

ANALYSIS OF THE USE OF AGILE METHODS, TOOLS AND TECHNIQUES IN FOUNDRY ENTERPRISES

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Abstract: In an increasingly volatile environment, the importance of agile management, which should be based on flexible procedures and agile strategy, is increasing. The purpose of the study was to analyze the trend of development, level of knowledge and implications with the application of agile methods, techniques in project, program and manufacturing process management tools, as well as to identify areas of activity of foundry companies in the context of increasing the efficiency of their operations through the use of agile project approach. The completed research indicated that the knowledge and variety of application of agile methods, tools and techniques is at a relatively low level within the framework of project, program and manufacturing process management in the surveyed foundries. Among the most commonly used instrumentation are: PDCA, Kanban, SCRUM, SCRUMBAN, Lean Development, DMAIC and XP. The research showed that the use of agile instrumentation in the areas of projects, programs and manufacturing process management allows work to be done in an orderly and transparent manner. Foundries that consistently use agile instrumentation produce high-quality and non-conformity-free products with short time-to-market. Future research directions will be to perform a comparative analysis of the level of knowledge and implications of agile instrumentation in foundries located in Poland and selected neighboring countries.

Keywords: Agile business management, Agility, management and quality, mechanical engineering, foundry engineering

1. INTRODUCTION

Effective business management is based on harmonizing the activities carried out for the benefit of an organizational unit with the intention of achieving its goals in an efficient manner. This means using resources wisely and without unnecessary waste, and in a way that leads to the desired outcome (Ulewicz and Blaskova, 2018; Ulewicz et al. 2019). Such activities can be considered in a structural context - management under which static aspects and harmonization of the structure of activities dominate, and in a process context according to which dynamic aspects and process harmonization of activities dominate

(Miskiewicz and Wolniak, 2020; Czerwinska and Pacana, 2022, Ulewicz, 2014). As the literature indicates, the structural approach focuses on achieving the goals of the organization as a whole. This approach views the enterprise as a collection of separate functions carried out within separate divisions (an approach that has attracted disapproval) (Ciric et al., 2021). The process approach, on the other hand, pays attention to meeting buyers' needs, reducing errors, identifying new sources of (internal) value, as well as inefficient material consumption and closely related costs (Pietraszek et al., 2020; Pacana and Czerwińska, 2019; Ulewicz et al. 2013; Hąbek et al. 2023). These actions, foster efficiency and flexibility in operations and increase productivity (Sowards, 2007; Rummler and Brache, 2000; Pacana and Czerwińska, 2021). The benefits indicated confirm that modern manufacturing companies are increasingly focusing their activities on a process approach, thus attempting to increase the level of efficiency of their operations (Trocki et al., 2003; Klimecka-Tatar, 2018, Kuzior et al. 2023). The treatment of the issue of ventures in foundry enterprises, which is the focus of the article, falls within the field of management, which is called project management (Project Management) (Aslam and Bilal, 2021). Structured methods, tools and techniques used in project management have been formed for more than a century (Skotnicka - Zasadin, 2010). The early 1970s, was associated with strong support for the well-established cascade approach, which is now often criticized for its relatively low flexibility and poor adaptation to the changing environment (Wolniak, 2020; Pacana and Czerwinska, 2020: Pacana and Siwiec, 2021; Siwiec and Pacana, 2021). The introduction of an agile approach (Agile) to project management activities is a response to the inflexibility of the cascading approach in project execution (Gemino et al., 2021; Kose, 2021). A significant step in changing the direction of management was made by Schwaber and Sutherlandaw, publishing an article in 1986 outlining a different management approach called SCRUM. The creators of this method believe that agile project management can be successfully applied not only in the IT industry - to the development of computer software, but also to any type of product – a product or even a service. According to the "Scrum Guide" SCRUM, is a framework of conduct with the help of which it is possible to solve complex adaptive problems, so that they effectively and creatively allow the production of products in accordance with standards and customer requirements (Schwaber and Sutherland, 2013; Lappi et al.. 2018; Krynke, 2020). The purpose of the study was to analyze the development trend, level of knowledge and implications with the use of agile methods, techniques in project, program and manufacturing process management tools, and to identify areas of foundry companies in terms of increasing the efficiency of their operations through the use of agile project approaches.

2. AGILE METHODS, TOOLS AND TECHNIQUES

Agile methodologies, as well as tools and techniques, are not one-size-fits-all and therefore cannot be used for every project. They are characterized by (Lalic et al., 2022):

- Relatively small project size,
- Good contact with the client,
- A skilled team (employees who are creative and can create spontaneously),
- Culture of the business unit (the company should have the support of the board of directors and operate in an agile manner),
- Continuous improvement.

An overview of the best-known and most widely used agile methodologies, tools and techniques is presented in Table 1.

Table 1
Overview of agile methods, tools and techniques

| Agile methods | Agile tools and techniques |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SCRUM, Extreme Programming (XP), Test Driven Development (TDD), Property Driven Development (FDD), Agile Unified Process (AUP), Dynamic Systems Development Method, Kanban, SCRUMBAN, Agile Modeling, Open Unified Process, Microsoft Solution Framework, DMAIC, PDCA, Last Planner System, Lean Development, Crystal Methodologies, Adaptive Software Development, Lean Development | Daily Stand-up, Sprint planning, User stories, Kanban board, Team reviews, Retrospective meetings, Sprint, Product backlog, Team walls, Sprint backlog, Relative estimate, Agile story chart, Dedicated teams, Collocation, Sprint review, Iteration, Task board, Workshop, Team communication, Feedback, WIP limit, EVM, time-boxing, Trend analysis, Burn down chart, Burn up chart, Control limits, Kaizen, Process improvement, VSM, Testing, Roadmap, Progressive processing, Wire-frames, Chartering, Learning Cycle, Collaboration Games, Agile Estimates, Agile Communications, Variance Analysis, Trend Analysis, Flow Diagram, Pre-Mortem, DoD, Usability Tests, Risk Planning, Customer Weighted Priority, Minimum Viable Product, Bucket size planning |

Source: study based on: Gemino et al., 2021; Kose, 2021; Penha et al., 2020; Lappi et al., 2018)

The most important assumption of agile methodologies is the observation that the customer's requirements not infrequently change during the project. Agile methodologies pay attention to direct communication between work team members - often minimizing the need for documentation (Penha et al., 2020).

3. METHODOLOGY OF RESEARCH

The research presented in the study is preliminary-pilot research. This type of research was carried out to gain preliminary knowledge of the analyzed community. Due to the pilot nature of the research, the research sample consisted of 40 foundry enterprises selected at random. The main headquarters of the enterprises were located in the area of the southeastern part of Poland. The research was performed according to the assumptions of qualitative and quantitative research using triangulation of research methods and techniques. Implementation of the research procedure included: content and comparative analyses, logical classification method, multiple case stage and also exemplification.

The study formulated the following research questions:

- What is the level of knowledge of agile methods, tools and techniques in foundry companies?
- What is the level of application of agile methods, tools and techniques in foundry enterprises in terms of managing the foundry's portfolio of projects, programs and procs?

The research proceedings used data obtained from: surveys, face-to-face interviews with management level employees and foundry companies (internal documents provided, authorized statements, information on websites). The survey covered the years 2021 and 2022.

4. RESULTS

Companies that want to be agile should be able to respond immediately to opportunities and threats in the environment. In this context, opportunities mean situations that pass

quickly, are impermanent and their exploitation allows to achieve the desired effects or intended goals. This type of enterprise adapts to market changes with ease and speed. Thus, agility in the context of the management of a manufacturing enterprise is a characteristic that signifies the company's ability to realize effective changes in the area of performed operations, processes and business relationships. It is a response to the constantly changing situation of the environment and inside the organization. The most significant findings regarding the specificity of agile methods, tools and techniques in Polish foundries are shown in Figures 1, 2, 3 and 4. The figures indicate the level of knowledge and application of agile methods, tools and techniques in the management of a portfolio of projects, programs and manufacturing processes carried out in the foundries participating in the survey. The Pareto - Lorenz charts (part (b) of Figures 1 - 4) were built on the basis of "Yes" answers to highlight real and authoritative implications. A "more likely Yes" response indicated that it would be possible to implement the studied agile methods, tools and techniques at the company, while a "more likely NO" response indicated that they would most likely not be implemented at the foundry. A "No" answer means that the studied variables will definitely not be implemented. First, the current state of knowledge of agile methods, tools and techniques in foundries was analyzed (Figure 1). The research indicated that the most well-known among the agile methods, tools and techniques analyzed are PDCA, Kanban, Lean Development and SCRUM. Looking at the Parelo - Lorenz analysis, these methods account for 79.6% of applied improvements in foundries from the category of agile methods, tools and techniques. The result obtained is related to the specificity of the methods, tools and techniques indicated by the companies allows for continuous improvement, constantly catching errors and waste during process execution and finding solutions to problems.

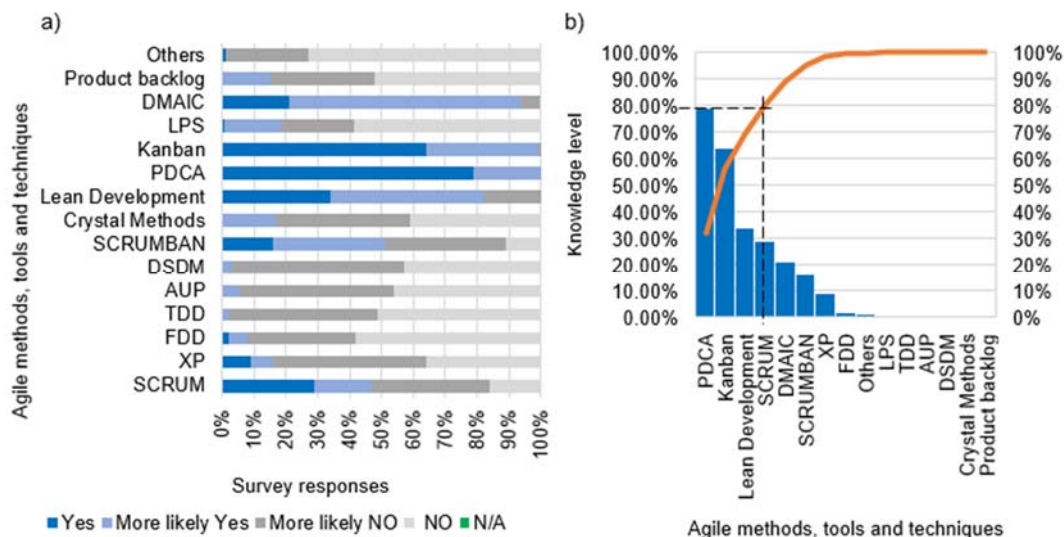


Fig. 1. Knowledge of agile methods, tools and techniques in foundries: a) survey result, b) Pareto-Lorenz chart of the popularity of the studied variables.

The survey also highlighted the current status of the use of agile methods, tools and techniques in foundries in areas related to project management (Figure 2).

Based on the results shown in Figure 2, it can be seen that the application of agile methods, tools and techniques in foundries in the area of project management is at a very low level. Most of the answers were "more likely NO" or "NO". Of the 19 methods of tools and techniques analyzed, foundries confirmed the implications of only 6 (PDCA, Kanban,

SCRUM, DMAIC, SCRUMBAN and Lean Development). Of which, according to the Pareto - Lorenz method, three account for 81.6% of the applications in the surveyed foundries and these are: PDCA, Kanban and SCRUM. Despite the relatively high familiarity with the Lean Development method, it received a similar result to the SCRUMBAN and DMAIC methods (8.9% -11.2% of applications).

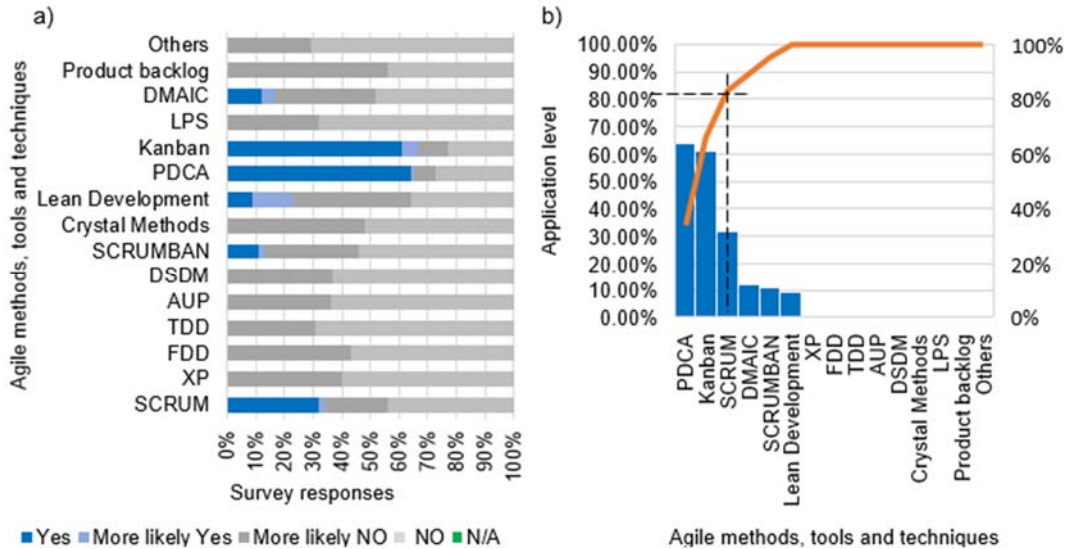


Fig. 2. Level of application of agile methods, tools and techniques in foundries in the field of project management: a) research result, b) Pareto-Lorenz chart of the implementation of the studied variables.

The technological development of manufacturing resources used in the foundry industry is geared toward robotization and automation strongly associated with digitization. Technologically and technically mature foundries require adequate preparation for the implementation of Industry 4.0. Therefore, the status of the use of agile methods, tools and techniques in foundries for program management was also analyzed. The result of the analysis is shown in Figure 3.

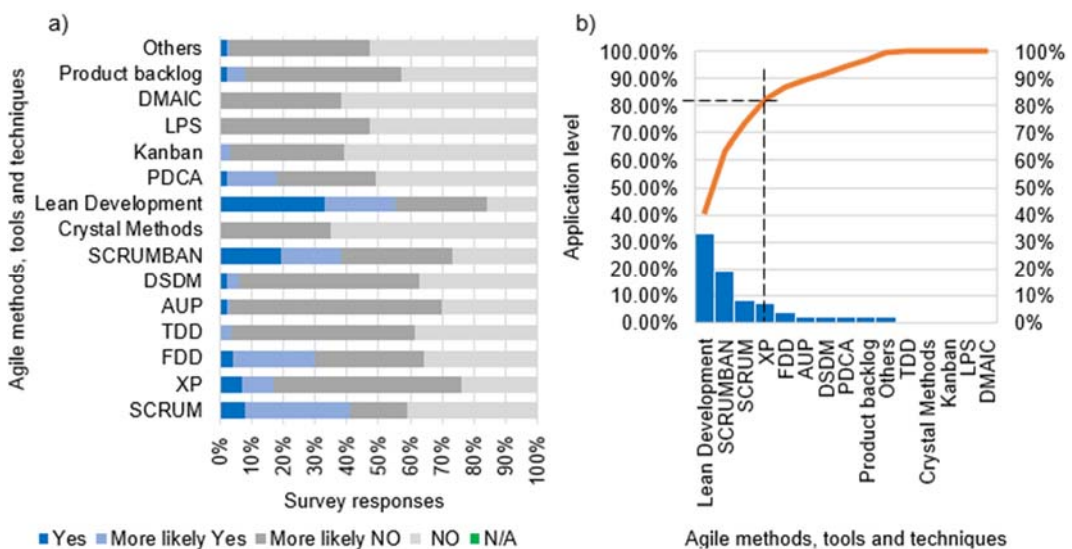


Fig. 3. The degree of use of agile methods, tools and techniques in foundries in the field of program management: a) research result, b) Pareto-Lorenz chart of the implementation of the studied variables.

Figure 3(a) shows that foundries use a number of agile methods, tools and techniques, among which lean development, SCRUMBAN, SCRUM, XP are the most commonly used - this set accounts for 82.3% of program management applications in the surveyed foundries (Figure 3(b)). IT systems development can integrate resources to form cyber-physical systems capable of analyzing and exchanging process data, introducing so-called machine learning with artificial intelligence. Industry 4.0 standards being transferred to the foundry industry are gradually transforming casting companies into Foundry 4.0. Which may be the reason why more agile methods, tools and techniques are being implemented and used in foundries in terms of software than projects being implemented. The level of use of agile methods, tools and techniques in the area of management and improvement of manufacturing processes was also analyzed. Which alludes to the concept of agile manufacturing. A key tenet of this concept is the process approach, which enables rapid adaptation to changing customer requirements and rapidly changing market situations while strictly controlling product quality and costs. The result of the study is illustrated in Figure 4.

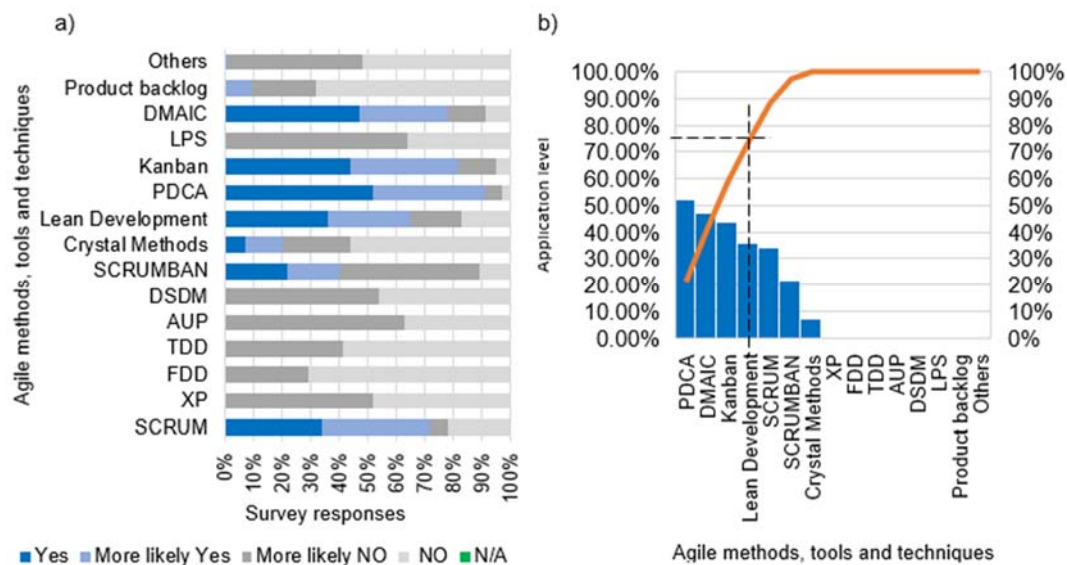


Fig. 4. The level of implications of agile methods, tools and techniques in foundries in the management of manufacturing processes: a) research result, b) Pareto-Lorenz chart of the implementation of the studied variables. Source: own study.

In the context of manufacturing process improvement, the most frequently used among agile methods, tools and techniques were PDCA, DMAIC, Kanban and Lean Development (78.3% of applications in the surveyed foundries). They allow work to be done in an orderly and transparent manner. Companies that have successfully implemented an agile set of methods produce high-quality and non-conformity-free products with short time-to-market. The surveyed foundries indicated that using the discussed instrumentation in the areas of projects, programs and manufacturing process management allows them to work in an orderly and transparent manner. In addition, foundries that consistently use agile instrumentation produce high-quality and non-conformity-free products with short time-to-market.

5. CONCLUSION

Among foundry companies, it is desirable to develop appropriate approaches and principles that allow both: effectively manage a portfolio of projects, programs, manufacturing processes, and at the same time allow successful implementation of the organization's strategic goals and customer satisfaction. Agility and its methods, tools and techniques offer one possible solution to increase competitiveness in a dynamic market. The purpose of the study was to analyze the development trend, level of knowledge AND implications with the application of agile methods, techniques in project, program and manufacturing process management tools, as well as to identify areas of activity of foundry companies in the context of increasing the efficiency of their operations through the use of agile project approach. The implementation of the survey made it possible to answer the questions posed in the study. Knowledge of agile methods, tools and techniques is at a relatively low level within the management of projects, programs and manufacturing processes in the surveyed foundries. In the context of improving the activities undertaken for the effective implementation of projects, the level of diversity of implementation can be described as low. In this regard, the most commonly used methods by the foundries include PDCA, Kanban and SCRUM. The realization of the development and implementation of programs adequate to the foundries' specifics is often supported by agile methods, tools and techniques. The surveyed foundries showed a significant degree of diversity in the used agile instrumentation (10 of the surveyed 19 methods) lean development, SCRUMBAN, SCRUM, XP were considered the most frequently used. In terms of improving manufacturing process management, despite the identification of only 7 agile methods, techniques and tools, their number of implementations is significant. Foundries most often use PDCA, DMAIC, Kanban and lean development.

Using the discussed instrumentation in the areas of projects, programs and manufacturing process management allows working in an orderly and transparent manner. In addition, foundries that consistently use agile instrumentation produce high-quality and non-conformity-free products with short time to market. Future research directions will be to increase the research group and perform a comparative analysis of the level of knowledge and implications of agile instrumentation in foundries located in Poland and selected neighboring countries.

REFERENCES

- Aslam, A., Bilal, A., 2021. *Impact of project management certification on project performance*, Journal Of Project Management, 6(3), 133-142. DOI: 10.5267/j.jpm.2021.3.001.
- Ciric, D., Delic, M., Lalic, B., Gracanin, D., Lolic, T., 2021. *Exploring the link between project management approach and project success dimensions: A structural model approach*, Advances in Production Engineering & Management, 16(1), 99-111.
- Czerwińska, K., Pacana, A., 2022. *Analysis of the maturity of process monitoring in manufacturing companies*, Production Engineering Archives, 28(3), 246-251.
- Gemino, A., Reich, BH., Serrador, PM., 2020. *Agile, Traditional, and Hybrid Approaches to Project Success: Is Hybrid a Poor Second Choice?*, Project Management Journal, 52(2), 161-175.
- Hąbek, P., Lavios, J., Grzywa, A., 2023. *Lean Manufacturing Practices Assessment Case Study of Automotive Company*. Production Engineering Archives, 29(3) 311-318. DOI: 10.30657/pea.2023.29.36

- Klimecka-Tatar, D., 2018, *contemporary quality management model of professional services in B2C and B2B systems cooperation*, 10TH International Scientific Conference Business and Management 2018, 371-380.
- Kose, BO., 2021. *Business process management approach for improving agile software process and agile maturity*, Journal of Software-Evolution and Process, 33(4).
- Krynke, M., 2020. *Application of linear programming in supply chain management in the foundry*, METAL 2020 - 29th International Conference on Metallurgy and Materials, Conference Proceedings, 1280-1286, DOI: 10.37904/metal.2020.3648
- Kuzior, A. Yarovenko, H., Brożek, P., Sidelnyk, N., Boyko, A., Vasilyeva T. 2023. *Company Cybersecurity System: Assessment, Risks and Expectations* Production Engineering Archives 2023, 29(4), 379-392
- Lalic, DC., Lalic, B., Delic, M., Gracanin, D., Stefanovic, D., 2022. *How project management approach impact project success? From traditional to agile*, International Journal Of Managing Projects In Business, 15(3), 494-521.
- Lappi, T., Kaveronen, T., Lwakatare, LE., Aaltonen, K., Kuvaja, P., *Toward an Improved Understanding of Agile Project Governance A Systematic Literature Review*, Project Management Journal, 49(6), 39-63.
- Miskiewicz, R., Wolniak, R., 2020. *Practical Application of the Industry 4.0 Concept in a Steel Company*, Sustainability, 12(14).
- Pacana, A., Czerwińska, K., 2019. *Analysis of the causes of control panel inconsistencies in the gravitational casting process by means of quality management instruments*, Production Engineering Archives, 25(25), 12-16.
- Pacana, A., Czerwińska, K., 2020, *Comparative Tests of the Quality of the Piston Combustion Chamber for a Diesel Engine*, Tehnicki Vjesnik-Technical Gazette, 27(3), 1021-1024.
- Pacana, A., Czerwińska, K., 2021, *Model of Diagnosing and Searching for Incompatibilities in Aluminium Castings*, Materials, 14(21).
- Pacana, A., Siwiec, D., 2021, *Universal model to support the quality improvement of industrial products*, Materials, 14(24), 7872,
- Pencha, R., da Silva, LF., Russo, RDSM., 2020. *Scaling Agile Practices*, Revista De Gestao E Projetos, 11(2), 1-11.
- Pietraszek, J., Radek, N., Goroshko, AV., 2020. *Challenges for the DOE methodology related to the introduction of Industry 4.0*, Production Engineering Archives, 26(4), 190-194.
- Schwaber, K., Sutherland J., 2013, *The Scrum Guide. Przewodnik po Scrumie: Reguły Gry*. www.scrumguides.org/docs/scrumguide/v1/Scrum-Guide-PL.pdf, (05.11.2023).
- Siwiec, D., Pacana, A., 2021. *Model of choice photovoltaic panels considering customers' expectations*, Energies, 14(18), 5977.
- Skotnicka – Zasadzień, B., 2010, *The use of tools improving quality in the production process*, Scientific Journals of the Maritime University of Szczecin, 24(96), 105-110.
- Sowards, D., 2007, *Learn to learn as an organization*, Contractor, 6.
- Trocki, M., Grucza, B., Ogonek K., 2003, *Zarządzanie projektami*, Polskie Wydawnictwo Ekonomiczne SA, Warszawa.
- Ulewicz R., Blaskova, V., 2018. *Sustainable development and knowledge management from the stakeholders' point of view*, Polish Journal of Management Studies, 18(2), 363-374.

- Ulewicz, R., 2014. Practical application of quality tools in the cast iron foundry, *Manufacturing Technology*, 14(1), 104–111
- Ulewicz, R., Mazur, M. 2019. The impact of lean tools on the level of occupational safety in metals foundries 28th International Conference on Metallurgy and Materials, Conference Proceedings, 2019, 2013–2019
- Ulewicz, R., Selejdak, J., Borkowski, S., Jagusiak-Kocik, M. 2013. Process management in the cast iron foundry, 22nd International Conference on Metallurgy and Materials, Conference Proceedings, 1926–1931
- Wolniak, R., 2020. *Main functions of operation management*, *Production Engineering Archives*, 26(1). 11-14.