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ASSESSMENT OF THE MANAGEMENT AWARENESS OF THE USE OF LM METHODS AND TOOLS IN THE AUTOMOTIVE INDUSTRY

Joanna FURMAN[1*], Tomasz MAŁYSA[2], Marzena KUCZYŃSKA-CHAŁADA[3], Tomasz FIGA[4], Oksana VELGOSOVA[5]

[1] Silesian University of Technology, Faculty of Materials Engineering, Department of Production Engineering; joanna.furman@polsl.pl, ORCID: 0000-0002-8828-7186
[2] Silesian University of Technology, Faculty of Materials Engineering, Department of Production Engineering; tomasz.malysa@polsl.pl, ORCID: 0000-0002-9352-0528
[3] Silesian University of Technology, Faculty of Materials Engineering, Department of Production Engineering; marzena.kuczynska-chalada@polsl.pl, ORCID: 0002-5273-8328
[4] Brembo Poland Sp. z o.o.; tomasz.figa@brembo.pl
[5] Technical University of Kosice, Faculty of Materials Metallurgy and Recycling, Institute of Materials and Quality Engineering, Slovakia; oksana.velgosova@tuke.sk, ORCID: 0000-0001-8903-2604
* Correspondence author

Purpose: The article presents the results of a survey on the use of methods and tools of the Lean Manufacturing (LM) concept by middle management in an automotive industry company in Poland. The conducted study will allow to assess the management's awareness in terms of knowledge of LM solutions, their use in everyday work, the impact of LM tools on improving the organization of production and occupational health and safety, and involvement in improvement projects. Knowledge, commitment, and support for employees are important factors in shaping the Lean culture in the company. The middle management, who manages the work in individual departments of this company, through appropriate attitudes and behavior builds the awareness of the entire team. The article ends with conclusions that can be treated as a form of guidance for top management to take improvement actions.

Design/methodology/approach: The study of employees' awareness of the use of methods and tools of the LM concept was carried out using the survey method. The research group consisted of middle management in the automotive industry company in Poland (respondents indicated by top management). To achieve the assumed goal, a four-stage research methodology was developed. In the first stage, a questionnaire was developed, which concerned three areas: OSH, LM methods and tools, and implemented management systems. For the purposes of the study and the assumed goal, one research area was taken into account, related to the use of LM methods and tools and the awareness of the middle management staff in this area. In the second stage of the research, the research sample was characterized. In the third stage, the minimum number of respondents was determined (using the PQStat tool). In the fourth stage, the results obtained were analyzed and conclusions were formulated, which may serve as guidelines for managers responsible for continuous improvement of processes in this company.

Findings: The conducted research made it possible to assess the awareness of the middle management regarding the use of LM solutions in the enterprise. The assessment of awareness was a subjective assessment resulting from the analysis of each survey question. Based on the conducted research, it was found that the vast majority of middle management has knowledge and high awareness in the field of continuous improvement, in the form of using the methods and tools of the LM concept in everyday work. Employees are aware of the impact of these solutions on various areas of activity (quality, safety, organization of production), engage in improvement projects, and identify and solve problems, but also see the difficulties associated with the implementation of LM methods and tools. The knowledge and awareness of middle management translate into the attitudes and behavior of production employees, which affects the culture of continuous improvement of the company. Based on the research results, areas requiring improvement were also identified.
Research limitations/implications: The conducted survey research was limited to assessing the awareness of a specific group of respondents, i.e. middle management. The direction of further research should focus on assessing the awareness of production employees to obtain more complete information related to shaping the Lean culture in this company.
Practical implications: The conducted research may provide important information for the management staff on the awareness of middle management in the application of solutions of the LM concept in this company. The research results also allow to identify areas requiring improvement actions.
Social implications: The article discusses issues related to the awareness and involvement of employees that shape the culture of continuous improvement in organizations.
Originality/value: The analysis of the literature for the years 2018-2023 showed that there is a research gap regarding the assessment of awareness of the LM concept among employees of automotive companies. Therefore, the article refers to the study of the awareness of middle management in the use of LM methods and tools in the automotive industry - in a large company in Poland.

Keywords: management awareness, Lean Manufacturing, continuous improvement, Toyota culture, Lean culture.

Category of the paper: research paper, case study.

1. Introduction

Dynamic changes in the environment, growing competition, and customer requirements make industrial enterprises look for ways to maintain a strong market position. One of the most important, and at the same time, necessary conditions for achieving this goal is the continuous improvement of all company processes (Furman et al., 2018). Many organizations use different management concepts to streamline processes and achieve intended results. One of the most popular concepts implemented in enterprises around the world is Lean Manufacturing (LM) (Gupta, Jain, 2013). The LM concept was developed in the 1990s based on the Toyota Production System (TPS), which was created by Taiichi Ohno and Shigeo Shingo. The system includes a set of methods, tools, and practices implemented at Toyota Motor Company since 1948 (Holweg, 2007; Pavanskar et al., 2003). The LM concept has been considered the main

approach to operations management for many years, and its importance among practitioners is constantly increasing (Kunyoria, Aila, 2022). It is widely recognized that organizations that have mastered lean manufacturing methods gain a cost and quality advantage over those still practicing traditional mass production (Fleischer, Liker, 1997).

Production in the LM system is referred to as lean because, compared to mass production, it uses significantly fewer resources in half the time (Womack et al., 2008). The goal of Lean Manufacturing is to produce high-quality products at the lowest possible cost and in the shortest possible time by eliminating waste (muda) (Dennis, 2007). Muda is defined as all activities occurring in processes that do not add value to the product from the customer's point of view (Bicheno, Holweg, 2016; Imai, 2006). These are the following categories: overproduction, inventory, unnecessary motion, unnecessary transport, over-processing, defects, and waiting, as well as the unused potential of production workers (Melton, 2005; Parczewski et al., 2022). As part of the Lean Manufacturing concept, various methods and tools are used, which eliminate or reduce identified wastes and streamline processes, striving for excellence by the principles of LM (Womack, Jones, 2003). The most common practices used by enterprises include: the 5S technique, visual management, standardized work, value stream mapping, Poka-Yoke, Just in Time, kanban, one-piece-flow, SMED, TPM, kaizen (Palange, Dhatrak, 2021; Jasti, Kodali, 2015; Pearce, Pons, 2013). As part of the Lean Manufacturing concept, quality management tools are also used to solve problems and eliminate losses. The most commonly used are Ishikawa diagram, 5 Why analysis, Pareto diagram, 8D report, A3 report (Zasadzień, 2020). The use of LM solutions can bring many benefits to enterprises, including: the elimination of errors and quality defects, reduction of inventory, reduction of the production cycle and changeover time, increase in productivity, or improvement of work safety (Małysa, Furman, 2021; Pavanskar et al., 2003). It is worth emphasizing that LM methods and tools are effective wherever they are properly selected and where there is the ingenuity and involvement of employees to bring out and accept a change in their working method or culture that will lead to a better working environment (Palange, Dhatrak, 2021).

The literature on the subject (Moradi, Sormunen, 2023; Grycuk, 2016; Podobiński 2015) also points to barriers in the use of lean solutions, which cause the undertaken actions to fail (the introduced changes are not maintained, and there are no expected results). One of the most important barriers is the lack of knowledge, support, and commitment of the management.

Commitment is perceived as a kind of attitude, or behavior of an organization employee in relation to the set goals and assigned tasks (Trenkner, Truszkiewicz, 2015). Thanks to the involvement of employees, it is possible to continuously improve processes. However, it requires appropriate thinking, teamwork, support from managers, and an organizational culture that values the search for opportunities to introduce changes (Brajer-Marczak, 2014). Each company has its own organizational culture, defined (Schein, 2004) as a set of basic assumptions developed by members of the organization, which teaches how to deal with the problems of external adaptation and internal integration. Organizational culture plays

an important role in shaping the right attitudes and behavior of employees. It promotes the pro-effective behavior of employees - thanks to this, employees replicate patterns of behavior and assumptions shaped in the organization (Serafin, 2015).

In companies whose production systems are based on TPS, a culture of continuous improvement (the Toyota culture, known as the Toyota Way) plays an important role. It is focused on people and their knowledge. The Toyota culture emphasizes the role of managers who are leaders (responsible for continuous improvement) and teachers. They teach employees to identify, analyze, communicate, and solve problems. The commitment of management and employees is one of the most important principles of a Lean culture and contributes to its sustainability. Thanks to the continuous support of the management and its positive attitude, the awareness of continuous improvement is shaped throughout the company (Imai, 2007; Liker, Hoseus, 2016; Liker, Meier, 2008).

Therefore, companies that use LM methods and tools as part of their production system and want to gain a sustainable competitive advantage on the market should constantly undertake activities involving employees (especially management) in the process of continuous improvement. In this way, it is possible to shape the right attitudes and behaviors and influence awareness in the field of continuous improvement (Figure 1).

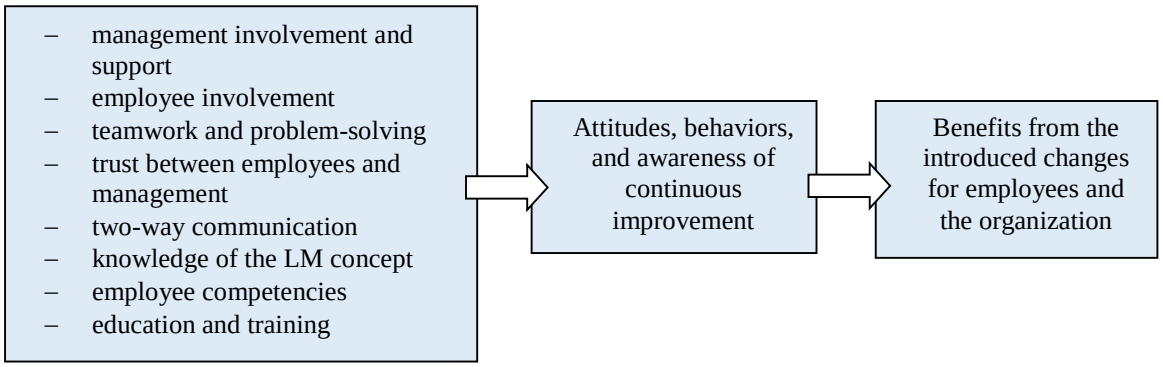

Figure 1. Factors affecting the shaping of attitudes, behaviors, and awareness in the field of continuous improvement in the organization.

Source: Own elaboration.

Researchers show significant interest in the subject related to the study of employees' awareness of the use of Lean Manufacturing methods and tools in manufacturing enterprises. To analyze the literature in this area, the Scopus and WoS databases and keywords were used: “awareness” and “lean”. Table 1 presents selected results of the literature analysis in the years 2018-2023.

Table 1.
Selected results of empirical research on employees' awareness of the LM concept

Authors	Research area
Musa et al., 2023	Assessment of the level of awareness and barriers to the use of Lean techniques in the construction industry in Nigeria. Research method: survey. Research group: construction professionals.
Bamisaye et al., 2023	Assessment of the level of awareness and adaptation of the Lean concept in the garment industry in Nigeria (small and medium enterprises). Research method: survey. Research group: managers, owners, directors, supervisors.
Keles, Yilmaz, 2022	Research on the level of awareness and knowledge in the field of lean manufacturing among employees of construction inspection institutions. Research method: survey. Research group: engineering employees
Wassan et al., 2022	Study of awareness, implementation, barriers, and benefits of the LM concept in small, medium, and large manufacturing companies in Pakistan (textile, metallurgical, automotive, and pharmaceutical industries). Research method: survey. Research group: managers, executives, and engineers from various departments.
Morshidi et al., 2022	Assessment of awareness and application of the LM concept in the aspect of improving safety in the construction industry in Malaysia. Research method: survey. Research group: construction professionals (safety managers, construction managers and project managers).
Podloch, Nowacki, 2022	The article presents an introduction to the research on the level of awareness of issues related to the LM concept among the management staff in many enterprises belonging to one international corporation (no industry specified); there are no results of this research yet.
Fateh, Sulaiman, 2021	Research on the level of awareness of the Lean concept among entities operating in the construction industry in Malaysia. Research method: survey. Research group: architects, quantity surveyors, engineers, contractors.
Klimecka-Tatar, 2021	Research of awareness and knowledge of LM principles in the context of the tools used in production companies in Poland (no industry specified). Research method: survey. Research group: production workers
Adzrie, Armi, 2021	Assessment of awareness of implemented Lean Manufacturing practices that have already been applied and TQM and TPM implementation in small and medium-sized enterprises in Malaysia (beverage industry). Research methods: survey. Research group: senior management.
Ahmed et al., 2021	Study on LM tools awareness, barriers, and challenges related to the implementation of LM tools in the construction industry in Bangladesh. Research method: survey. Research group: construction practitioners in different types of construction organizations.
Amade et al., 2021	Determining the scope and level of awareness about Lean techniques in the construction industry in Nigeria. Research method: survey. Research group: construction professionals.
Gelmez et al., 2020	Studying the awareness of enterprises in the field of lean manufacturing and the barriers encountered during the implementation of LM in Turkey. Research method: survey. Research group: textile companies.
Sahoo, 2020	Studying the status of Lean Manufacturing in Indian enterprises in terms of adopting the LM concept, its understanding, benefits, motivation, and challenges related to the implementation of LM practices (automotive component manufacturing SMEs). Research method: interview, observation, survey. Research group: entrepreneurs and managers at different organizational levels.

Cont. table 1.

Yahya et al., 2019	Studying the awareness, implementation, level of effectiveness, and potential future use of LM tools and techniques in enterprises in Malaysia (various industries) Research method: survey. Research group: directors, managers, engineers, executives, and academicians.
Bajjou, Chafi, 2018	Studying the level of awareness of Lean Manufacturing practices in the construction industry in Morocco, to identify the benefits and identify barriers to the implementation of LM practices. Research method: survey. Research group: construction practitioners.

Source: Own elaboration.

It can be noticed that many publications on employee awareness of the use of LM tools relate to the construction industry. One of the publications (Table 1) refers to the automotive industry in India (Sahoo, 2020). Therefore, there is a research gap related to the assessment of awareness of the use of LM tools in the automotive industry. Automotive companies were the first to implement Toyota Production System solutions and they are widely used there. However, there are no results of research on the assessment of employees' awareness in this area.

Therefore, the study focused on assessing the awareness of middle management staff and the use of their knowledge in the field of applying the methods and tools of the LM concept in the automotive industry company in Poland. The obtained results will allow to identify areas requiring improvement actions in this enterprise.

2. Methodology

The study of employee awareness in the use of methods and tools of the Lean Manufacturing concept was carried out using the survey method, addressed to a specific research group. The assessment of employee awareness is a subjective assessment resulting from the analysis of each question in the survey. To achieve the assumed goal, a four-stage research methodology was developed (Figure 2).

In the first stage, a questionnaire consisting of forty questions was developed. The questionnaire referred to issues related to three areas:

- occupational safety and health (OSH),
- applied methods and tools of the LM concept,
- implemented management systems.

For the purposes of the study and the assumed goal, one research area was taken into account, related to the use of LM methods and tools and the management's awareness in this regard.

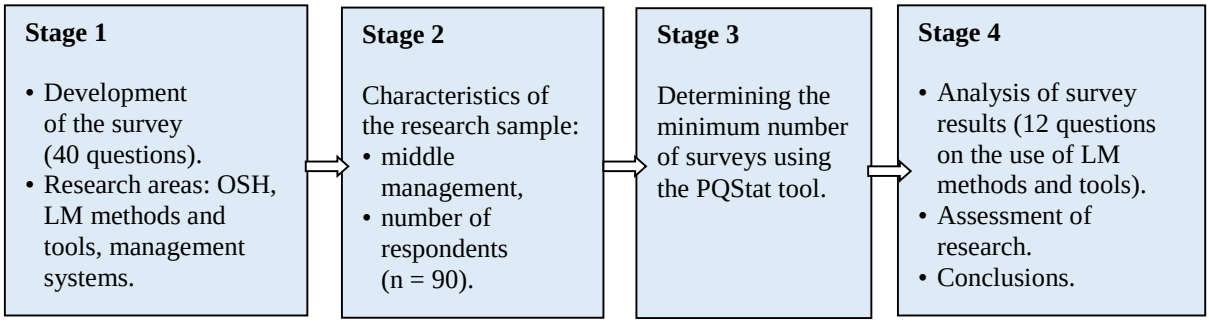

Figure 2. Research methodology.

Source: Own elaboration.

In the second stage of the research, the research sample was characterized - the developed questionnaire was addressed to middle management (90 respondents). The number of respondents was determined by the company's top management.

In the third stage, the minimum number of respondents was determined. For this purpose, a statistical analysis tool (PQStat) was used. With the assumptions of a significance level of 0.05 and an estimation error of 0.02, it was estimated that the necessary number of surveys should be 87.

In the fourth stage of the research, the results obtained were analyzed and conclusions were formulated, which may serve as guidelines for managers responsible for continuous improvement of processes.

3. Awareness of the management in the use of methods and tools of the LM concept

3.1. Characteristics of the research sample and the questionnaire

The survey was conducted in the first quarter of 2023. The research was addressed to middle management to assess awareness and knowledge of LM concept solutions used in the company. The survey was conducted among 90 respondents working in two production plants, in a 2-shift system. Respondents are persons managing work in the following departments: quality, maintenance, technology, production, logistics/warehouse, and administration - the largest group was production department managers (23 persons). Most respondents are persons aged 41-50 with 16-20 years of work experience (at their current employer). The survey, in addition to the respondent's identification data (demographics), contained 12 single and multiple-choice questions regarding (Table 2):

- applying methods and tools derived from Toyota Production System (5S, Kaizen, suggestion system, SMED, TPM, Autonomous Maintenance, standardization, Visual Management),
- using Problem-Solving tools in everyday working (5 Why analysis, 5W+1H analysis, Ishikawa diagram, Pareto diagram),
- the impact of the applied solutions on improving the organization of production and OSH,
- difficulties (or lack of difficulties) with the implementation of these solutions in the managed departments,
- involvement in improvement projects (Kaizen and the suggestion system).

Table 2.
Survey question, number of respondents, and number of answers returned

Question	Number of respondents	Number of answers returned
What tools are used in the company's daily functioning as part of the implemented systems? (multiple-choice question)	90	90
How long have you known and used these tools? (single-choice question)	90	90
What tools in the field of Problem-Solving are used in your company? (multiple-choice question)	90	90
In which areas do you use Problem-Solving tools? (multiple-choice question)	90	90
What is the type of impact of the implemented management methods and tools on improving the organization of production? (single-choice question)	90	90
Which tool, in your opinion, has the greatest impact on improving the organization of production? (single-choice question)	90	89
What is the type of impact of the implemented management methods and tools on OSH's improvement? (single-choice question)	90	90
Which tool, in your opinion, has the greatest impact on OSH's improvement? (single-choice question)	90	89
Which tools were the most difficult to implement in your company? (multiple-choice question)	90	87
Which tools were the easiest to implement in your company? (multiple-choice question)	90	87
Do you submit ideas in the Suggestion Program (Kaizen)? (single-choice question)	90	89
What scope do you submit your Kaizen ideas from? (multiple-choice question)	90	88

Source: Own elaboration.

The answers obtained will allow the assessment of knowledge in the field of solutions used in everyday work for process improvement and the assessment of the level of involvement of middle management in these activities. This translates into employee awareness and a culture of continuous improvement in the company.

3.2. Analysis of the conducted research - discussion

The company in which the research was conducted has systems supporting the optimization of production and production-related processes, e.g. a system based on TPS - under which methods and tools from the LM concept are used. The most frequently used tools in everyday work are (Figure 3): Kaizen and the 5S method (171 responses in total), followed by TPM, SMED, and Visual Management (VM) (161 responses in total). The fewest answers (28) concerned Autonomous Maintenance (AM), although it is an important pillar of the TPM system (indicated in the survey). Different answers may result from the fact that not all departments in which the respondents work use the tools mentioned (e.g. administration, warehouse). Among all respondents, 72% have known and used these tools for more than 5 years, 12% - for 3-5 years, and 11% - for 1-3 years (Figure 4). The results indicate that the middle management has the knowledge and high awareness in applying solutions to the LM concept. It should be noted, however, that 5% of the respondents do not use any of the tools listed. This is important information for the management to take improvement actions.

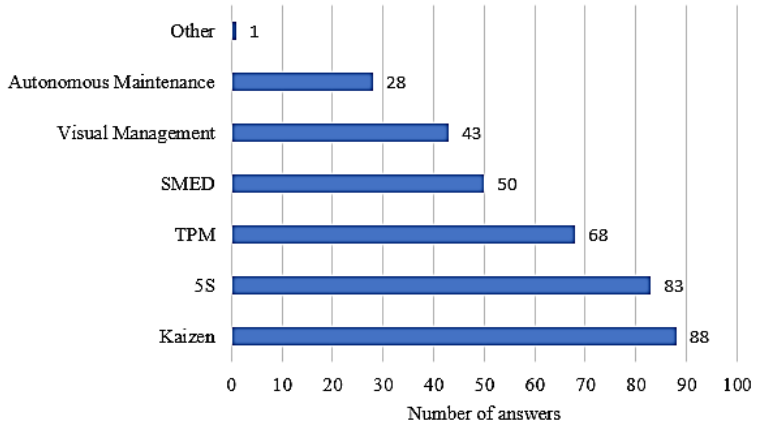

Figure 3. What tools are used in the company's daily functioning as part of the implemented systems? – results.

Source: Own elaboration.

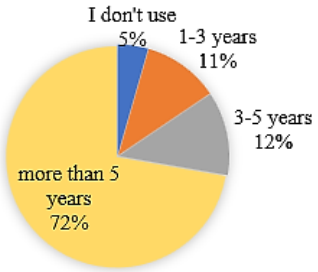

Figure 4. How long have you known and used these tools? – results.

Source: Own elaboration.

Problem-solving is an integral part of the continuous improvement process and is at the heart of TPS. It emphasizes the role of management (as leaders) in engaging employees to identify and solve problems, which translates into increased awareness of continuous improvement. In the company where the research was conducted, the middle management

knows and uses the following most often (Figure 5): 5 Whys analysis (87 responses), Ishikawa diagram (70 responses), and Pareto diagram (65 responses). These tools are easy to use and can be used in any area of the enterprise. In the survey, respondents most often use Problem-Solving tools in two main areas: quality management (60 responses) and production process management (60 responses). This is justified due to the profile of the plant's activity (automotive industry) and high requirements in terms of technology and quality. Problem-solving tools are also used in the areas of production logistics, health and safety, human resources management, and the environment (Figure 6). The answers obtained indicate that the respondents have the knowledge and high awareness of the use of Problem-Solving tools in their daily work.

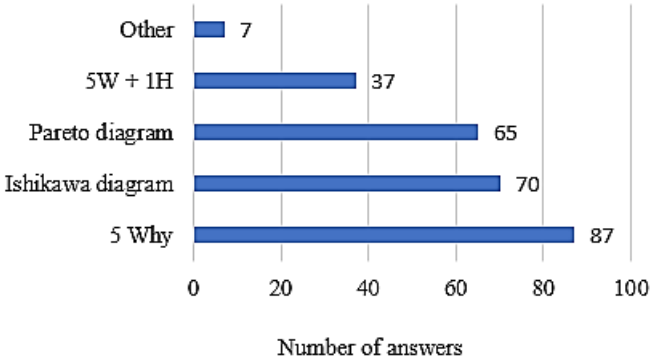

Figure 5. What tools in the field of Problem-Solving are used in your company? – results.

Source: Own elaboration.

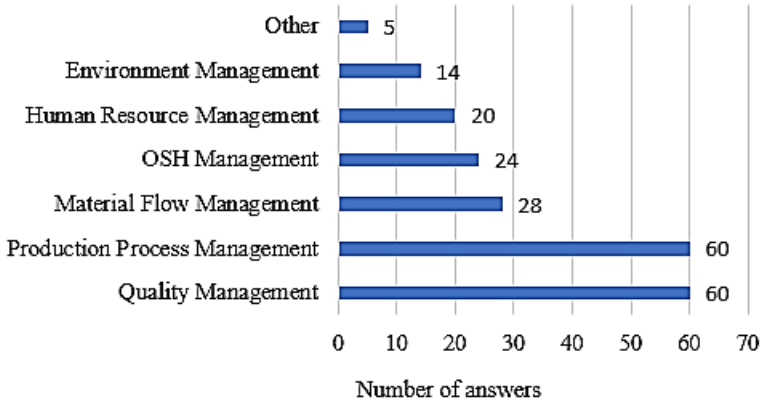

Figure 6. In which areas do you use Problem-Solving tools? – results.

Source: Own elaboration.

The methods and tools of the LM concept, as indicated in the literature review, affect the processes in enterprises and bring many benefits. Therefore, the survey asked respondents about their subjective assessment of the impact of the tools they use on two aspects: organization of production and work safety. According to the majority of respondents, the tools used have a large and very large impact on improving the organization of production (55 respondents) and OSH (62 respondents). Only 3 respondents believe that these tools have no impact on these two areas (Figure 7a-b).

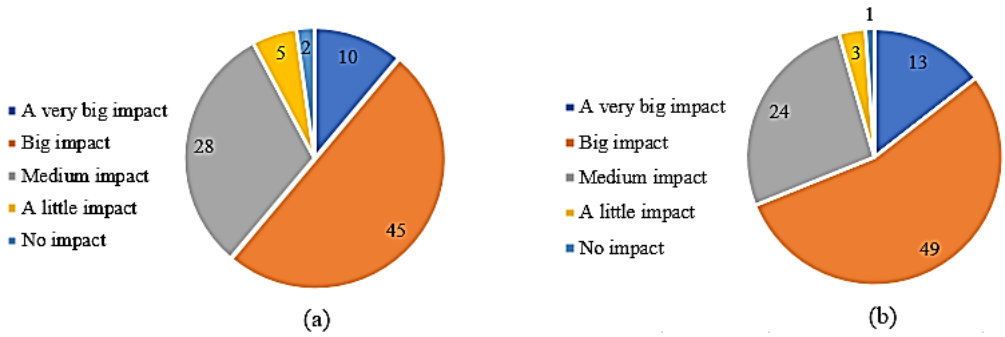

Figure 7. What is the type of impact of the implemented management methods and tools on improving the organization of production (a) and OSH (b)? – results.

Source: Own elaboration.

According to the respondents, standardization has the greatest impact on the organization of production (34 responses). This is indicative of a high degree of awareness in the field of applied LM solutions - standardization is considered the most important LM tool without which processes cannot be improved. Subsequently, the respondents indicated (Figure 8):

– Kaizen and the suggestion system (13 responses) – through the implementation of improvement projects,
– 5S method (12 responses) – which organizes and standardizes work at workstations,
– TPM (10 responses) – which ensures reliable operation of machines.

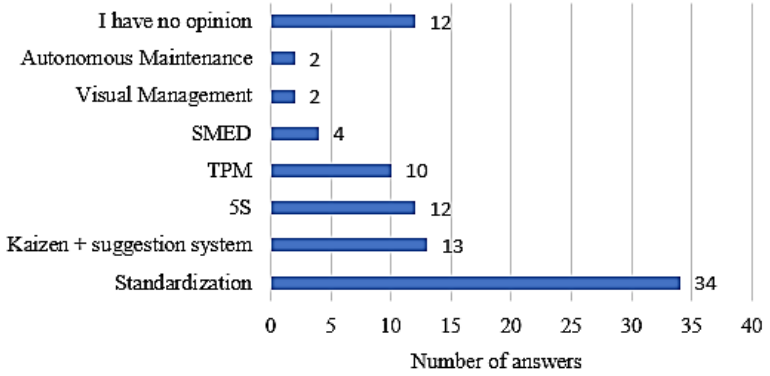

Figure 8. Which tool, in your opinion, has the greatest impact on improving the organization of production? – results.

Source: Own elaboration.

Only four respondents indicated the SMED method, which affects the flexibility of the process and reduces the changeover time. Twelve respondents expressed no opinion, which may indicate a lack of knowledge about the effects of using these tools (important information for the management) – Figure 8.

More than half of the respondents (50) indicated the measures taken as part of Accident Prevention as a tool that has the greatest impact on improving work safety (Figure 9). This is not a tool classified as LM solutions, but such an answer is indicative of a high level of awareness of middle management in the field of work safety. Subsequently, the respondents indicated three LM tools that have an impact on improving OSH: standardization

(15 respondents), Kaizen and the suggestion system (11 respondents), and the 5S method (6 respondents). These are the solutions most often used by enterprises of various industries, which have an impact on improving work safety. The answers obtained confirm the knowledge and high awareness of the respondents in this area.

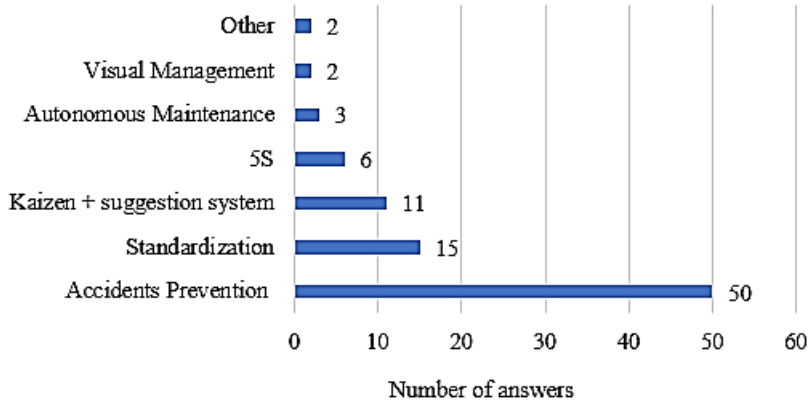

Figure 9. Which tool, in your opinion, has the greatest impact on OSH's improvement? – results.
Source: Own elaboration.

An important aspect of using LM solutions in everyday work is also the ease of their implementation. This affects the involvement of employees in the actions taken. Therefore, respondents were asked to assess which tools were the easiest and which were the most difficult to implement. (Figure 10-11). Standardization, the 5S method, Kaizen and the suggestion system, and AM are the tools that, according to the respondents, caused the greatest difficulty in implementation. The easiest tools to implement, according to the respondents, were: Kaizen and the suggestion system and the 5S method This diversity in answers may result from the department in which the respondents work and the involvement of employees in the change process. This is important information for the management to analyze this aspect and take appropriate improvement actions. Nevertheless, the answers obtained testify to the respondents' awareness in this area (the ability to identify problems).

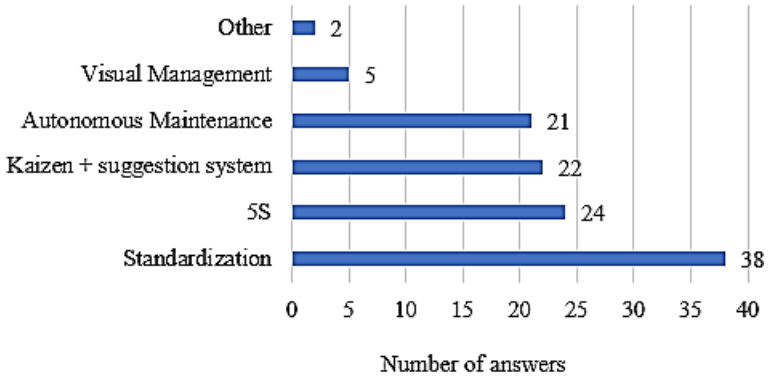

Figure 10. Which tools were the most difficult to implement in your company? – results.
Source: Own elaboration.

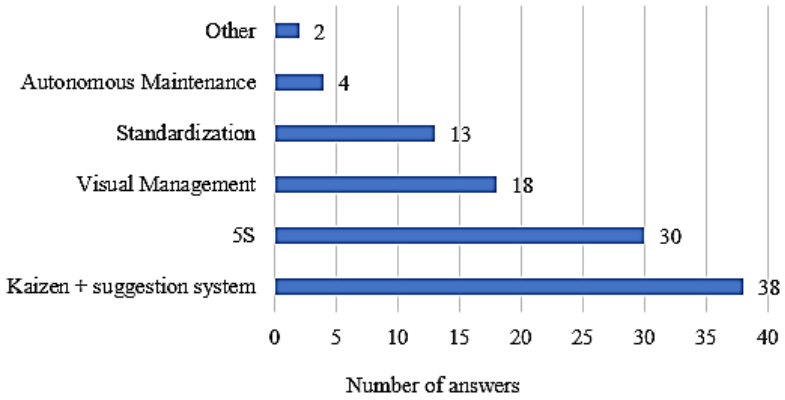

Figure 11. Which tools were the easiest to implement in your company? – results.

Source: Own elaboration.

The involvement of the middle management in improvement projects was also assessed, which is an important element of the culture of continuous improvement (Lean culture) and translates into shaping the awareness of all employees in this aspect. The vast majority of respondents (70) submit ideas through the Suggestion Program (Kaizen). Most ideas concerned areas related to improving working methods, quality, and work safety (Figure 12a-b). Therefore, the obtained answers indicate high awareness of employees in this area. It is worth mentioning that the impact of the applied solutions of the LM concept on improving the organization of production, OSH, and quality was confirmed by the respondents in several questions of the survey. However, 19 respondents did not submit ideas, which is important information for the management staff.

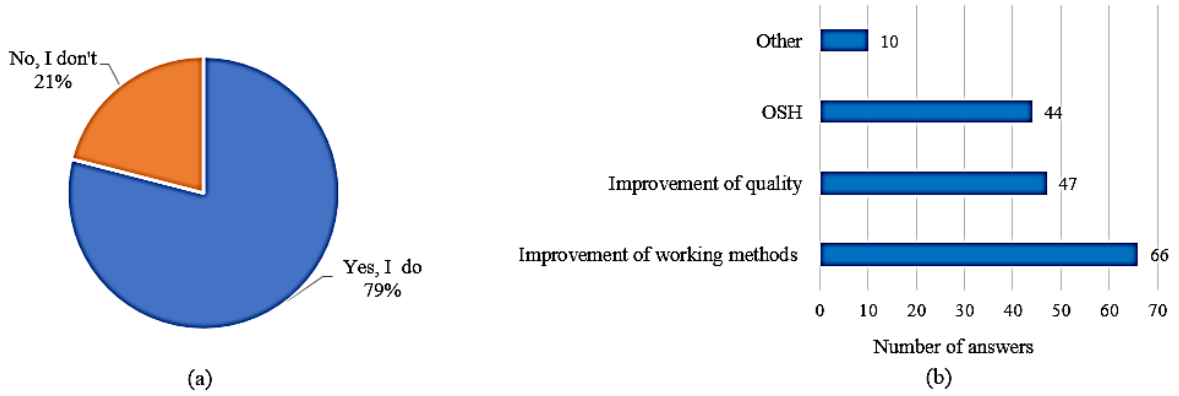

Figure 12. (a) Do you submit ideas in the Suggestion Program (Kaizen)? (b) What scope do you submit your Kaizen ideas from? - results.

Source: Own elaboration.

4. Summary

The conducted surveys made it possible to assess the awareness of middle management in the use of methods and tools of the Lean Manufacturing concept. The assessment of awareness was a subjective assessment resulting from the analysis of each survey question. Based on the conducted research, it was found that the vast majority of middle management has knowledge and high awareness in the field of continuous improvement, in the form of using LM methods and tools in the daily functioning of the company.

High awareness results from the knowledge of methods and tools derived from the Toyota Production System, which most of the respondents have been using for many years (5 years and more). In addition, employees know methods of solving problems and apply them in various areas (mainly in the field of quality management and production process management). More than half of the respondents are aware of the impact of the methods and tools used on the organization of production and work safety, indicating the tools that have the greatest impact on these areas. Respondents are also aware of the difficulties associated with the implementation of LM methods and tools in the departments in which they work. The results of the research also indicate the high commitment of the management in the form of submitting improvement ideas, which mainly affect the improvement of working methods, quality, and OSH.

The research results also indicate areas requiring improvement (awareness of the use of LM methods and tools is low):

- 5% of respondents do not use LM tools,
- 3 respondents believe that used tools do not affect the improvement of the organization of production and OSH,
- 12 respondents have no opinion on which tools improve the organization of production,
- 19 respondents do not submit ideas in the Suggestion Program,
- a discrepancy was found regarding the ease/difficulty of implementing different LM tools.

The obtained results (regarding low awareness) are important information for the management staff, allowing them to find out the reasons and take improvement actions. These can be, for example, additional training in the field of LM methods and tools, meetings at action boards to discuss current problems, or obtained results.

The important role of management in the process of continuous improvement should be emphasized. The knowledge and awareness of the management translate into the attitudes and behavior of employees (their commitment). This increases the level of the culture of continuous improvement in the company and can bring many benefits.

The conducted research was limited to assessing the awareness of a specific group of respondents (middle management), and the assessment was based on the results of 12 questions of the survey. Therefore, the direction of further research should also focus on assessing the awareness of production employees to obtain more complete information related to the development of the Lean culture in this company.

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