools and items that could be used in the future. This reduced waiting time and motion. The collected waste was segregated and placed in garbage containers in

accordance with the applicable waste division, which is part of the ecological aspect by saving raw materials and minimizing the amount of waste generated. The conducted research indicated the problem of unnecessary movement of employees between the laboratory and the room where the documentation is stored. This resulted in transportation, motion and often lost part of the documentation. As part of the implementation of the improvements, a place for storing binders with documentation was designated in the laboratory, and each of them was appropriately described with a created label in order to find the necessary information faster. Missing documents have been completed. Cleaning activities were also undertaken to remove dirt on the floor, furniture and equipment. The last stage of improvements was to conduct initial training for laboratory technicians in the 5S, in order to develop staff competences and raise the level of awareness of the benefits resulting from its use.

Based on the survey conducted after improvements, it was found that the omissions indicated in the first stage of the research had been eliminated and the time of searching for the necessary equipment was shortened from 36 s to 24 s.

This article provides an example of the practical application of simple 5S principles in the workplace, achieving real production benefits while contributing to environmental protection. This work can serve as a source of knowledge for employers and employees on how to implement organizational improvements within the 5S framework and contribute to increasing awareness of the benefits of implementing Lean Management tools in their companies.

Conclusions

As a result of the research, types of problems existing in the road industry laboratory were identified. These were negligence related to poor management of the workplace, storage of unnecessary items and waste, incorrect storage of documentation and contaminated surfaces. Another problem was the low awareness of employees regarding the use of the 5S. After implementing the improvements, it was found that the originally indicated areas of waste were eliminated, mainly in the form of shortening the time of searching for tools, materials and equipment needed to perform a given activity by approximately 33.33%. The implementation of the 5S in the road industry allowed for the creation of an ergonomic workplace, which improved the laboratory's work efficiency. The use of the 5S is also part of the ecological aspect, due to the reduction of the amount of waste generated and the saving of natural resources (Lean Green). The discussed case of implementing 5S principles concerns a workstation in a road engineering laboratory. It is important to remember that, despite the universality of the presented solution, this tool should be tailored to the specifics of each workplace. Another limitation of implementing 5S principles may be the need for the continuous involvement of all employees and systematic adherence to the implemented principles. Further research is planned in this area in the future, which will allow for the refinement of the proposed solutions in other workplaces as well.

This study has several limitations. It is based on a single case of one laboratory workstation in a specific organisational context, with a small group of technicians as respondents. Therefore, the results are not statistically generalizable to all laboratories or organisations. The conclusions should be seen as analytically generalizable: they indicate types of problems likely to appear in similar laboratory settings, rather than providing broad quantitative evidence. Future studies including more laboratories and institutions are needed to verify and extend these findings.

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