

THE IMPORTANCE OF ROBOETHICS IN INNOVATION TECHNOLOGY MANAGEMENT

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Abstract: The article considers topical issues of roboethics and its importance in innovation technology management in the modern technological environment. The paper examines the role of leadership in the modern technological environment and analyzes the interaction between humans and robots. The authors studied the influence of robotics on interpersonal relations, collective work, and the adaptation of workers to modern technological challenges. The work pays special attention to the ethical aspects of human interaction with robots in an innovative environment. The article's authors highlight the importance of developing ethical standards to ensure safety, efficiency, and social responsibility in innovation management. The study carried out an in-depth analysis of the aspects mentioned above. It made conclusions that contribute to the understanding of the critical problems of roboethics in the innovative management of technologies and also determined the ways of further research for the practical introduction of robotics in the corporate environment.

Keywords: leadership, management, technology, roboethics

1. INTRODUCTION

Robotics and intelligent systems have become an integral part of modern technological progress. Roboethics, as a field of science and ethics that investigates the behavior and interaction of robots with people and the environment, becomes critical to understanding and solving the most important ethical issues that arise in applying technologies 4.0. (Suchacka et al., 2023; Kemendi et al., 2022; Tzafestas, 2016; Veruggio et al., 2012)

The relevance of the study of robotics becomes especially important in connection with changes in the world economy, which are accompanied by the expansion of the use of robots and automation, requiring new approaches to management activities. Automation of production processes creates questions about future employment, qualifications, and social protection of workers. (Kuzior et al, 2023; Kuzior, 2022). The growing autonomy of robots raises ethical questions related to rights and interactions with humans.



The methodology used in this study is aimed at investigating the importance of roboethics in innovation technology management. The work synthesizes various approaches and concepts of leadership and technologies and summarizes them to create a holistic image of the role of a leader in a technological environment. The systematic analysis of the features of human-robot interaction revealed the positive aspects and challenges associated with introducing robotics in organizations. The work includes research and analysis of modern trends in implementing roboethics in the corporate environment. A literature review of existing scientific works devoted to roboethics in the context of innovation technology management indicates that previous studies focused on the importance of creating and complying with ethical requirements when using intelligent systems in organizations. (Veruggio et al., 2016; Dautenhahn, 2007; Seibt et al., 2014; Damiano et al., 2018; Fleres et al., 2023; Kwilinski and Kuzior, 2020; Kuzior and Zozul'ak, 2019). The author analyzed the results to formulate conclusions about the importance of roboethics in innovation technology management.

Ethical issues that already arise in connection with robotization will be amplified many times over when robotization is supplemented with semi-autonomous or autonomous control related to artificial intelligence (AI). The main social problem will be the rapid reduction of employment resulting from the aggressive use of "lean management" techniques (Ulewicz and Ulewicz, 2020; Ulewicz et al., 2021), but also the possible visual surveillance of employees by AI surveillance systems instead of typical inspections (Knop et al., 2019). Ethical problems will also inevitably arise when assessing the importance of goods at risk by taking action or not taking action, which is often a dilemma when implementing sustainable techniques in the chemical (Kozłowski et al., 2002; Ulewicz et al., 2003; Radzymińska-Lenarcik and Ulewicz, 2019), biotechnology (Skrzypczak-Pietraszek and Pietraszek, 2014), energy (Ulewicz et al., 2020) or maritime transport (Deja et al., 2021) industries. The implementation of modified robotic and robotic-related behaviors will also affect typical "hard" industrial areas such as welding (Patek et al., 2014; Radek et al., 2018) or special coating application techniques (Radek and Konstanty, 2012; Radek et al., 2019) due to the high saturation of relevant technological lines with robots. All modifications made in the industrial area will have a secondary impact on the applied process modeling and data analysis techniques, for example by changing single-criteria objective functions or radically modifying the weights in the case of multi-criteria functions. As a result, this will change the classic DOE approach (Radek et al., 2014), as well as non-classical methods such as dimensionality reduction (Pietraszek and Skrzypczak-Pietraszek, 2015), resampling distribution modeling (Pietraszek et al., 2016) or nonparametric modeling (Pietraszek et al., 2017).

2. LEADERSHIP IN THE MODERN TECHNOLOGICAL ENVIRONMENT

Leadership's role in technology implementation and management is determined by the leader's ability to manage and guide the organization in conditions of rapid technological development.

The leader defines technology implementation strategies through clear strategic goals and objectives and the creation of an open innovation culture that stimulates and encourages a creative approach to problem-solving. (Creighton, 2003; Hesbol, 2004) A modern leader is responsible for ensuring the necessary resources for successful technology implementation, such as financial, technical, and human resources. The leader's task is also to establish safety standards and ethics of technology use, which determines the

rules of activity in the organization, as well as ensure the desafety standards and ethics of technology use, which determines the rules of activity in the organization, as well as ensure the development of the team's technical and interpersonal competencies, teaching them new methods and tools. A specific skill of a leader is the ability to predict future technological trends and prepare the organization for future challenges to ensure its sustainability and competitiveness in the rapidly changing world of technology. (Dexter et al., 2019)

Various leadership models reflect management's adaptation to the challenges that arise during the introduction of new technologies. The leader's interaction with employees and technologies affects the achievement of efficiency and innovation in the organizational environment. (Tortorella et al., 2023) Table 1 examines two aspects of leadership models: the interaction of the leader with employees and the interaction of the leader with technology. development of the team's technical and interpersonal competencies, teaching them new methods and tools. A specific skill of a leader is the ability to predict future technological trends and prepare the organization for future challenges to ensure its sustainability and competitiveness in the rapidly changing world of technology (Dexter et al., 2019; McPhillips et al. 2024).

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Table 1. Features of the leader's interaction with employees and technologies in different models of leadership

Leadership model	Leader-employee interaction	Leader-technology interaction
Leadership 4.0 (Molino et al., 2021)	Active discussion and exchange of ideas in an online environment.	Using advanced technologies to achieve business goals.
Transformational leadership (Ahmad, 2020)	Stimulation of creativity and innovation in the team.	Implementation of new technologies to stimulate innovation.
Global leadership (Johnson et al., 2022)	Establishing effective means of communication for distributed teams.	Use of technologies for global management.
Distributed leadership (Berraies et al., 2021)	Implementation of distributed management practices in the team.	Using technology for collaboration and coordination.
Adaptive leadership (Kawiana et al., 2023)	Stimulating flexibility and reactivity of the team to changes.	Using technologies to adapt to new conditions.
Servant leadership (Chen, 2022)	Listening and understanding the needs of employees.	Using technology to facilitate team work.
Empathic leadership (Arghode et al., 2022)	Active listening and perception of employees' emotions.	Using technology to facilitate communication and support.

Source: developed by the author

As seen from Table 1, successful leadership in today's world requires flexibility and adaptability from leaders.

The active implementation of digital tools defines leadership 4.0 to create an open communication environment and promote innovation. Transformational leadership is aimed at stimulating creativity through the use of innovative technologies. Global leadership and distributed leadership ensure effective communication in conditions of global distribution. Adaptive leadership forms flexibility and responsiveness to changes in the technological environment. Servant leadership and empathic leadership focus on collaboration and emotional support of employees, using technology for convenient communication. The obtained data indicate the need to adapt the leadership approach to the technological context of the organization where teams work and develop.

Ethics acts as a standard feature for the proposed leadership styles. The leadership styles described prioritize ethical principles, recognizing that ethics are essential for building trust, fairness, and success in an organizational environment.

3. PECULIARITIES OF HUMAN-ROBOT INTERACTION

The interaction between people and robots in organizations is becoming an integral part of the modern world, which is undergoing revolutionary changes thanks to the automation of various processes and innovative technologies.

Effective interaction between people and robots affects work performance, organizational culture, and employee well-being. (Decety et al., 2011).

Developing effective strategies for interaction between people and robots, ensuring harmonious coexistence and joint work, is an essential task of modern leaders. Robots in routine and time-consuming tasks allow employees to focus on creative and strategic work, which contributes to the development of human potential and increases the quality of the work performed. An essential part of successful interaction is the creation and implementation of ethical standards for the use of robotics, taking into account the rights of employees and ensuring transparency in automation processes. Robots should be introduced based on the principles of mutually beneficial cooperation and consideration of human values. (Joe et al., 2019; McGinn et al., 2017; Mich, 2022; Kuzior et al., 2021) Thus, the interaction between people and robots in organizations requires a comprehensive approach that includes technical, organizational, and ethical aspects.

The interaction process between people and work in organizations can have positive results (Anagnoste, 2017; Santos et al., 2019) and form specific challenges for modern leaders. (Syed et al., 2020; Grung-Olsen, 2017; Kuzior et al., 2023) Table 2 shows the positive aspects of interaction between people and robots.

Table 2. Positive aspects of the implementation of robotics in organizations

Positive aspect of interaction	Characteristic
Efficiency and productivity	Robots can be programmed to perform monotonous and routine tasks automatically, freeing people from such duties to focus on more creative and creative work.
Accuracy and reliability	Compared to humans, robots can work continuously without losing productivity or accuracy.
Innovations and technological development	Implementing robots can stimulate technological development, contributing to the growth of efficiency and competitiveness of organizations.

Source: developed by the author

The implementation of robotics in organizations significantly improves efficiency and productivity due to the automation of routine tasks.

Table 3 lists the challenges of implementing robotics in organizations and suggests ways to solve them.

Table 3. Challenges in implementing robotics in organizations and ways to solve them

Challenge	Characteristic	The solution method
Loss of jobs	Robots can define a reduction in the need for human resources in specific sectors, which can lead to unemployment and social challenges.	Cooperation with government and educational institutions to create retraining programs and development of social activities.
Training and retraining of employees	Implementing new technologies may require employees to be trained and retrained to adapt to new working conditions.	Implementation of training systems and support of educational initiatives.
Ethical issues	Ethical questions arise regarding who is responsible for possible mistakes or decisions robots make.	Determination of standards of responsible use of technologies and involvement of specialists in the field of ethics.
Intercultural aspects	In international companies, there may be problems in the interaction of robots with different cultures and work styles.	Cultural training for employees and the development and implementation of culturally sensitive programs.

Source: developed by the author

Table 3 clearly shows the problems that arise when implementing robotics in organizations. Job losses, the need for training and retraining workers, ethical issues, and intercultural aspects are becoming essential challenges that require a careful managerial and social approach. Proposals for cooperation with the government and educational institutions, implementation of training systems, standards for responsible use of technology, and cultural training indicate possible ways to solve such challenges and ensure ethical implementation of robotics in modern society.

4. THE PLACE OF ROBOETHICS IN THE INNOVATION MANAGEMENT SYSTEM

The place of roboethics in the innovation technology management system is determined by the need to consider the ethical aspects of using robotics and innovative technologies. (Kuzior et al., 2022) In the modern technological space, where robotics and intelligent systems become drivers of innovation, roboethics is an essential element of strategic management.

Roboethics defines the principles and standards that become the foundation for developing, implementing, and using autonomous systems and intelligent algorithms. In the innovation technology management, roboethics is a regulator, which helps avoid the negative ethical consequences of using the latest technologies. (Veruggio et al., 2012; Mowshowitz, 2008)

One of the functions of roboethics is the definition of an ethical framework for the development and implementation of innovative solutions in the field of robotics, namely the establishment of rules for the interaction of robots with people and the environment, as well as the justification of ethical standards for robotics developments.

Roboethics contributes to creating ethical norms and rules that regulate the relationship between automated systems and people and define the limits of robot autonomy in the industrial and social spheres. (Operto, 2021; Battistuzzi et al., 2018)

Incorporating roboethics into the innovation technology management system aims to create effective and ethical strategies for developing robotics. Roboethics in the innovation technology management is an element that contributes to the creation of a modern technological environment that considers not only the technical but also the ethical aspects of the use of robotics.

5. DISCUSSIONS

Integrating roboethics into the innovation technology management system is essential in developing robotics and providing ethical grounds for the interaction between technological innovations and people. In considering this novelty, we face aspects that affect robotics's efficiency, safety, and acceptance in today's society.

One of the central elements of the study is the recognition of the need to introduce ethics into the software of robots, which calls into question the traditional approach to robotics exclusively as a technical mechanism. Instead, the emphasis is on understanding the role of robots in determining the ethical parameters of functioning. An important issue is not only ensuring technical safety but also taking into account ethical standards in the interaction of robots with people. This approach aims to prevent possible conflicts and unforeseen situations where robots have a choice related to ethical norms.

The development and integration of ethical standards into technological innovations directly impacts the creation of safe and ethical innovation management. When implementing technological innovations, organizations should consider technical advantages and their social and ethical impact on society. Such an approach opens up new opportunities for the development of robotics and its integration into society, where technological innovations contribute to ethical and safe interactions with people. At the same time, there is a question of creating an effective mechanism for the code of ethics and its implementation in real society, ensuring the harmonious development of technologies and human values.

6. CONCLUSIONS

Roboethics in the innovation technology management is an essential component of the modern business environment, where the role of technological innovations and interaction with robots is growing. Considering ethical standards in roboethics is a crucial step to ensure the safety and efficiency of using robots in various fields of activity. Robots can improve teamwork and change worker roles and responsibilities, requiring improved communication and interaction. Roboethics ensures the efficiency and accuracy of tasks and promotes innovative development, increased competitiveness, and technological progress. The problems of job losses, the need for training and retraining of workers, ethical issues, and cross-cultural aspects need to be carefully addressed through investment in education, the development of ethical standards, and the creation of culturally sensitive approaches.

Despite significant advances in roboethics, there is a need for further research and development of technological innovation management concepts, considering the role of robotics. Future directions of research may be:

- development of standards and principles for the ethical use of robots by the values of modern society;
- a deeper understanding of the influence of roboethics on social relations and the psychosocial comfort of people in the working environment;
- study of methods of training and training of employees for practical cooperation with robots.

Roboethics provides technical advantages and defines the basis for the ethical and responsible use of robots in a high-tech society. The development of this field is essential for building a humanized future where technologies serve the interests of society and contribute to the optimization of organizational processes.

REFERENCE

- Ahmad, S., Azman bin Ali, N., Jantan, A.H., Bowyer, D., Campbell, N., Reaz, M., 2020. *Organizational Effectiveness Through Transformational Leadership and Technology Innovation: A Systematic Literature Review and Future Research Agenda*. Journal of International Business and Management. DOI:10.37227/jibm-2020-04-44
- Anagnoste, S., 2017. *Robotic automation process – the next major revolution in terms of back office operations improvement*. Proceedings of the International Conference on Business Excellence, Bucharest, 11. DOI:10.1515/picbe-2017-0072
- Arghode, V., Lathan, A., Alagaraja, M., Rajaram, K., McLean, G.N., 2022. *Empathic organizational culture and leadership: conceptualizing the framework*. European Journal of Training and Development, 46 (1/2), 239-256. DOI:10.1108/EJTD-09-2020-0139
- Battistuzzi, L., Sgorbissa, A., Papadopoulos, C., Papadopoulos, I., & Koulouglioti, C., 2018. *Embedding Ethics in the Design of Culturally Competent Socially Assistive Robots*. In: 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE. DOI:10.1109/iros.2018.8594361
- Berraies, S., Hamza, K.A. and Chtioui, R., 2021. *Distributed leadership and exploratory and exploitative innovations: mediating roles of tacit and explicit knowledge sharing and organizational trust*. Journal of Knowledge Management, 25(5), 1287-1318. DOI:10.1108/JKM-04-2020-0311
- Chen, M., Zada, M., Khan, J., Saba, N. U., 2022. *How Does Servant Leadership Influences Creativity? Enhancing Employee Creativity via Creative Process Engagement and Knowledge Sharing*. Frontiers in Psychology, 13. DOI:10.3389/fpsyg.2022.947092
- Creighton, T., 2003. *The principal as technology leader*. Thousand Oaks, CA: Corwin Press.
- Damiano, L., Dumouche, I.P., 2018. *Anthropomorphism in human-robot co-evolution*. Frontiers in Psychology, 9, 1–9. DOI:10.3389/fpsyg.2018.00468
- Dautenhahn, K., 2007. *Socially intelligent robots: dimensions of human-robot interaction*. Philosophical Transactions of the Royal Society B: Biological Sciences, 362(1480), 679–704. DOI:10.1098/rstb.2006.2004
- Deja, A., Ulewicz, R., Kyrychenko, Y., 2021. Analysis and assessment of environmental threats in maritime transport. Transportation Research Procedia, 55, 1073-1080. DOI: 10.1016/j.trpro.2021.07.078
- Decety, J., Ickes, W., Batson, C. D., & Blair, K. S., 2011. *Social Neuroscience of Empathy*. MIT Press.
- Dexter, S., & Richardson, J. W., 2019. *What does technology integration research tell us about the leadership of technology?* Journal of Research on Technology in Education, 52(1), 17–36. DOI:10.1080/15391523.2019.1668316
- Fleres, A., Veling, L., Broz, F., Damiano, L., 2023. *Integrative Robo-Ethics: Uncovering Roboticians' Attitudes to Ethics and Moving Forward*. International Journal of Social Robotics. DOI:10.1007/s12369-023-00978-2
- Grung-Olsen, H., 2017. *A strategic look at robotic process automation*. BP Trends.

- Hesbol, K., 2004. *Leadership for learning through technology: A catalyst for change*. Paper presented at the annual meeting of the American Educational Research Association (AERA) in San Diego.
- Joe, W. Y., & Song, S. Y., 2019. *Applying Human-Robot Interaction Technology in Retail Industries*. International Journal of Mechanical Engineering and Robotics Research, 839–844. DOI:10.18178/ijmerr.8.6.839-844
- Johnson, A.A., Huesing, T., Ludema, J.D. and Hinds, B., 2022. *Global Leadership is Shared Leadership: How Smart Global Leaders Build Cultures of Collaboration to Drive Results and Get Things Done*. The Study and Practice of Global Leadership (Building Leadership Bridges), Emerald Publishing Limited, Leeds, 35-50. DOI:10.1108/S2058-88012022003
- Kawiana, I. G. P., 2023. *Digital Leadership: Building Adaptive Organizations In The Digital Age*. Jurnal Multidisiplin Sahombu, 3(01), 170–179. DOI:10.58471/jms.v3i01.2709
- Kemendi, Á., Michelberger, P., & Mesjasz-Lech, A. (2022). Industry 4.0 and 5.0—organizational and competency challenges of enterprises. Polish Journal of Management Studies, 26(2), 209-232. DOI: 10.17512/pjms.2022.26.2.13
- Knop, K., Olejarz, E., Ulewicz, R., 2019. Evaluating and Improving the Effectiveness of Visual Inspection of Products from the Automotive Industry. Lecture Notes in Mechanical Engineering, 1, 231-243. DOI: 10.1007/978-3-030-17269-5_17
- Kozłowski, C.A., Ulewicz, M., Walkowiak, W., Girek, T., Jablonska, J., 2002. The effect of tautomeric rearrangement on the separation of Zn(II) and Cd(II) in ion flotation process with 4-thiazolidinone derivatives. Minerals Engineering, 15, 677-682. DOI: 10.1016/S0892-6875(02)00166-8
- Kuzior, A., 2022. Technological Unemployment in the Perspective of Industry 4.0 Development. Virtual Economics, 5(1), 7–23. DOI: 10.34021/VE.2022.05.01(1)
- Kuzior, A., Arefiev, S., & Poberezhna, Z., 2023. *Informatization of innovative technologies for ensuring macroeconomic trends in the conditions of a circular economy*. Journal of Open Innovation: Technology, Market, and Complexity, 9(1), 10–20. DOI:10.1016/j.joitmc.2023.01.001
- Kuzior, A., Arefieva, O., Kovalchuk, A., Brożek, P., & Tytykalo, V., 2022. *Strategic Guidelines for the Intellectualization of Human Capital in the Context of Innovative Transformation*. Sustainability, 14(19), 11937. DOI:10.3390/su141911937
- Kuzior, A., Kochmańska, A., Marszałek-Kotzur, I., 2021. *Information and Communication Technologies as A Tool of Modern Communication in Organizations and Society*. Proceedings of the 37th International Business Information Management Association (IBIMA). Cordoba, Spain, ISBN: 978-0-9998551-6-4, ISSN: 2767-9640
- Kuzior, A., Yarovenko, H., Brożek, P., Sidelnyk, N., Boyko, A. & Vasilyeva, T., 2023. *Company Cybersecurity System: Assessment, Risks and Expectations*. Production Engineering Archives 29(4):379-392. DOI: 10.30657/pea.2023.29.43
- Kuzior, A., Zozul'ak, J., 2019. Adaptation of the Idea of Phronesis in Contemporary Approach to Innovation. Management Systems in Production Engineering, 27(2), 84–87. DOI: 10.1515/mspe-2019-0014
- Kwilinski, A., Kuzior, A., 2020. *Cognitive Technologies in the Management and Formation of Directions of the Priority Development of Industrial Enterprises*. Management Systems in Production Engineering, 28(2), 133–138. DOI:10.2478/mspe-2020-0020
- McGinn, C., Cullinan, M. F., Culleton, M., & Kelly, K., 2017. *A human-oriented framework for developing assistive service robots*. Disability and Rehabilitation: Assistive Technology, 13(3), 293–304. DOI:10.1080/17483107.2017.1328616
- McPhillips, M., Tegtmeier, S., Nikitina, T., 2024. Going all in or spreading your bet: a configurational perspective on open innovation interaction channels in production sectors. Production Engineering Archives, 30(2) 191-203. DOI: 10.30657/pea.2024.30.18
- Mich, L., 2022. *Artificial Intelligence and Machine Learning*. In Handbook of e-Tourism. Springer International Publishing, 435-455. DOI:10.1007/978-3-030-48652-5_25

- Molino, M., Cortese, C.G., Ghislieri, C., 2021. *Technology Acceptance and Leadership 4.0: A Qualitative Quantitative Study*. International Journal of Environmental Research and Public Health, 18(20), 10845. DOI:10.3390/ijerph182010845
- Mowshowitz, A., 2008. *Technology as excuse for questionable ethics*. AI Society 22(23), 271–282. DOI:10.1007/s00146-007-0147-9
- Operto, F., 2021. *Elements of Roboethics*. In: Makers at School, Educational Robotics and Innovative Learning Environments. Springer International Publishing, 73-79. DOI:10.1007/978-3-030-77040-2_10
- Patek, M., Konar, R., Sladek, A., Radek, N., 2014. Non-destructive testing of split sleeve welds by the ultrasonic TOFD method. Manufacturing Technology, 14, 403-407. DOI: 10.21062/ujep/x.2014/a/1213-2489/MT/14/3/403
- Pietraszek, J., Dwornicka, R., Szczotok, A., 2016. The Bootstrap Approach to the Statistical Significance of Parameters in the Fixed Effects Model. ECCOMAS Congress 2016, 3, 6061-6068. DOI: 10.7712/100016.2240.9206
- Pietraszek, J., Skrzypczak-Pietraszek, E., 2015. The uncertainty and robustness of the principal component analysis as a tool for the dimensionality reduction. Solid State Phenomena, 235, 1-8. DOI: 10.4028/www.scientific.net/SSP.235.1
- Pietraszek, J., Szczotok, A., Kołomycki, M., Radek, N., Kozień, E., 2017. Non-parametric assessment of the uncertainty in the analysis of the airfoil blade traces. METAL 2017 - 26th Int. Conf. on Metall. and Mater., 1412-1418.
- Radek, N., Konstanty, J., 2012. Cermets ESD coatings modified by laser treatment. Archives of Metallurgy and Materials, 57, 665-670. DOI: 10.2478/v10172-012-0071-y
- Radek, N., Pietraszek, J., Antoszewski, B., 2014. The average friction coefficient of laser textured surfaces of silicon carbide identified by RSM methodology. Advanced Materials Research, 874, 29-34. DOI: 10.4028/www.scientific.net/AMR.874.29
- Radek, N., Pietraszek, J., Goroshko, A., 2018. The impact of laser welding parameters on the mechanical properties of the weld. AIP Conf. Proc., 2017, art. 020025. DOI: 10.1063/1.5056288
- Radek, N., Pietraszek, J., Szczotok, A., Fabian, P., Kalinowski, A., 2019. Microstructure and tribological properties of DLC coatings. Materials Research Proceedings, 17, 171-176. DOI: 10.21741/9781644901038-26
- Radzyńska-Lenarcik, E., Ulewicz, M., 2019. The application of polymer inclusion membranes based on CTA with 1-alkylimidazole for the separation of zinc(II) and manganese(II) ions from aqueous solutions. Polymers, 11, art. 242. DOI: 10.3390/polym11020242
- Santos, F., Pereira, R., & Vasconcelos, J. B., 2019. *Toward robotic process automation implementation: an end-to-end perspective*. Business Process Management Journal, 26(2), 405–420. DOI:10.1108/bpmj-12-2018-0380
- Seibt, J., Hakli, R., Nørskov, M., 2014. *Sociable robots and the future of social relations*. Robo-Philosophy, 273, 374-380
- Skrzypczak-Pietraszek, E., Pietraszek, J., 2014. Seasonal changes of flavonoid content in *Melittis melissophyllum* L. (Lamiaceae). Chemistry and Biodiversity, 11, 562-570. DOI: 10.1002/cbdv.201300148
- Suchacka, M., Pabian, A. M., & Ulewicz, R. 2023. Industry 4.0 and socio-economic evolution. *Polish Journal of Management Studies*, 28(1), 311-329, DOI:10.17512/pjms.2023.28.1.18
- Syed, R., Suriadi, S., Adams, M., Bandara, W., Leemans, S. J. J., Ouyang, C., ter Hofstede, A. H. M., van de Weerd, I., Wynn, M. T., & Reijers, H. A., 2020. *Robotic Process Automation: Contemporary themes and challenges*. Computers in Industry, 115, 103162. DOI:10.1016/j.compind.2019.103162
- Tortorella, G., Prashar, A., Antony, J., Mac Cawley, A.F., Vassolo, R. and Sony, M., 2023. *Role of leadership in the digitalisation of manufacturing organisations*. Journal of Manufacturing Technology Management, 34 (2), 315-336. DOI:10.1108/JMTM-09-2022-0312
- Tzafestas, S. G. G., 2016. *Roboethics: A Navigating Overview*. Springer.

- Ulewicz, R., Kleszcz, D., Ulewicz, M., 2021. *Implementation of Lean Instruments in Ceramics Industries*. Management Systems in Production Engineering, 29, 203-207. DOI: 10.2478/mspe-2021-0025
- Ulewicz, R., Ulewicz, M., 2020. *Problems in the Implementation of the Lean Concept in the Construction Industries*. Lecture Notes in Civil Engineering, 47, 495-500. DOI: 10.1007/978-3-030-27011-7_63
- Ulewicz, M., Walkowiak, W., Brandt, K., Porwolik-Czomperlik, I., 2003. Ion flotation of zinc(II) and cadmium(II) in the presence of side-armed diphosphaza-16-crown-6 ethers. Separation Science and Technology, 38, 633-645. DOI: 10.1081/SS-120016655
- Ulewicz, M., Zhelykh, V., Furdas, Y., Kozak, K., 2020. Assessment of the Economic Feasibility of Using Alternative Energy Sources in Ukraine. Lecture Notes in Civil Engineering, 100, 482-489. DOI: 10.1007/978-3-030-57340-9_59
- Veruggio, G., Abney, K., 2012. *Roboethics: The applied ethics for a new science in robot ethics*. In: Robot Ethics: The Ethical and Social Implications of Robotics. MIT Press, Cambridge, 347–363
- Veruggio, G., Operto, F., & Bekey, G., 2016. *Roboethics: Social and ethical implications*. Springer handbook of robotics. Cham: Springer, 2135-2160. DOI:10.1007/978-3-319-32552-1_80