

ELIMINATION OF WASTE USING SELECTED METHODS AND TOOLS IN ENTERPRISES

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Introduction

Since the 1990s, companies have been striving to increase their competitiveness and market value. Current times force companies to take actions that allow them to stay on the market and increase the level of competitiveness. Because of this competitiveness, it is necessary to look for other ways than price competition, quality competition, information competition or customer service competition to constantly improve its level (Łukasik, 2014, p. 121). Experts in companies, especially in manufacturing, often turn to particular methods and tools to reduce production costs, optimize processes and ensure the quality of their products or services. In addition, such actions make it possible to exclude from the process the non-added value, i. e. the value for which customers do not pay, because they buy a product or service and are not interested in the company's problems during production, e.g. defects, excessive transportation or other types of waste which can be found in enterprises. It is also worth mentioning that different methods and tools to problem solving are often understood differently in both theory and practice (Bednarz, 2014, pp. 463–464; Gładysz, 2019, pp. 54–61).

Therefore, the purpose of this article is to examine the impact of using selected methods and tools on the elimination of various types of waste in manufacturing enterprises. The article also refers to the importance of proper selection of methods and tools for the problems encountered and raises the aspect of continuous improvement¹.

Literature review

One of the main objectives of companies is to eliminate waste (jap. muda literally „useless, futile, unnecessary”) and continuous improvement (Womack, Jones, 2003; Choma et al., 2020, pp. 13–14; Pawlak, 2021). Enterprises use various methods and tools to eliminate various forms of waste (Hadaś, Pawlak, 2021, pp. 572–584).

The literature on the subject identifies seven main sources of waste, namely (Ohno, 2008, p. 22):

1. Overproduction, understood as production „for stock” in too large quantities, too far in advance and often based on inflated forecasts. Overproduction can still be at individual stations that are on the assembly line and then the result is improper flow of information or materials and inventory.
2. Rejects and rework basically understood as inadequate product quality, defective materials, which are the result of errors and irregularities of production workers, but also administrative workers, and which must be corrected at the cost of additional time, energy and capital.
3. Transport, understood as unnecessary movement of products, semi-finished products, materials and parts and unnecessary or excessive movement of people. The result is a loss of time and space, which is usually due to poorly designed workspace, e.g., too large distances between machines.
4. Waiting, understood as periods of idleness of employees, materials, parts and unscheduled downtime of machines and equipment. Undesirable consequences of waiting can be problems with the flow of the production process, its long duration and failure to meet delivery deadlines.
5. Processing, understood as improper organization of workplaces, which results from non-ergonomic and irrational management of workspace. Makes the process difficult and can cause accidents during work resulting from activities that require a lot of effort.
6. Inventory, defined as excess disposable inventory that is the result of, for example, a delay or error in information. It is also a surplus of raw materials, work in progress or finished products leading to longer lead times, damage and obsolescence of products, transport and storage costs and delays.
7. Unsafe or unhealthy conditions, understood as unsafe or harmful conditions, use of inappropriate methods, tools, procedures, often when a simpler approach may be more effective.

In addition to the above-mentioned and briefly characterized seven types of waste, Jeffrey Liker mentions a no less important eighth type of waste, namely:

8. Untapped human potential is an organization's failure to use the ideas, creativity, competencies, talents, and available time of its employees.

The authors of the article also distinguish an additional source of waste that sometimes appears in the theory which is (Dobrowolski, 2021, pp. 29–31):

9. Ill-suited methods or tools to solve problems. Incompetent use of Problem Solving results in unsolved problem while consuming resources. It is

often caused by an incorrectly identified source of the problem or a failure to involve people who are experts in the work being done. Sometimes employees are reluctant to collaborate on these types of projects for fear of facing consequences for mistakes.

However, when implementing subsequent methods and tools to eliminate waste, it is important to first identify only the basic and most common wastes, so as not to cause financial expenses and sudden, revolutionary changes (Pawlak, Andryszak, 2021, pp. 330–343).

There are many methods and tools used in the market to eliminate waste. The following are noteworthy:

- TQM – total quality management,
- ISO – standards for creating quality systems,
- TOC – theory of constraints,
- JiT – just-in-time delivery system,
- Lean – the concept of lean management,
- Reengineering – a method of process restructuring of an enterprise,
- SPC – statistical process control,
- Six Sigma – a quality management method,
- MRP – integrated management systems supporting material requirements planning,
- SCM – supply chain management,
- ERP – an integrated system that supports enterprise resource planning.

The choice of the appropriate method, of course, belongs to the company that uses it to eliminate waste.

The implementation of methods or tools is often the result of a desire to improve the current situation in the company or to solve a problem that occurs in it and disorganizes work or adversely affects the results that the company wants to achieve. One of the many mistakes that can be made when starting changes is the lack of conversation about the problem with the right person who is, for example, responsible for the given position and could, as an expert, say what in his/her opinion is the cause of, for example, over processing or defects. Additionally, the lack of a precise definition of the problem results in impossibility to solve something that has not been defined. Sometimes it happens that even when a manager finds the right professional and wants to discuss the problem with him or her, the employee is reluctant to provide valuable information for fear of being blamed and consequently punished. Assuring an employee that they will not be punished when they report a problem will result in staff feeling important to the organization, engagement and increased competence, which will have a measurable impact on the business as a whole. It is important to remember that it is not the individual who is to blame for errors in the process (Dobrowolski, 2021, pp. 29–31).

The fundamental cause of change failure is the lack of understanding of the methods and tools used. Often management is interested in improving performance within the company, and the aim of the project is to implement appropriate methods and tools. This is a tactic that is doomed to failure because it omits important steps such as analysis of the current situation, identification of needs, and introduction of a training system to get the whole company involved in the changes. Also, it is necessary to consistently implement

the idea of continuous improvement at the very end with area leaders, thus ensuring success for proper management. Resistance of superiors is connected with the fact that they want to achieve quick success, not engaging their own resources, but to implement a proper methods and tools, being convinced that this is enough (Król, 2021, p. 17).

It should also be remembered that a properly conducted process of problem solving, including the implementation of new methods or tools, should be based on five basic steps (Liker, Meier, 2021, p. 388):

- Understand the current situation and define the problem,
- Conduct a comprehensive root cause analysis,
- Analyze alternatives,
- Use the PDCA cycle (Plan-Do-Check-Act). Plan – recognize an opportunity and plan a change, Do – implement the solution, Check – verify the results, Act – apply the results,
- Learn from the process.

A properly conducted PDCA cycle should end with the standardization of successful ideas. It is an activity that, according to the concept of continuous improvement, ensures changes in the organization of processes and thus development.

A review of available research allows us to conclude that reducing waste and nonvalue processes is one of the most important aspects in an organization. Striving to achieve this goal can result in business improvement, improved customer satisfaction and increased profits. The publication, based on a literature review, makes a comparative analysis of methods and tools such as Lean Management, ISO, TQM, Six Sigma and integrates some of them. Combining methods and tools in pairs can reduce the disadvantages of each of them. Their implementation must be adapted to the conditions in a given enterprise. No universal combination has been found that would suit every company (Nouri et al., 2015, pp. 11–12, 17–21).

Continuous development is crucial to being competitive in today's dynamic world. Based on the literature review, the authors proposed that the implementation of Lean tools and methods as a side effect may facilitate knowledge creation in the context of problem solving and development. The authors deduced how lean methods and tools support knowledge exchange through SECI (socialization, externalization, combination, internalization). The article verified the hypotheses put forward using a survey. The hypothesis that the implementation of Lean tools facilitates the knowledge exchange process was proven to be correct (Zhang, Chen, 2016, pp. 1267–1274).

Lean and Green production were widely described 30 years ago, and the basis of the new business was the elimination of waste through Lean Management tools, referring to Taichii Ohno's 8 types of waste, which the authors have mentioned in this publication. Some companies, despite implementing methods and tools to reduce waste, still struggle with failures and problems. These failures concern the incorrect selection and sequence of implementation of methods and tools (Lean and Green). The results of surveys in companies showed a positive impact

of the implemented selected tools and methods and the use of given methods and tools in enterprises. It was noted that TPM reduces as many as 5 out of 8 types of waste, but its implementation does not guarantee full success. Each company must adapt the implementation path of Lean Management and green methods and tools to individual needs (Leksic et al., 2020, pp. 81–92).

The authors did not find any global or local research examining the relationship between the number of implemented methods and tools to eliminate waste and the occurrence of various types of waste. The primary research question inspiring the authors to conduct the study was: Is there a relationship between the number of methods implemented and the number of types of waste that occur? Therefore, the aim of the publication is to determine the relationship between the number of implemented

methods and tools to eliminate waste and the number of declared types of waste.

Research methodology

The survey was conducted among companies in the Wielkopolskie Voivodeship in Poland. The research method was a survey, which included a questionnaire for collecting data. The questionnaires were sent by e-mail. The study used the CAWI method (Computer-Assisted Web Interview). Over 700 questionnaires were sent to randomly selected manufacturing companies that met the condition of location in the province. A total of 80 responses were received, which could be analyzed and conclusions drawn. Many companies refused to participate in scientific research because they were not interested in

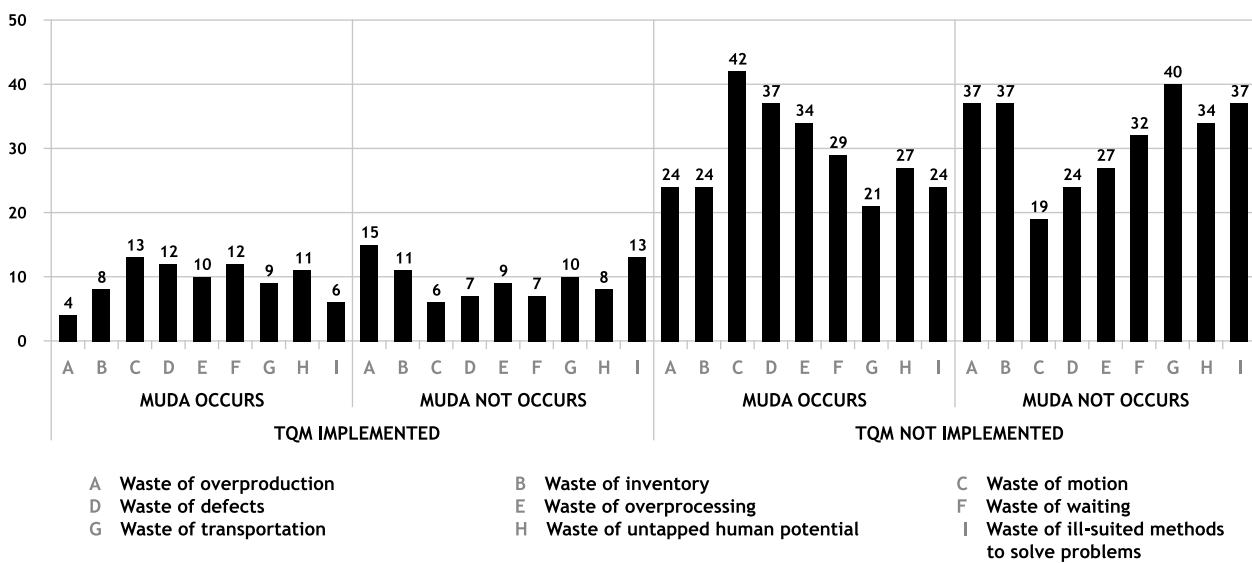


Figure 1. TQM and the occurrence of wastage
Source: own elaboration based on conducted research

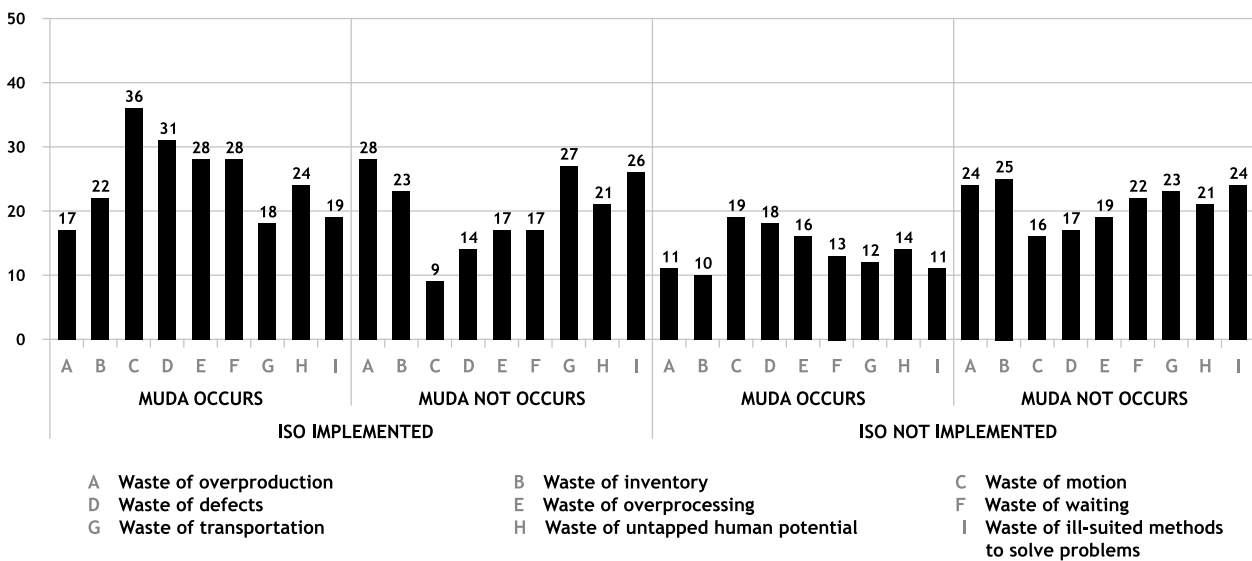


Figure 2. ISO and the occurrence of wastage
Source: own elaboration based on conducted research

it. However, the research sample is sufficient to conduct analyses. The questionnaire included standard metric and fifteen questions regarding the use of the method to eliminate waste in enterprises. However, for the purposes of the following analysis, the results have been sorted into whether a particular method or tool is implemented and whether a particular type of waste occurs. The subject of the research are people properly responsible for production in enterprises. The study population was defined:

- Subject of the study: specialist/manager (production department).
- Research unit: production enterprise.
- Scope: area of the Wielkopolskie Voivodeship in Poland.
- Research time: Q2 2022.

Findings of scientific research

The analysis of the respondents' answers is presented below. The charts below include the Japanese „muda” that are identified in the literature review.

The chart (Figure 1) shows the relationship between the implementation of the TQM and the occurrence of wastage or lack thereof in the surveyed companies. Companies declared the occurrence of different types of wastage within the organization. The results of the survey conducted showed that companies that had implemented TQM most often indicate the occurrence of waste of motion. In contrast, waste in the form of overproduction and ill-suited methods or tools to solve problems are the least common. In contrast, wasteful overproduction and ill-suited methods and tools to solve problems are the least

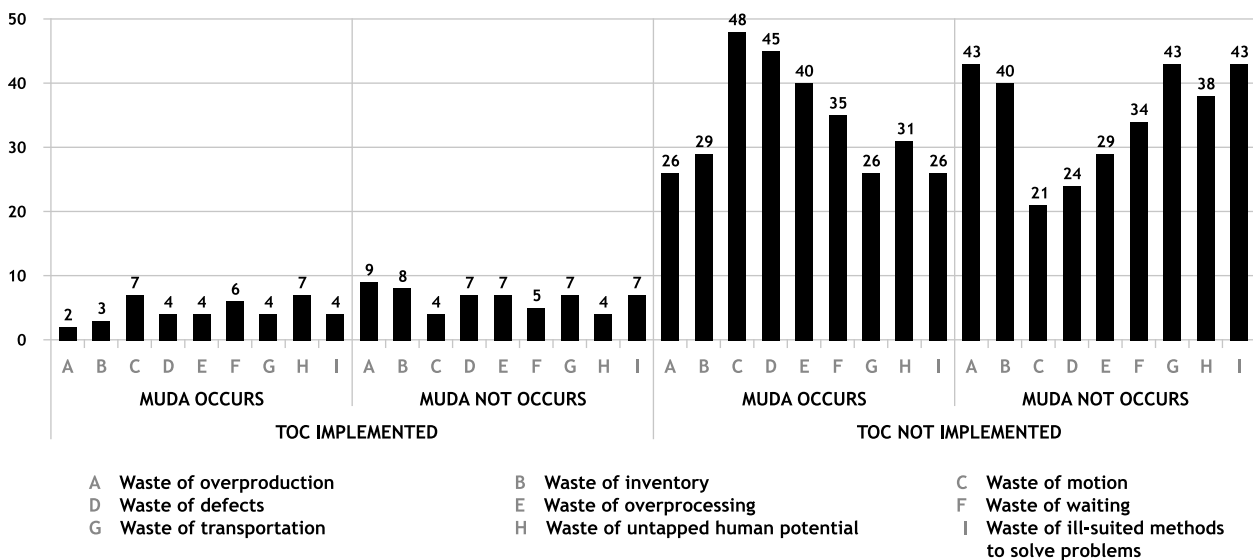


Figure 3. TOC and the occurrence of wastage
Source: own elaboration based on conducted research

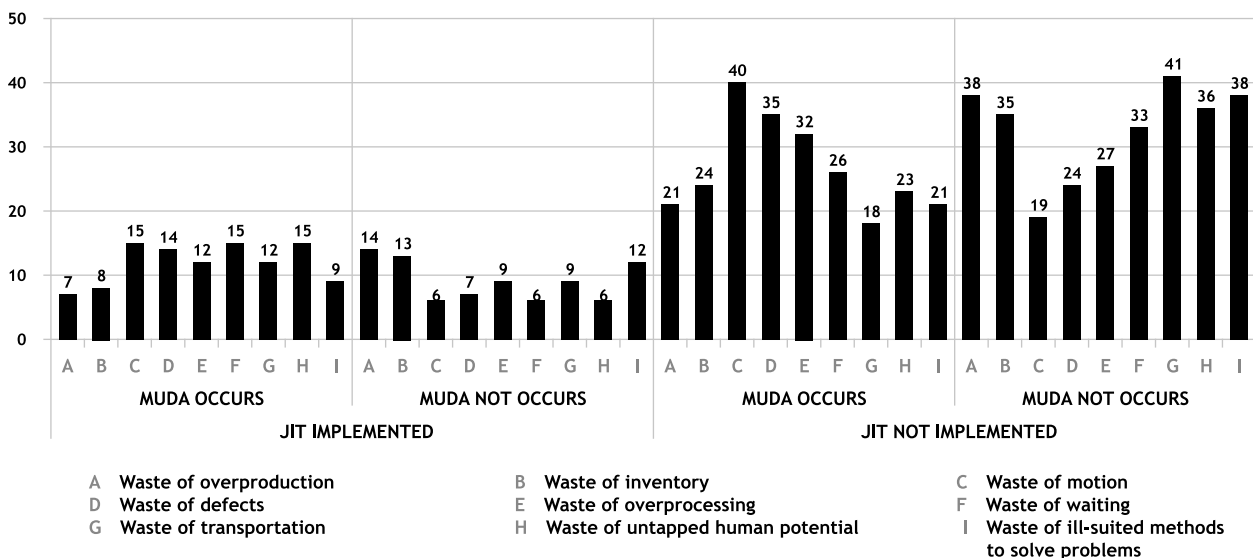


Figure 4. JiT and the occurrence of wastage
Source: own elaboration based on conducted research

frequent. When TQM is not implemented, companies tend to experience waste such as excessive motion, defects, and over – processing. The most commonly reported lack of waste in this case was the lack of waste such as excessive transportation, inventory, overproduction and ill-suited methods or tools to solve problems.

The chart (Figure 2) shows the use of ISO by the surveyed companies in the context of the occurrence of waste in the organization. Wastage such as excessive motion and defects are most common in both ISO and non-ISO companies. In the case of companies that have implemented ISO, excessive transportation and overproduction are the least likely to occur. Companies that have not implemented ISO most often declare that waste such as excessive inventory, ill-suited methods or tools to solve problems and overproduction does not occur.

The chart (Figure 3) shows the relationship between the implementation of a TOC in relation to the occurrence of different types of waste in companies. The vast majority declared that they had not implemented this method. However, companies that have implemented TOC most often point to waste such as the occurrence of excessive motion untapped human potential and least often to overproduction. Companies that have not implemented TOC most often report waste such as excessive motion and defects, and least often overproduction and inventory.

The chart (Figure 4) shows the relationship of the use of the JiT system in relation to the occurrence of different types of wastage. In the absence of this system, companies declared the presence of waste in the form of excessive motion, defects and over-processing. On the other hand, the least frequently indicated waste was

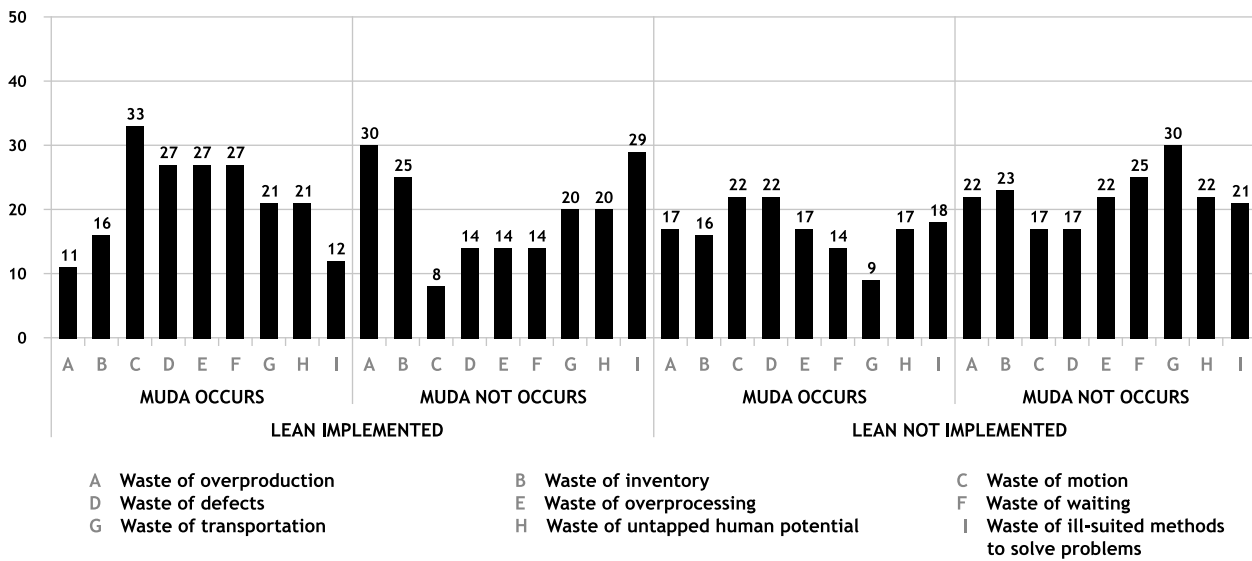


Figure 5. Lean and the occurrence of wastage
Source: own elaboration based on conducted research

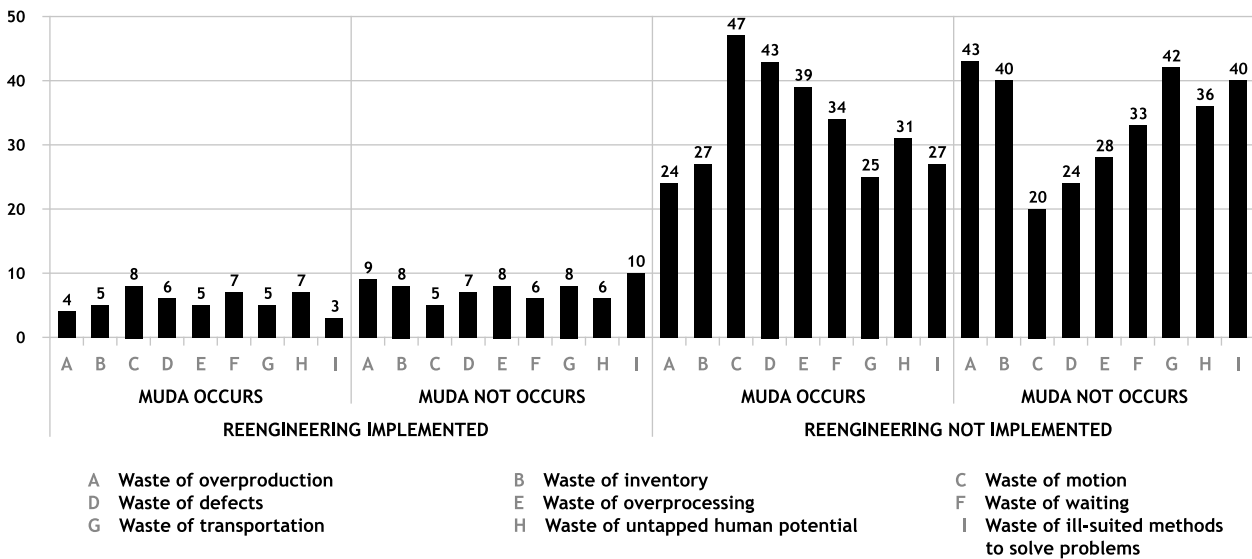


Figure 6. Reengineering and the occurrence of wastage
Source: own elaboration based on conducted research

excessive transportation, overproduction and ill-suited methods or tools to solve problems. In companies that use JiT, waste in the form of untapped human potential, waiting, and excessive motion was most common. In contrast, wastage such as overproduction, inventory, and ill-suited methods or tools to solve problem was the least common.

The chart (Figure 5) shows the relationship between the implementation of Lean in companies and the occurrence of waste. In companies where Lean was not implemented, excessive motion and defects were the most frequent, while excessive transportation was the least frequent. In companies that had implemented Lean, waste most often manifested itself in the form of excessive motion and least often in the form of overproduction and ill-suited methods or tools to solve problems.

The chart (Figure 6) shows the relationship between the implementation of Reengineering and the occurrence of wastage in companies. In both the implementation of this method and its absence, the most common waste declared was excessive motion. In contrast, companies that had implemented Reengineering most often reported the absence of overproduction and ill-suited methods or tools to solve problems. For companies with unimplemented Reengineering, they most often reported overproduction and excessive transportation.

The chart (Figure 7) shows the relationship between the occurrence of waste and the implementation of SPC in companies. In both cases of implementation or lack of implementation of this method, the most frequently reported wastes were defects and excessive motion. On the other hand, waste in the form of overproduction

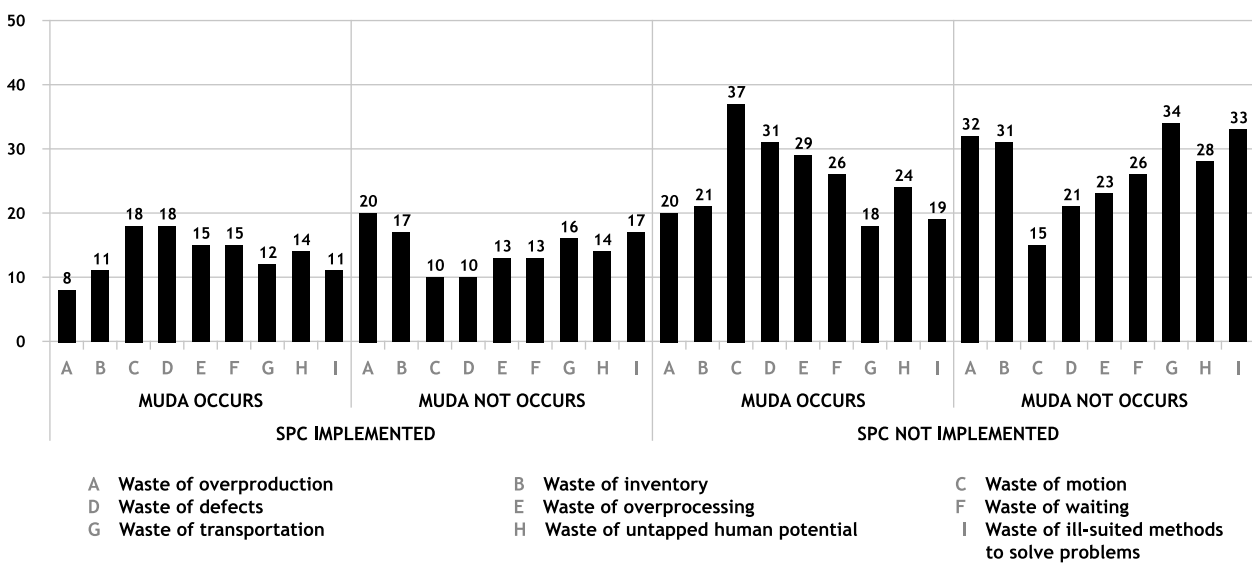


Figure 7. SPC and the occurrence of wastage
Source: own elaboration based on conducted research

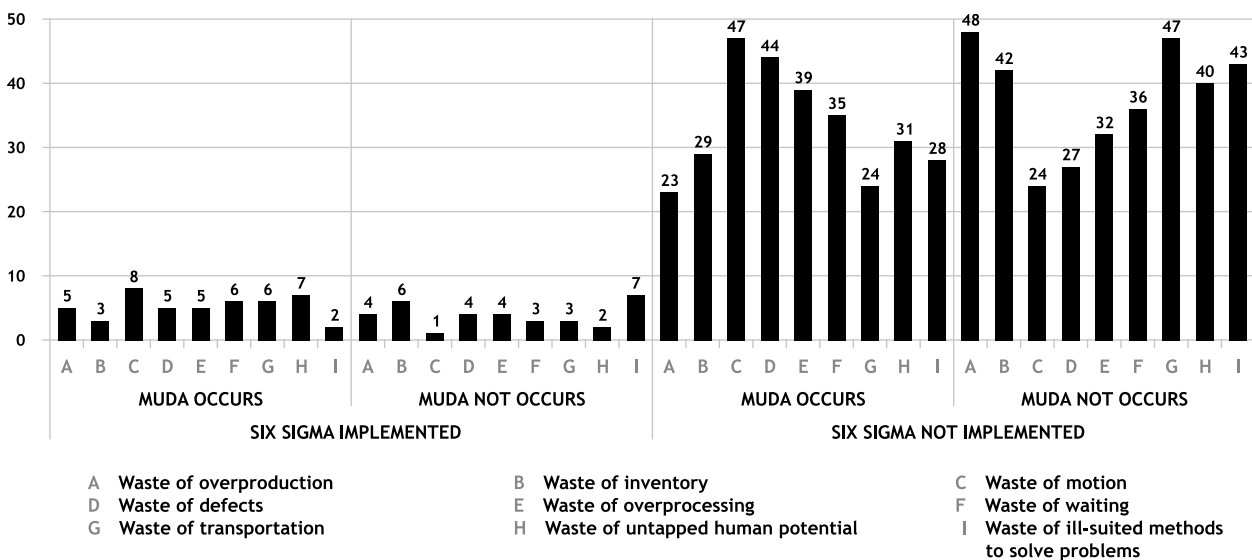


Figure 8. Six Sigma and the occurrence of wastage
Source: own elaboration based on conducted research

was the least frequent. In the absence of implementation of this method, the most commonly reported waste was excessive transportation, ill-suited methods or tools to solve problems and overproduction.

The chart (Figure 8) shows the relationship between the implementation of Six Sigma and the declaration of the occurrence of waste in companies. The most common waste was excessive motion in both Six Sigma implementation and non-implementation. However, waste in the form of ill-suited methods or tools to solve problems was least common in Six Sigma implementation. In the absence of Six Sigma implementation, the occurrence of overproduction and excessive transportation was declared least frequently.

The chart (Figure 9) shows the relationship between the implementation of MRP and the occurrence of

wastage in companies. For companies that have implemented an MRP system, wastage in the form of excessive motion and waiting is the most common, and overproduction and ill-suited methods or tools to solve problems are least common. Companies that have not implemented MRP declare the most frequent occurrence of unnecessary motion, defects and over processing. Wastage in the form of excessive transportation, on the other hand, is the least frequent.

The chart (Figure 10) shows the relationship between the implementation of MRP and the occurrence of wastage in companies. For organizations that have implemented an MRP system, wastage in the form of excessive motion and waiting is the most common, and overproduction and ill-suited methods or tools to solve problems are the least common. Enterprises that have

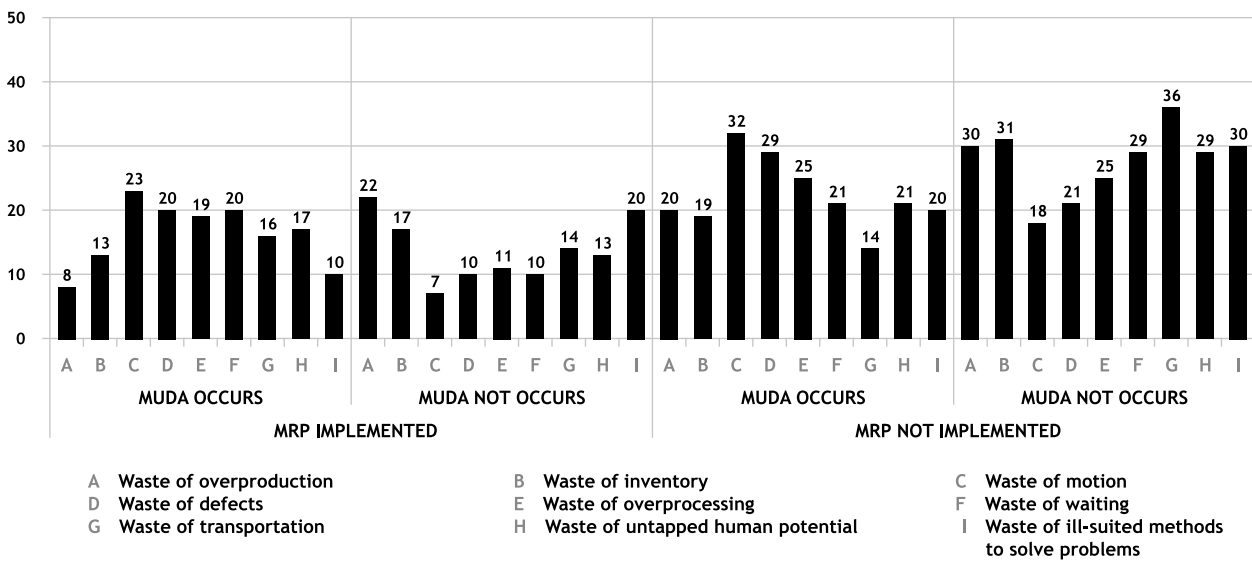


Figure 9. MRP and the occurrence of wastage
Source: own elaboration based on conducted research

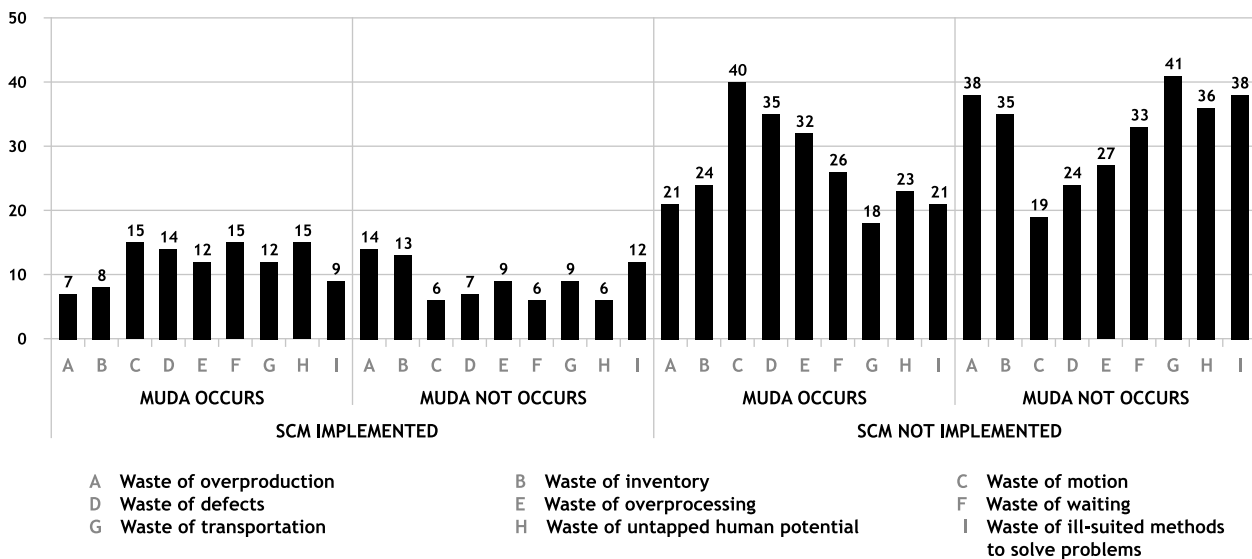


Figure 10. SCM and the occurrence of wastage
Source: own elaboration based on conducted research

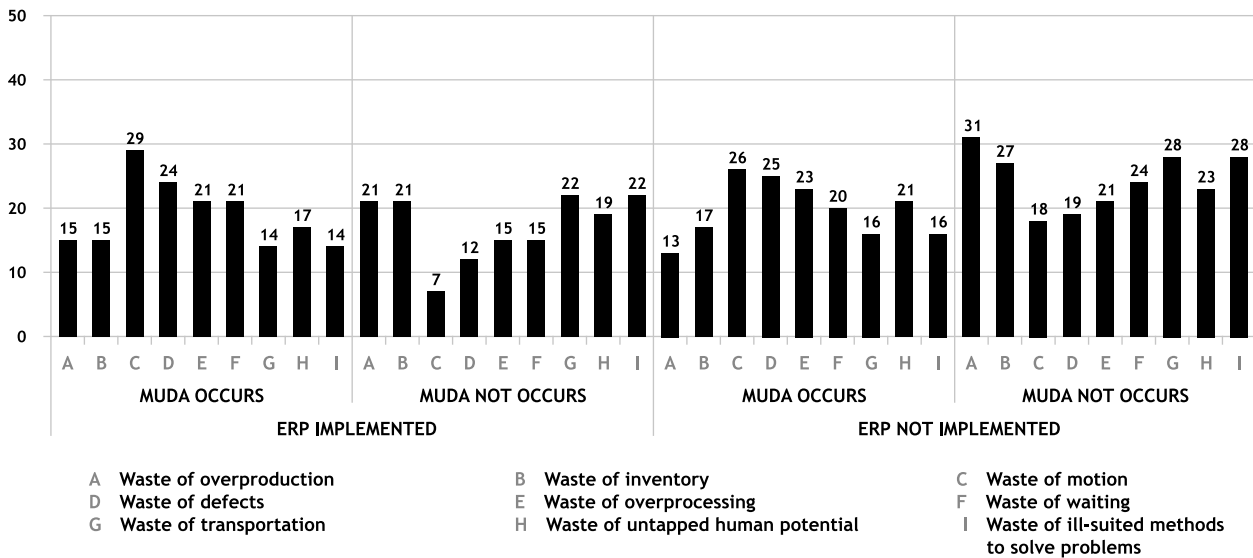


Figure 11. ERP and the occurrence of wastage
 Source: own elaboration based on conducted research

not implemented MRP declare the most frequent occurrence of unnecessary motion, defects and over processing. Wastage in the form of excessive transport, on the other hand, is the least frequent.

The chart (Figure 11) presents declarations of enterprises in noticing the occurrence of particular types of waste in the context of implementing or not implementing an ERP system. In companies that had implemented ERP the most frequently observed wastes were excessive transportation, and the least frequent were waste in the form of excessive transportation and ill-suited methods or tools to solve problems. On the other hand, in companies that did not implement an ERP system, waste in the form of unnecessary motion and defects appeared most frequently, and overproduction, excessive transportation and ill-suited methods or tools to solve problems appeared least frequently.

Conclusions

Companies implementing various types of methods and tools may also forget that these are often changes that require continuous improvement and involvement of all employees (including senior management). Methods and tools to eliminate waste are not methods and tools that just need to be implemented and will work on their own. The reason for the large amount of waste in the organization may also be the fact that the trend towards its elimination is becoming more and more popular, which also causes companies to implement various methods and tools that they may not need. As a result, in theory, companies are improved and modernized, and in practice this means further methods and tools are implemented for the purpose of implementation. Moreover, these companies, despite the methods and tools they have implemented, do not achieve the expected results and only waste time, effort and resources. Waste and mismatched problem solving methods and tools are

waste themselves. Moreover, despite the appropriate implementation of methods and tools, enterprises may still not deal with the causes of waste, but only fight its effects.

The study was conducted among manufacturing enterprises that were least likely to indicate the presence of overproduction as a source of waste. This is the worst source described in the literature because it carries the specter of further waste at many levels. Also noteworthy is the waste declared by companies in the form of excessive motion. This is the kind of waste that is difficult to detect. The authors reflect on its causes in different companies. A possible thesis is that despite the lack of overproduction, the remaining processes are improperly planned. The fact that companies differed in the way and type of operations may also be important, which undoubtedly affects the way management and planning is done within the organization. It is also worth mentioning that companies that implement more methods and tools may have a chance to detect more, sometimes hidden types of waste. The results are astonishing and completely contrary to initial thoughts.

The authors of the article initially assumed that companies declaring a greater number of implemented methods and tools to eliminate waste would therefore record a smaller number of detected wastes in the organization. The results presented in this publication show that, unfortunately, these thoughts are not true. Moreover, there are companies that, after implementing JiT, also declare that there is waste in the form of excessive waiting, which is completely contrary to the assumptions of the on-time delivery system. It is also worth mentioning that despite many declarations about the lack of waste in the form of improper selection of problem-solving methods and tools, it should be emphasized that despite this, decision-makers in companies apparently do not make the right choices for the company. Such actions do not solve the problems and create more foam that must be removed. To sum up, the proper selection of methods and tools for eliminating waste should be well tailored to the needs of

an individual and unique entity, which is each company. However, in order to fully benefit from the implementation of subsequent methods and tools, it is necessary to remember about continuous improvement (including existing solutions) and involvement of all employees in the organization. Moreover, the research sample was small and amounted to 80 questionnaires. Another limitation was participation bias – only 80 questionnaires out of 700 sent were answered back.

The research was limited due to the small research area – Wielkopolska. The authors suggest deepening and extending the research to other areas in Poland and/or other categories of entities. The study may also be enriched by the selection of other methods and tools to eliminate waste.

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Endnote

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Eliminacja marnotrawstwa w przedsiębiorstwach z wykorzystaniem wybranych metod i narzędzi

Streszczenie

Celem artykułu jest zbadanie zależności pomiędzy stosowaniem wybranych metod i narzędzi do eliminacji marnotrawstwa a występowaniem poszczególnych rodzajów marnotrawstwa w przedsiębiorstwach. W artykule zbadano zależność pomiędzy liczbą wybranych metod i narzędzi do eliminacji a liczbą wykrytych marnotrawstw. Z badań wynika, że wiele firm, pomimo wdrażania określonych metod i narzędzi, zapomina o idei skutecznego wdrażania metod i narzędzi eliminacji marnotrawstwa. Wiąże się to z ciągłym doskonaleniem i wyborem właściwych metod i narzędzi rozwiązywania problemów.

Słowa kluczowe

badania ankietowe, marnotrawstwo, metody, narzędzia