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PFR Group

Cluster benchmarking in Poland – edition 2022

General report

Warszawa, 2023

This report was commissioned by the Polish Agency for Enterprise Development following a periodic benchmarking study on clusters in Poland. It is essential to clarify that the views expressed in this study are exclusively those of the authors and do not reflect the official position of the Polish Agency for Enterprise Development. Additionally, these opinions do not impose any binding obligations on the agency.

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Contents

1. Glossary of key terms

3D production (additive manufacturing). The procedure of creating a digital (virtual) three-dimensional model of an object involving the application of layers of material in a sequential manner utilizing a 3D-printer[1].

Arithmetic average. The sum of the variable values of all units in the surveyed population, divided by the number of these units[2].

Artificial intelligence (AI). A field of knowledge that includes fuzzy logic, evolutionary computing, neural networks, artificial life, and robotics. In the context of Industry 4.0, it is usually identified with a set of technologies that enable machines to learn and solve complex problems. Artificial intelligence has great potential to reorganize the way value chains function, as it helps to obtain accurate forecasts of customer demand, optimizes research and development, and reduces production costs while increasing the technological advancement of offered products. Value chain leaders are using AI to monitor manufacturing processes in real time, reduce process lead times, speed innovation to market, and improve process efficiency. In particular, artificial intelligence allows for better control of customer purchases and provides them with a greater experience[3].

Artificial intelligence things (Artificial Intelligence of Things - AIoT). Application of artificial intelligence (AI) to enhance the Internet of Things (IoT) and make it faster, smarter, greener and safer[4].

Autonomous robots. A technical device that moves smoothly in a specific environment to perform a given task and carries out, without direct operator intervention, a sequence of activities under the control of a supervisory system, either imposed from the outside or planned by itself[5].

Benchmark. The highest indicator value achieved by a cluster in a given area or sub-area[6].

Benchmarking. Benchmarking is a well-known method of imitating others that has been part of the organizational process for many years. It is a technique that allows learning from best-in-

[1] Stadnicki, J. (2016). Additive production: prospects for development and impact on the spatial organization of the economy. Economy and Finance, 7, 63-71.
[2] Sobczyk M., Statistics, PWN, Warsaw 2001.
[3] Kauf S., Laskowska-Rutkowska (2020), Digitization in improving supply chain management, In: Laskowska-Rutkowska (ed.), Digitization in management, Warsaw: CeDeWu.
[4] Zhang J., Tao D. (2020). Empowering things with intelligence: a survey of the progress, challenges, and opportunities in artificial intelligence of things. IEEE Internet of Things Journal, 8(10), 7789-7817.
[5] Chmielniak A., Extended outline of the prescript for the subject "Autonomous Mobile Robots", www.airmgr.elka.pw.edu.pl/pdf/arm_streczenia.pdf (accessed April 19, 2023).
[6] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.

class solutions and implementing them through observation and existing examples. Positive imitation, as the method can also be called, is a way of learning and adapting, devoid of the significant risk of making mistakes extent[7].

Big Data Analytics. Analysis of large, variable, and diverse (so-called 3V - Volume, Velocity, Variety) data sets, generated automatically and at high frequency, subjected to special processing methods. Big data analytics includes the use of advanced data analysis methods and models primarily to identify interdependencies and predict future phenomena. Despite the enormous potential for opportunities and benefits, the use of Big Data analytics is evolutionary and currently in the initial stage of adoption management[8].

Block chains (blockchain). A blockchain is a data structure that aggregates records into what is called the master ledger, incorporating cryptography as a fundamental element of the process. In the value chain, applications of blockchain technology, such as in clusters, can be utilized within an integrated monitoring and control system. This setup enables the tracking of various stages in the chain, including product delivery validation, payment verification, and enhanced security. Notably, this technology does not have a defined storage mechanism; rather, it operates based on a set of protocols that govern data growth string[9].

CATI (*Computer Assisted Telephone Interview).* Telephone interview carried out with assistance from a computer program that facilitates the research process, especially in recording and archiving the data collected data[10].

CAWI (*Computer Assisted Web Interview)*. An interview conducted via the Internet involves the respondent completing a questionnaire hosted on a specially defined website (interviewer's platform) on his/her own[11].

Cloud Computing (CC). A method of accessing shared and easily configurable computing resources through a computer network (including networks, servers, data warehouses, applications, and services) that can be dynamically allocated and released on demand, requiring minimal involvement from technical services. The primary characteristics of cloud computing include: self-configuration tailored to the individual needs of users, accessibility via various

[7] Matusiak K. (ed.), Innovations and technology transfer. Glossary of terms, Polish Agency for Enterprise Development, Warsaw 2008.
[8] Kache F., Seuring S. (2017). Challenges and Opportunities of Digital Information at the Intersection of Big Data Analytics and Supply Chain Management. International Journal of Operations & Production Management", Vol. 37, Iss. 1.
[9] Bartkiewicz W., Czerwonka P., Pamuła A. (2020). Modern tools for the digitization of organizations, Łódź: University of Łódź Publishing House.
[10] Ibid.
[11] Ibid.

devices connected to the network regardless of location, flexibility to change the required resources, measurability of the service, and fees charged based on resource usage[12].

Cluster coordinator. An institutional entity (hence also the term cluster organization) that organizes and facilitates the development of interactions, connections, and cooperation in the cluster, while also providing specialized services to companies and other entities operating within a given cluster. In the early stages of cooperation development, these functions are often performed not by an institution, but by a specific person referred to as an animator[13].

Cluster initiative. Organized activities aimed at enhancing the growth and competitiveness of clusters in the region, involving cluster companies, government, and/or researchers community[14].

Cluster members. Entities operating within the cluster include enterprises, environmental institutions in the R&D sector (such as universities, research institutes, and educational institutions) that create business support infrastructure (including incubators, science and technology parks, technology transfer centers, special economic zones, certification institutions, training and consulting companies, financial institutions, and other specialized business support entities), as well as public organizations[15].

Cluster strategy. A long-term cluster development plan contains a set of goals that can be achieved through the collective activities of cluster members. The cluster strategy should be developed based on a shared vision of cluster development, formulated within the cluster by consensus[16].

Cluster. Geographic clusters of interconnected firms, specialized suppliers, service providers, firms in related sectors, and related institutions in specific fields compete with each other but also cooperating[17].

Coding. The process of converting the data obtained directly during the study into values compatible with the computer program for the statistical data analysis will be carried out[18].

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[12] Mell P., Grance T. (2011). The NIST Definition of Cloud Computing, Recommendations of the National Institute of Standards and Technology. U.S. Department of Commerce: National Institute of Standards and Technology Special Publication No. 800-145.
[13] Directions and assumptions of the cluster policy in Poland until 2020. Recommendations of the cluster policy working group, PARP 2012.
[14] Solvell A., Lindqvist G., Ketels Ch., The Cluster Initiative Greenbook, Ivory Tower AB, Stockholm 2003, p. 9.
[15] Directions and assumptions of the cluster policy in Poland until 2020. Recommendations of the cluster policy working group, PARP 2012.
[16] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.
[17] Porter M., Porter about competition, Polskie Wydawnictwo Ekonomiczne, Warsaw, 2001, p. 246.
[18] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.

Cybersecurity (cybersecurity). Ensuring safe conditions for the use of digital technologies is crucial. In the case of Industry 4.0 technology, the risks related to cybersecurity are significantly increased. The issue of ensuring cybersecurity should be considered from two perspectives: the protection of digital infrastructure and data protection. Many current plants and production lines are inadequately adapted to operate in the digital world. Therefore, with the implementation of new technological solutions that enable data flow and the integration of various systems, it will be necessary to ensure their safety use[19].

Desk research. A research technique that involves analyzing existing data (secondary data) to obtain useful information and conclusions. Examples of secondary data include documents, reports, websites (materials posted on the Internet), statistical data, trade press, and others. Before using secondary data sources, they should be analyzed in terms of their credibility[20].

Digital platforms. Diversified technological solutions that help overcome territorial barriers and facilitate cooperation between two or more entities, often to an extent unavailable in traditional forms of cooperation[21].

Digitization. The process of converting individual analog streams of information into digital format[22].

Digitization. The use of information and communication technologies (ICT) to create value[23].

DIH - Digital Innovation Hub. Institutions support the digital transformation of enterprises to enhance their market competitiveness by utilizing innovative solutions across a broad range of digital technologies. They are chosen through a national competition organized by the minister responsible for the economy)[24].

EDIH - European Digital Innovation Hub. EDIHs are centers that consolidate knowledge and expertise in the realm of digital transformation for businesses. Their role is to enhance the

[19] Kowalski A., Mackiewicz M. (2019). Challenges and instruments of innovation policy in Poland in the context of Industry 4.0, in: Kowalski A., Weresa MA (2019, ed.), Poland: Competitiveness Report 2019. International competitiveness in the context of Industry 4.0 development, Warsaw: Warsaw School of Economics.
[20] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.
[21] Musiatowicz -Podbial, G. (2021). Digital platforms as cooperation tools - new opportunities and threats. IT and management. Problems and Challenges of the Digital Economy (ed.) Z. Drążek, T. Komorowski., 9-25.
[22] Kowalski A., Weresa M. (eds), Poland: Competitiveness Report 2019. International Competitiveness in the Context of Development of Industry 4.0, Warsaw: Warsaw School of Economics – Publishing.
[23] Kowalski A., Weresa M. (eds), Poland: Competitiveness Report 2019. International Competitiveness in the Context of Development of Industry 4.0, Warsaw: Warsaw School of Economics – Publishing.
[24] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.

competitiveness of companies by supporting them in the digital transformation process. They are selected at the European level[25].

ESG. An approach that considers environmental, social, and corporate governance criteria (Environmental, Social and Governance - ESG) when assessing the organization's activities in non-financial terms to encourage the integration of sustainable development concepts with strategy management[26].

Expert method. A qualitative research method that formulates conclusions based on group judgments, aiming to select a variant that aligns with the opinions of the majority or all experts who possess knowledge and experience in the area being researched[27].

Expert. A person with specialized knowledge in the field of clustering, while also having experience in conducting empirical research using interviews questionnaires[28].

Good practices (best practices). The concept of good practices originates from the field of organization management and is closely tied to benchmarking. Good practices are not new solutions; they are actions proven effective, previously applied successfully in other organizations. Their implementation aims to enhance organizational performance and increase efficiency effectiveness[29].

Indicator. Proper indicator, providing data for cluster benchmarking, enabling positioning of detailed aspects of cluster functioning in relation to benchmarking partners[30].

Industrial Internet of Things (IIoT). The use of Internet of Things technology in industry, particularly for the measurement, supervision, and management of dispersed assets, as well as for processing the obtained data to acquire knowledge and manage processes, systems, and value chains, aims to optimize their operation. According to research, four typical stages of implementing the Internet of Things are: 1) objects are networked, 2) monitoring of objects is introduced, 3) entities use the collected data to optimize processes, and 4) companies transfer the acquired information to their product range and develop new services[31].

[25] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.
[26] Kowalski A., Description of the subject of the contract for the Benchmarking of clusters in Poland - 2022 edition, PARP, Warsaw 2021.
[27] Kędzior Z. (ed.), Market research. Methods and applications, PWE, Warsaw 2005.
[28] Ibid.
[29] Matusiak K. (ed.), Innovations and technology transfer. Glossary of terms, PARP, Warsaw 2011.
[30] Mejsak R., Siedlecki M., A new methodology for cluster benchmarking along with member surveys, PARP, Warsaw, 2015.
[31] Bartkiewicz W., Czerwonka P., Pamuła A. (2020). Modern tools for the digitization of organizations, Łódź: University of Łódź Publishing House.

Industry 4.0 (Industry 4.0). A concept that represents the adoption by industrial enterprises of techniques and processes enabled by digitization, cloud computing, the Internet of Things, and big data analytics to gain a competitive advantage in domestic and global markets[32].

Internet of Things (IoT). The concept refers to the way objects and devices can collect, process, and exchange data with one another using communication networks, particularly the Internet. By measuring the effectiveness of individual operations and automating business processes, quality is improved, predictability is increased, and costs are reduced. Therefore, it is a complex ecosystem of technologies, including modules and devices, means of communication, platforms built specifically for it, mass storage, servers, analytics software, and IT services security[33].

IT system. A time, space, technical, technological, and logical component of the information system of a given organizational object (enterprise or institution), responsible for acquiring, processing, and providing decision-makers with the necessary data and information for management decision-making processes, implemented using computers technology[34].

Median. The median separates the ordered population into two equal halves, with 50% of individuals having trait values below and 50% above it median[35].

National Key Cluster (KKK). A cluster of significant importance for the country's economy and high international competitiveness; national key clusters are identified at the national level, e.g., based on criteria related to: critical mass, development and innovation potential, existing and planned cooperation, as well as experience and potential of the coordinator[36].

National smart specializations (KIS). Industries whose development will ensure the creation of innovative socio-economic solutions, enhance the economy's added value, and boost its competitiveness on the international arena[37].

Normalization. The purpose of normalizing variable values is to make the variables comparable. This is achieved by removing the measurement results of their denominations and unifying their orders of magnitude[38].

Polish Classification of Activities (PKD). A conventionally accepted, hierarchically structured division of various types of socio-economic activity is adopted for use in statistics, record-

[32]Kowalski A., Weresa M. (eds), Poland: Competitiveness Report 2019. International Competitiveness in the Context of Development of Industry 4.0, Warsaw: Warsaw School of Economics – Publishing.
[33] Liwarska-Fulczyk, K. (2020). The Internet of Things - organizational implications. e-mentor, (3 (85)), 23-31.
[34] Fjałkowski, Z., Information and computer science in logistic systems, www.fjalkowski.neostrada.pl/Teksty/ZF_Informacja_i_informatyka_w_systemach_logistic.pdf (accessed April 19, 2023).
[35] Sobczyk M., Statistics, PWN, Warsaw 2001.
[36] www.gov.pl/web/ Rozwoju/krajowe-klastry-keyowe (accessed on April 19, 2023).
[37] www.krajowebezpiecznespecjalizacje.pl (accessed on April 19, 2023).
[38] Walesiak M., Review of formulas for normalization of variable values and their properties in statistical multivariate analysis, Statistical Review R. LXI - issue 4 - 2014.

keeping, documentation, accounting, and in official registers and information systems of the public administration[39].

Quartiles. Values of the examined feature divide it into specific parts based on the number of units. The first quartile separates the ordered population into two groups such that 25% of units have values lower than the first quartile, and 75% have higher values. The third quartile divides the ordered population into two parts so that 75% of individuals have lower values and 25% have higher than the third quartile[40].

Regional Smart Specialization (RIS). Regional smart specialization refers to the unique assets and resources identified within a region, highlighting the competitive advantage and uniting regional partners and resources. EU Member States were obliged to implement RIS at the regional level as a tool for specialization and enhancement competitiveness[41].

Simulation - digital twin (digital twin). The simulation of real processes within a digital model aids in decision-making processes. Comparing the state of object images over time improves the quality of predictive analysis[42].

Smart specialization (smart specialization strategy). An innovative policy concept that emphasizes vertical prioritization (favoring certain technologies, fields, and groups of companies) while defining methods for identifying desirable areas of policy intervention in the field of innovation[43].

Stimulant. A variable with a high value is desirable in terms of the general characteristics of the phenomenon study[44].

Sub-synthetic benchmark. Value of the highest arithmetic average of indicators allocated to a given sub-area of benchmarking[45].

[39] Regulation of the Council of Ministers of December 24, 2007 on the Polish Classification of Activities (PKD), Journal of Laws No. 251, Item 1885.
[40] Sobczyk M., Statistics, PWN, Warsaw 2001.
[41] Regionalne Intelligent Specjalacje, www.smart.wzp.pl/energetyne-specjalizacje/regionalne-bezpieczne-specjalizacje (accessed on April 19, 2023).
[42] Drąg P., Kamińska A., Nowak M. (2019), Measuring the Benefits of Geoinnovation on the Example of Building a Facility Model. Innovations and the well-being of society and the economy. Measurement attempt, Publishing House of the Wrocław University of Technology.
[43] Foray D., Goenaga X., The goals of smart specialization, JRC Scientific and Policy Report, S3 Policy Brief Series No. 01/2013.
[44] Ibid.
[45] Ibid.

Support institutions (business environment). A diverse group of non-commercial institutions focused on supporting entrepreneurship and self-employment, technology transfer and commercialization, and enhancing competitiveness of SMEs[46].

Synthetic benchmark. The value of the highest arithmetic mean of sub-synthetic indicators comprising individual benchmarking areas[47].

Unitarianization. Normalization of variables to achieve a uniform range of variation (equal to a constant of 1) is defined—classically—by the difference between their maximum and minimum values[48].

Value chain. The value chain is a sequence of activities undertaken by an enterprise to create value for customers. Two types of activities can be distinguished in the value chain: primary and auxiliary. Primary activities relate directly to the production process and include procurement logistics, production operations, distribution logistics, marketing and sales, and after-sales service. Auxiliary activities support the essential functions of the value chain and are essential to the company's efficiency; they consist of: procurement, technology development, human resources management and infrastructure[49].

[46] Matusiak K. (ed.), Innovations and technology transfer. Glossary of terms, Polish Agency for Enterprise Development, Warsaw 2011.
[47] Ibid.
[48] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.
[49] Porter M., The Competitive Advantage: Creating and Sustaining Superior Performance. N.Y.: Free Press, 1985.

2. Introduction

This publication was created as part of the sixth edition of the report titled **"Cluster benchmarking in Poland - 2022 edition"**, aimed at enhancing our understanding of the current state of cluster development in Poland. The study was commissioned by the **Polish Agency for Enterprise Development (PARP)**.

Benchmarking serves as a strategy to pinpoint best practices within both private and public sector organizations by comparing them to other reference entities. The main goal of this study was to identify and showcase the best standards and practices found in the investigated clusters. Furthermore, the study sought to offer recommendations on desirable paths for cluster development, specifically aimed at cluster coordinators and organizations tasked with shaping cluster policies in Poland. It also lays the groundwork for improving various aspects of cluster operations across the country.

The research included 41 clusters from different regions in Poland. Below is the list of clusters presented in alphabetical order:

- „LODZistics" - Logistics Business Network of Central Poland
- Associaton West Pomeranian Chemical Cluster "Green Chemistry"
- Bydgoszcz Industrial Cluster Tool Valley
- Bydgoszcz IT Cluster
- Carpathian Tourist Cluster
- Cluster "Polish Automotive Group"
- Cluster for Photonics and Fiber Optics
- Cluster of Information Technologies in Building Industry
- Cluster of Innovative Manufacturing Technologies (CINNOMATECH)
- Construction Cluster INNOWATOR
- Digital Creative Cluster
- East Automotive Alliance
- Food Cluster of Southern Wielkopolska Association in Kalisz
- Interizon ICT Cluster
- ITCorner
- Kujawy Agro Cluster
- Lodz ICT Cluster
- Lower Silesian Automotive Cluster
- Lower Silesian Educational Cluster
- Lublin Eco-Energy Cluster
- Lublin Enterprise Cluster
- Lublin Medicine

- Lubuski Metal Cluster
- Mazovia Cluster ICT
- MedSilesia - The Silesian Network of Medical Devices
- Metal Processing Cluster
- North-South Logistics&Transport Cluster
- NUTRIBIOMED Cluster
- Podkarpackie Flavors Cluster
- Polish Cluster of Composite Technologies
- Polish Construction Cluster
- Polska Nature Cluster
- RADOM METAL CLUSTER
- Silesia Automotive & Advanced Manufacturing
- Silesian Aviation Cluster
- Sustainable Infrastructure Cluster
- The Cluster of Tourist Brands Of Eastern Poland
- The Easter Metalworking Cluster
- Waste Management and Recycling Cluster
- West Pomeranian ICT Cluster
- Wielkopolska ICT Cluster

The Polish Agency for Enterprise Development has been instrumental in advancing the concept of clustering in Poland. Active since 2005, the agency has consistently supported and nurtured cluster development. This enduring commitment underpins their active role in shaping and implementing vital elements of cluster policy nationwide. Through ongoing efforts, the agency has greatly contributed to the growth and progress of the cluster ecosystem in the country.

3. Summary

The current edition of the Cluster Benchmarking in Poland study continues the series of studies initiated by the Polish Agency for Enterprise Development (PARP) in 2010. Previous studies were conducted in 2010, 2012, 2014, 2018, and 2021. In this 2022 edition, the report presents the findings of a study conducted on 41 selected clusters in Poland, encompassing a total of 642 cluster members.

The report provides a thorough analysis of cluster development during the study period, specifically from 2020 to 2021. It highlights the most significant conclusions drawn from the research. Additionally, the report includes an examination of best practices and recommendations for various stakeholders, including cluster coordinators, entities operating within the cluster environment, and government and local administration institutions responsible for shaping cluster policy in Poland.

The key findings of the study are presented below:

1. Benchmarking analysis was conducted across five key areas. The research findings in relation to these areas were as follows:
    a. **Cluster resources.** The study revealed a moderate median value (0.28) and a moderately high benchmark value (0.78) for cluster resources. No clear leader emerged among the surveyed population regarding resource allocation, although at least half of the clusters achieved favorable results in this area. The cluster's human resources received the highest ratings in both median (0.28) and benchmark (1.00) terms. However, the sub-areas of infrastructural resources (median: 0.13) and financial resources (median: 0.14) received relatively low scores, indicating that at least half of the examined clusters faced challenges with limited infrastructural and financial capabilities. Notably, very large clusters (consisting of 121 or more members[50]), with KKK status, operating since at least 2009, and having well-defined strategic documents (including a written strategy subject to periodic updates), achieved the best results in these areas. Geographically, clusters located in the southern macroregion demonstrated the highest performance. In terms of industry, no specific group emerged as clear leaders, although the construction industry and the production and processing of metals were found to have relatively poorer results in this regard. For subsequent areas, information about the leaders of the rankings is repeated.

[50] Considering the distribution of the number of members among the examined clusters, they were divided into four possibly equal categories: small clusters (20-47 members, 10 clusters), medium clusters (48-77 members, 10 clusters), large clusters (78-120 members, 10 clusters), very large clusters (121 and more members, 11 clusters).

b. **Cluster processes.** The study reveals a very high median value (0.46) and a relatively high benchmark value (0.84) for cluster processes. Similar to the previous edition of the survey, clusters demonstrate an overall even level in this aspect. At least half of the clusters are regarded as good or very good in terms of processes. Among the sub-areas, the digitization of the cluster (median: 0.71) and management processes (median: 0.68) received the highest ratings, indicating strong performance. However, innovative activity (median: 0.24) scored relatively lower. When analyzing processes, it is worth noting that, in addition to very large clusters established before 2009, good results are also achieved by large clusters and those founded between 2010 and 2014. Geographically, there are no significant differences in cluster performance across various locations, although clusters in the southern macroregion continue to exhibit leadership in this regard. Nonetheless, this advantage does not extend to cluster resources. The lowest scores are observed among clusters focusing on quality of life, tourism, and recreation.

c. **Cluster results.** The study reveals a notably low median value (0.22) and a very high benchmark value (0.94) for cluster results. In this category, at least half of the clusters achieve very low results, indicating room for improvement. However, one cluster stands out as a clear leader in terms of results. Among the sub-areas, competence development received the highest rating (median: 0.30), highlighting the importance of skill enhancement within clusters. Conversely, the development of innovation in the cluster scored the lowest (median: 0.13), suggesting potential areas for further focus and improvement. These results are consistent across both large and very large clusters. When considering industries, the clusters performing the best are primarily in the chemistry, bioeconomy, materials engineering, and energy sectors. Conversely, the clusters with the lowest scores belong to the metal production and processing sectors, as well as the construction sector.

d. **Impact on the environment.** The study indicates a moderate median value (0.32) and a very high benchmark value (0.92) for the impact of clusters on the environment. The significant difference between the median and benchmark values suggests notable variation in development levels among clusters in this area. At least one cluster stands out as a clear leader in its environmental impact. Among the sub-areas, the clusters performed best in shaping surrounding conditions and their effects on the natural environment, with median ratings of 0.45 and 0.44, respectively. Conversely, specialization and advanced technologies received the lowest rating (0.23), indicating potential areas for improvement. The eastern macroregion demonstrates a distinct

advantage in this respect, both regarding cluster resources and environmental impact. In terms of industries, clusters representing the chemistry, bioeconomy, materials engineering, and energy sectors are the clear leaders, while the weakest-performing group comprises clusters in the construction, quality of life, tourism, and recreation sectors.

e. **Cluster internationalization**. The study reveals a low median value (0.22) and a relatively high benchmark value (0.88) for cluster internationalization. The significant difference between the median and benchmark values highlights a considerable disparity in the level of development in this area among clusters. At least half of the clusters achieved very low results, indicating room for improvement. However, at least one cluster stands out as a clear leader in terms of internationalization. Among the sub-areas, the internationalization potential received the highest median rating (0.34), suggesting that clusters possess opportunities for global engagement. Conversely, international activity received the lowest rating (0.22), implying a need for enhanced efforts in this area. Clusters established between 2010 and 2014 outperformed those established before 2009 regarding internationalization. Once again, clusters in the construction, quality of life, tourism, and recreation sectors demonstrated the weakest performance in internationalization.

2. The most important results and conclusions for each of the above are outlined below.

   a. **Cluster resources.** the study reveals several important findings regarding cluster resources. Firstly, there has been an increase in the number of people serving the clusters compared to the previous benchmarking. Out of the 41 clusters surveyed, 1-2 people were reported in 10 clusters, with an average of 6.1 people per cluster. Additionally, 53% of cluster members believe that this number of personnel is sufficient, while 16% have expressed a different opinion. Furthermore, active participation of researchers in cluster work is observed, with approximately 22 scientists collaborating with each cluster. Research infrastructure is provided by 22 clusters, with an average area of 3.6 thousand m2. In 2020-2021, 16 clusters invested in research infrastructure. Regarding production infrastructure, 16 clusters offer such facilities, with an average area of 1.7 thousand m2. However, only 9 clusters reported making investments in production infrastructure during the specified period. Clusters show active utilization of IT platforms, primarily for communication (83% of clusters), knowledge repository (51%), and cooperation management (41%). The budgets of surveyed clusters in 2020-2021 varied significantly, with an average of 4.2 million PLN and a median of 122,000 PLN. Thirteen clusters reported budgets exceeding 1 million PLN, while 11 clusters had budgets that did not exceed

100,000 PLN. Public funds were identified as one of the sources of financing for clusters, with 25 clusters reporting their acquisition. The average value of public funds obtained was 2.8 million PLN, with a median of 45,000 PLN. Access to financial instruments was of lesser importance for clusters, as loan funds and venture capital were already available in 19% of clusters each.

b. **Cluster processes**. Approximately 63% of clusters have a written strategy that is updated. The development of the strategy often involves the participation of cluster members, as confirmed by 54% of the surveyed representatives. Ninety-five percent of clusters conducted research on the needs and satisfaction of cluster members, but only 34% of them did so on a cyclical basis. Approximately 70% of cluster members report significant benefits from participating in the cluster, indicating an improvement compared to the previous edition of the study. On average, the surveyed clusters held 20 meetings per year, marking a significant increase compared to the previous edition, likely due to the shift to remote work during the COVID- 19 pandemic. Around 48% of members established business relations with foreign partners thanks to their participation in the cluster. Clusters actively support various stages of the value chain, particularly in marketing and sales, as well as the production and planning of products and services. Approximately 75% of surveyed cluster members highly evaluate the coordinators' activities in supporting individual elements of common value chains. The integration and development of relationships within the cluster received high ratings for market activity, with 85 members giving high scores. Clusters engage in marketing activities such as creating a cluster logo, advertising, and public relations. Additionally, 31 clusters participated in fairs, exhibitions, and other national events for promotional purposes. Coordinators provide members with access to pro- innovation services, including specialized training (30 clusters), innovation consulting (28 clusters), and monitoring of technological trends (24 clusters). Sixty- one percent of clusters have an institution supporting technology transfer, and 34% purchase knowledge and technology. Regarding digitization, the most commonly used IT systems are for customer relationship management (80% of clusters), resource management (68% of clusters), and document management (66% of clusters). Among the 13 analyzed Industry 4. 4.0 technologies, the most commonly used ones include widely understood IT systems (80% of clusters), cybersecurity solutions (73% of clusters), and 3 D production (71% of clusters).

c. **Cluster results.** Research in this area focused on developing cooperation within the cluster, including assessing implemented projects, creating joint offers, and obtaining orders for implementation. Thirty-two clusters implemented projects

co-financed by public funds, indicating a significant increase compared to the previous edition of the study (nineteen clusters). Over 43% of cluster members participated in these projects, with an average project value of nearly 23 million PLN and a median of 2.1 million PLN. Joint production or provision of services was recorded in 25 clusters, involving an average of seven members in this activity. In 19 clusters, coordinators played an active role in winning contracts. Twenty-seven clusters implemented R&D work and innovation initiatives, with an average of four projects per cluster. Product innovations (638) and process innovations (373) were reported, indicating an approximate 50% increase compared to the previous edition of the survey. Twenty-two clusters reported technology transfers, contributing to the implementation of product and process innovations. Coordinators supported the development of competencies among cluster members through various activities such as training, workshops, courses, conferences, seminars, and the organization of post-graduate studies. Only two clusters did not indicate any activity in this regard. Sixty-one percent of cluster members participated in these competence-raising activities.

d. **Impact on the environment.** Clusters demonstrated environmental cooperation through signed agreements with various entities. Active agreements were established with public authorities by 26 clusters, with business support institutions by 32 clusters, and with institutions in the R&D and education sector by 31 clusters. Clusters can expect support from public authorities, primarily in terms of promotion (51% of responses), financial support (46%), and training and education support (39%). In the case of R&D and education sector institutions, cooperation is most frequently of an individual nature with selected scientists (73%), institutions in the field of didactics (66%), and project implementation (61%). Clusters participating in the study reported the execution of 1,310 internships and 1,092 apprenticeships, indicating a high level of engagement in this area. Representatives from clusters often sit on various types of bodies (34 clusters), enabling them to undertake activities with a positive impact on the environment, such as CSR initiatives, support for educational activities, co-organization of social events, and direct support for local non-governmental institutions (28 clusters). Clusters engage in activities aimed at improving the condition of the natural habitat, including the use of circular economy concepts, implementing solutions derived from energy audits, conducting R&D work in low-emission technologies, and producing and distributing energy from renewable sources. Regarding specialization and advanced technologies, an average of 64.8% of cluster enterprises operate within the framework of National Intelligent Specialization (KIS), and 62% operate within the framework

of Regionally Important Specialization (RIS). However, a smaller percentage of cluster enterprises (34.8%) operate within Key Enabling Technologies (KETs), which are essential for the future development of the EU.

e. **Cluster internationalization.** Internationalization is viewed as a vital phase in cluster development, with the potential to greatly benefit cluster members. Thirty-four clusters provided support to their members in internationalization efforts, offering a variety of services (an average of 6.4 services). Approximately 34% of cluster members participating in the study availed themselves of these services. The majority of clusters (30) have developed foreign language versions of their websites, indicating their readiness for international engagement. However, 11 clusters should consider creating an English version of their online business card to enhance their international visibility. Cooperation agreements with foreign entities have been established by 28 clusters, with an average of over 5 agreements per cluster. Moreover, more than two-thirds of clusters (27) have undertaken international projects and partnerships, with an average project value of 10.6 million PLN (median of 0.3 million PLN), reflecting a substantial variation in project values. The organization of international events has been actively pursued by 29 clusters, and 20 clusters have reported the presence of foreign capital among their members, particularly in the ICT and automotive sectors. These clusters demonstrate a proactive approach by organizing trips to foreign fairs, exhibitions, and events, with a total of over 870 such trips arranged. This has been facilitated through sub-measure 2.3.3 of the Internationalization of National Key Clusters under the Operational Program Smart Growth. Additionally, 24 clusters engage in hosting incoming missions for foreign clusters, promoting international collaboration.

The study findings reveal that large or very large clusters, particularly those designated as National Key Clusters, hold an advantage across various areas, sub-areas, and partial indicators of the study. These clusters, established before 2010 and during the years 2010-2015, demonstrated favorable outcomes. Additionally, having a written strategy that undergoes regular updates further contributes to their advantageous position within the cluster landscape.

3. Exceptions to the previously mentioned rule can be observed in certain sub-areas, often specific to particular industries. For example, ICT clusters tend to excel in digitization, while clusters focused on chemistry, bioeconomy, materials engineering, and energy have a competitive edge regarding their environmental impact.

4. A positive correlation exists between the number of cluster members and the average benchmark value. This relationship is attributed to indicators such as the cluster budget, employment within member entities, and the number of organized events. In these

cases, larger clusters naturally have an advantage over smaller ones. However, there are exceptions when measuring the percentage of specific situations (e.g., the percentage of members operating in high technology fields[51]). Nonetheless, the overall trend demonstrates that a greater number of members is associated with a higher average benchmark value.

5. **Strengths and weaknesses** of clusters were assessed by considering the median scores obtained in individual sub-areas. Strengths were identified as elements where the median score for the entire cluster group exceeded 0.30, while weaknesses were determined by elements with a median score below 0.20. Notably, compared to the previous edition, there has been an increase in the value of these indicators and a reduction in the number of cluster weaknesses. These improvements primarily stem from the overall better performance observed in the current edition of the survey.

Table 1. Strengths and weaknesses of the studied clusters (median value in brackets)

Strengths of clusters	Weaknesses of clusters
Management processes (0.68)	Financial resources (0.13)
Cluster communication (0.34)	infrastructure resources (0.14)
Market activity (0.33)	Development of innovation in the cluster (0.13)
Marketing activity (0.34)	
Cluster digitization (0.71)	
Impact on the natural environment (0.43)	
Impact on shaping the environmental conditions (0.44)	
Internationalization potential (0.33)	

Source: own elaboration based on research involving cluster coordinators (N=41).

6. The study identified several dozen effective practices implemented by national clusters, with many clusters willingly sharing their achievements. A total of 13 national and 3 foreign effective practices were selected and described, following the research methodology. Each effective practice was assigned a key area, with the most common areas being cooperation with the environment (4 clusters), the development of cooperation within the cluster, and innovative activity (3 clusters each) as the subjects of the identified effective practices.

[51] To increase the readability of further analysis and graphs, whenever the report mentions high and medium-high technologies, it also means knowledge-intensive services.

7. The report concludes with a list of recommendations directed at various categories of institutions. These recommendations encompass government and local government, cluster coordinators, business support institutions, as well as universities and other entities within the higher education and science system. They cover several areas, including the system for implementing public tasks by clusters, processes related to cluster development and internationalization, enhancement of clusters' offerings and networking, standardizing approaches to cluster reporting (such as calls for KKK, benchmarking, and European badges), impact on the external environment (including the natural environment), and the adoption of modern solutions and technologies. These recommendations aim to provide guidance for further improving cluster performance and promoting their growth and effectiveness.

4. Methodological introduction

4.1. Research methodology

Benchmarking is a method used to identify and present exemplary operating practices of organizations by comparing them with others in both the private and public sectors. In the context of clusters, the study aimed to identify and showcase the best models and good practices found in the surveyed clusters, as well as to offer recommendations for cluster development. It specifically targeted cluster coordinators and institutions responsible for shaping cluster policy in Poland, with the goal of enhancing various aspects of cluster functioning in the country.

The study employed a comprehensive, cross-sectional analysis of clusters based on two integral elements:

- Cluster characteristics encompassed basic attributes used for cross-sectional analyses, such as age, size, location, and industry specialization. These characteristics included formalization, size, geographical concentration, and sectoral concentration (including in terms of KIS and RIS).
- Cluster benchmarking involved comparing the developmental status of clusters across various operational areas, accompanied by the presentation of relevant good practices. The study utilized a division into five primary benchmarking areas and 19 specific sub-areas.

In the sixth edition of the benchmarking, 41 clusters from across Poland participated. The study was conducted in the fourth quarter of 2022 and involved:

- Interviews with the coordinators of the 41 participating clusters.
- An opinion survey was conducted using the Computer-Assisted Telephone Interviewing (CATI) method and Computer-Assisted Web Interviewing (CAWI) for 642 member participants.
- Effective practices based on desk research analysis and in-depth interviews with both Polish and foreign clusters.

The findings were gathered into a comprehensive report and separate reports dedicated to each participating cluster.

Opinion surveys of cluster members were used to assess their perceptions of benefits and satisfaction related to cluster membership. These surveys also served to confirm and validate the data obtained from the cluster coordinators. The data collected during interviews with cluster coordinators were thoroughly reviewed by researchers and supplemented with information gathered through desk research analysis.

In total, 90 indicators related to cluster functioning were analyzed, offering insights into the state and level of development of clusters in Poland for the study period from 2020 to 2021. The table below illustrates the examined areas and sub-areas covered in the study.

Table 1. List of examined areas and sub-areas of benchmarking along with the number of indicators.

Benchmarking area	Benchmarking sub-area	Number of indicators
I. Resources cluster	I.1. Human resources	4
	I.2. Infrastructure resources	6
	I.3. Financial resources	4
II. Cluster processes	II.1. Management processes	5
	II.2. Cluster communication	2
	II.3. Market activity	5
	II.4. Marketing activity	5
	II.5. Innovative activity	5
	II.6. Cluster digitization	2
III. Cluster results	III.1. Development of cooperation in the cluster	10
	III.2. Development of innovation in the cluster	7
	III.3. Development of competences in the cluster	3
IV. Impact of the cluster on the environment	IV.1. Cooperation with the environment	8
	IV.2. Influence on shaping the environmental conditions	3
	IV.3. Impact on the natural environment	1
	IV.4. Specialization and advanced technologies	4
V. Internationalization of the cluster	V.1. Internationalization potential	3
	V.2. International activity	6
	V.3. Export and pro-export activities	7

Source: Cluster benchmarking methodology - 2022 edition.

The data required to estimate the value of 88 indicators was gathered through research with cluster coordinators. Two additional indicators, the number of language versions of the website and the number of search engine results for the cluster's name, were estimated based on secondary data analysis performed by the Contractor (the number of language versions of the website and the number of results for the phrase "name of the cluster" in Internet search engines).

The study involved analyzing the aforementioned areas for the entire cluster group, as well as for individual clusters. The report includes cross-sectional analyses based on the following criteria:

1. **Cluster status:** classified as a National Key Cluster, with no current status along with plans to obtain and no status without plans to obtain.
2. **Cluster size:** in this study categories are defined as small (20-47 members), medium (48-77 members), large (78-120 members), and very large (121 or more members).
3. **Cluster age:** mature (created before 2010), clusters created between 2010 and 2014, and young (created after 2014).
4. **Cluster location:** the division was made according to macroregions in Poland[52].
5. **Having a cluster strategy:** having a strategy and updating it.
6. **Industry:** the researched clusters were divided into six industries:
   - construction;
   - chemistry, bioeconomy, materials engineering and energy;
   - ICT;
   - quality of life, tourism and recreation;
   - automotive, aerospace production, and transportation;
   - metal production and processing.

The comparison was conducted using standardized indicators, where the values of each indicator were transformed into a range from 0 to 1. This transformation allowed for the calculation of averages and facilitated the comparison of results. The cluster benchmarking analysis involved the use of the following indicators:

- **Medians** – divide clusters into two equal parts regarding size (weaker and better).
- **Benchmark** – means an indicator of the best cluster in a given area.

These indicators enabled a comprehensive analysis of cluster phenomena and comparisons between clusters based on various combinations of indicator values:

- **The low value of the median** (close to 0) – indicates that at least half of the clusters obtained very poor results compared to the others.
- **High benchmark value** (close to 1) – one or a specific group of clusters achieved an exceptionally high position in benchmarking, clearly distancing themselves from other clusters.

[52] According to the NUTS classification in Poland, 7 macro-regions can be distinguished (as of January 1, 2021). Despite the fact that the Mazowieckie Voivodeship has the status of a separate macroregion, clusters from this area were analyzed together with units from the central macroregion (Łódź and Świętokrzyskie Voivodships) to simplify the analysis.

- **The median is nearly half of the benchmark value** – the level of cluster development is evenly distributed within a given area or sub-area of benchmarking (there are no strong leaders among any group of clusters, nor weak clusters).

It is important to note that a direct comparison between benchmarks from the previous and current editions is not entirely possible due to several factors. These factors include changes in the list of indicators used and variations in the composition of the clusters participating in each edition.

4.2. Cluster selection

The clusters selected for the study were based on the following criteria:

- **Legal form and activity**. The cluster must have been established as a legal entity and been actively operating for a minimum of three years.
- **Critical mass**. The cluster must have a minimum of 20 cluster members.
- **Organizational form**. The cluster needed to demonstrate a specific organizational structure and formalized cooperation among its constituent entities.
- **Geographical concentration**. The majority of cluster members must be geographically concentrated, with more than half of the members located within a distance of 200 km from the cluster coordinator's office.
- **Sector representation**. The sample of clusters included in the study represented various sectors of the economy.

During the recruitment process, efforts were made to include clusters from each voivodeship (based on the coordinator's seat) in the sample. However, this goal could not be achieved for the Opolskie and Warmińsko-Mazurskie voivodeships due to the lack of eligible entities meeting the study criteria.

In total, a merged database of approximately 80 active clusters was created. However, some of these clusters were excluded from the study either because they did not meet the established criteria or due to their lack of activity[53]. From the remaining clusters, approximately 60 met the requirements and were considered for participation in the study. Finally, a total of 41 clusters were selected to participate, as they reflected the cluster environment in Poland and provided a diverse representation in terms of characteristics such as the period of operation, critical mass, and industry specialization.

Among the participating clusters, 16 were classified with the current status as of August 2022 under the Krajowe Klastry Kluczowe (National Key Cluster) program, while 25 clusters did not hold this status. This inclusion of both types of clusters enabled a comprehensive analysis of different cluster models and their impact on cluster development in Poland.

[53] The database was created on the basis of data from previous benchmarking editions, when the level of cluster activity was subjected to a detailed analysis. At that time, from the initial list of 200 clusters, activity was confirmed among about 80 of them. The database was supplemented with relatively new clusters, which, however, mostly could not participate in the study due to the fact that the criterion of the date of cluster establishment was not met.

Table 2. Characteristics of clusters participating in benchmarking

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
1.	NUTRIBIOMED Cluster	2007	104	74 - other professional, scientific and technical activities	Lower Silesia
2.	The Easter Metalworking Cluster	2009	88	25 - manufacture of finished metal products, excluding machinery and equipment	Lublin
3.	Construction Cluster INNOWATOR	2010	82	94 - activity organization members	Świętokrzyskie
4.	Cluster "Polish Automotive Group"	2011	71	29 - manufacture of motor vehicles, trailers and semi-trailers, except motorcycles	Subcarpathian
5.	East Automotive Alliance	2015	32	94 - activity organization members	Subcarpathian
6.	Podkarpackie Flavors Cluster	2013	55	10 - production articles food	Subcarpathian
7.	Mazovia Cluster ICT	2007	418	62 - activities related to software and consultancy in the field of computer science and related activities	Masovian
8.	Silesian Aviation Cluster	2006	110	51 - air transport	Silesian
9.	Polish Construction Cluster	2011	427	94 - activity organization members	Podlaskie
10.	Waste Management and Recycling Cluster	2012	146	38 - recovery raw materials	Masovian
11.	Polska Nature Cluster	2016	32	94 - activity organization members	Masovian
12.	Radom Metal Cluster	2011	35	25 - manufacture of finished metal products, excluding machinery and equipment	Masovian
13.	„LODZistics" - Logistics Business Network of Central Poland	2016	20	52 - warehousing and service activities supporting transport	Lodz
14.	Cluster for Photonics and Fiber Optics	2012	54	26 - manufacture of computers, electronic and optical goods	Lublin
15.	Cluster of Information Technologies in Building Industry	2012	67	71 - activities in the field of architecture and engineering; research and technical analysis	Lesser Poland
16.	West Pomeranian ICT Cluster	2011	77	62 - activities related to software and consultancy in the field of computer science and related activities	West Pomeranian

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
17.	Lubuski Metal Cluster	2008	55	28 - manufacture of machinery and equipment nec	Lubuskie
18.	Lublin Eco-Energy Cluster	2011	35	35 - generation and supply of electricity, gas, steam, hot water and air for air conditioning systems	Lublin
19.	Polish Cluster of Composite Technologies	2017	106	22 - manufacture of rubber and plastic products	Lesser Poland
20.	Food Cluster of Southern Wielkopolska Association in Kalisz	2009	56	10 - production articles food	Greater Poland
21.	Lower Silesian Automotive Cluster	2014	54	25 - manufacture of finished metal products, excluding machinery and equipment	Lower Silesia
22.	Lublin Medicine	2014	170	86 - care health	Lublin
23.	North-South Logistics&Transport Cluster	2012	235	49 - land transport and pipeline transport	Pomeranian
24.	Bydgoszcz Industrial Cluster Tool Valley	2006	122	22 - manufacture of rubber and plastic products	Kuyavian-Pomeranian
25.	Lower Silesian Educational Cluster	2015	171	85 - education	Lower Silesia
26.	Cluster of Innovative Manufacturing Technologies (CINNOMATECH)	2012	78	28 - manufacture of machinery and equipment nec	Lower Silesia
27.	Lodz ICT Cluster	2012	47	62 - activities related to software and consultancy in the field of computer science and related activities	Lodz
28.	ITCorner	2013	101	62 - activities related to software and consultancy in the field of computer science and related activities	Lower Silesia
29.	Silesia Automotive & Advanced Manufacturing	2011	178	29 - manufacture of motor vehicles, trailers and semi-trailers, except motorcycles	Silesian
30.	Digital Creative Cluster	2007	70	85 - education	Masovian

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
31.	Associaton West Pomeranian Chemical Cluster "Green Chemistry"	2007	159	20 - production of chemicals and chemical products	West Pomeranian
32.	Interizon ICT Cluster	2009	88	62 - activities related to software and consultancy in the field of computer science and related activities	Pomeranian
33.	MedSilesia - The Silesian Network of Medical Devices	2007	111	74 - other professional, scientific and technical activities	Silesian
34.	Sustainable Infrastructure Cluster	2011	128	94 - activity organization members	Lesser Poland
35.	Bydgoszcz IT Cluster	2013	34	62 - activities related to software and consultancy in the field of computer science and related activities	Kuyavian-Pomeranian
36.	Kujawy Agro Cluster	2014	20	10 - production articles food	Kuyavian-Pomeranian
37.	The Cluster Of Tourist Brands Of Eastern Poland	2012	37	93 - sporting, entertainment and recreational activities	Podlaskie
38.	Metal Processing Cluster	2007	130	94 - activity organization members	Podlaskie
39.	Lublin Enterprise Cluster	2008	23	94 - activity organization members	Lublin
40.	Wielkopolska ICT Cluster	2008	120	94 - activity organization members	Greater Poland
41.	Carpathian Tourist Cluster	2013	62	55 - accommodation	Subcarpathian

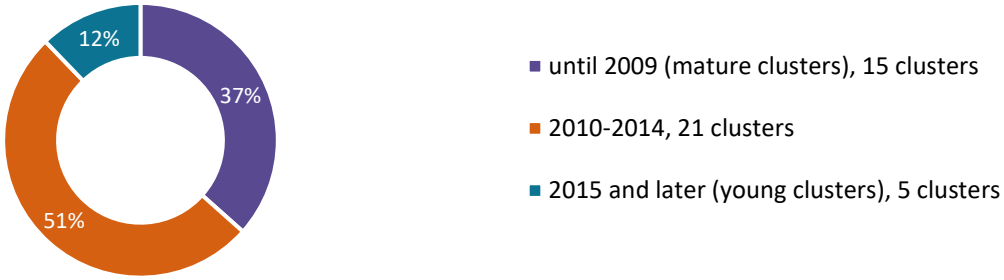
Source: own study.

The composition of the study participants was primarily influenced by the year in which the clusters were established. The largest representation came from clusters founded between 2010 and 2015, with 22 clusters in this category. Additionally, there were 14 clusters established before 2010. These timeframes align with the financial perspective of 2007-2014, during which support instruments for cluster creation were available in Poland.

During the recruitment process, it was observed that several newly established clusters emerged after 2015. However, most of these clusters did not meet the required criteria for minimum operation duration or membership numbers, rendering them ineligible for participation in the study. Nonetheless, five clusters established after 2015 successfully met the

criteria and were included in the study, providing some representation of more recently established clusters.

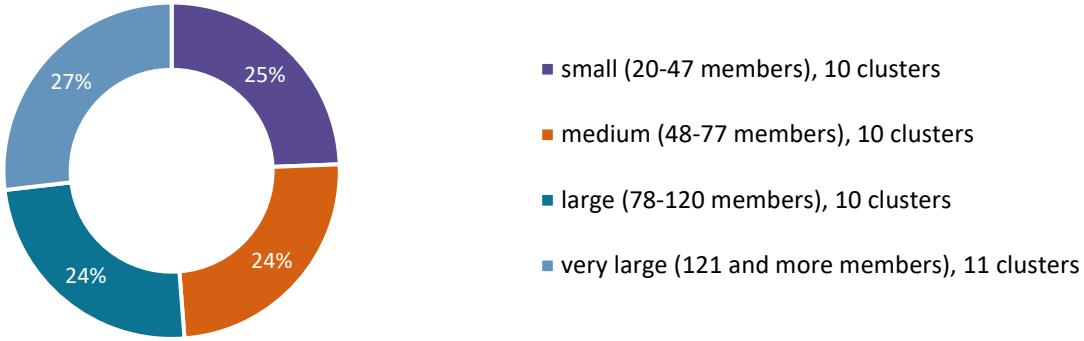
Graph 1. Characteristics of clusters participating in benchmarking - year of establishment



Source: own elaboration based on research involving cluster coordinators (N=41).

Based on the number of members, the clusters in the study were categorized into four groups of similar sizes: small clusters with 20-47 members (10), medium clusters with 48-77 members (10), large clusters with 78-120 members (10), and very large clusters with over 120 members. On average, across all examined clusters, the total number of members was calculated to be 102.6.

Graph 2. Characteristics of clusters participating in benchmarking - number of members



Source: own elaboration based on research involving cluster coordinators (N=41).

The largest clusters in terms of membership during the study include the Polish Construction Cluster (427 members), the Mazowiecki ICT Cluster (418), and the North-South Logistics & Transport Cluster (235). It is worth noting that on the list of very large clusters, almost all had the status of KKK. Among the clusters with over 100 members, only the following did not have this status:

- Lower Silesian Education Cluster (171 members).
- Lublin Medicine (170).

- Wielkopolska ICT Cluster (120).
- ITCorner (102).

It should be noted that the clusters examined in the study primarily operate in the services sector. This sector tends to facilitate the formation of clusters with a large number of members. However, it is essential to recognize that having numerous members does not necessarily guarantee the fulfillment of all requirements to obtain the status of a National Key Cluster (KKK).

According to the declarations submitted by the surveyed clusters, the total number of members at the end of the surveyed period was 4,208. This represented a 16.8% increase compared to the previous edition of the survey. On average, each cluster had 103 entities as members. It is worth mentioning that the number of unique entities was slightly lower, as some entities were members of more than one cluster. This was particularly true for business support institutions, universities, and other entities within the higher education and science system.

During the benchmarking period (2020-2021), there was an overall increase in membership. The participating clusters reported accepting 809 new members, while 307 cancellations occurred during the same period.

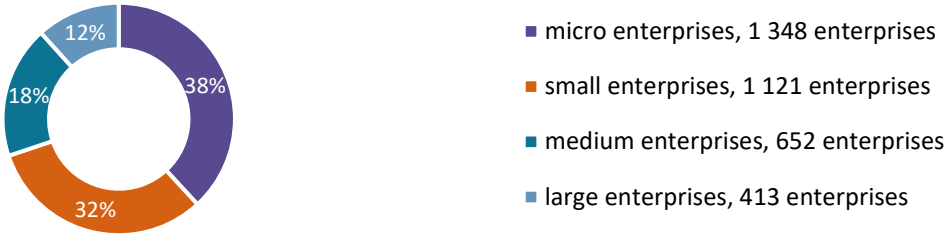
The structure of the clusters primarily consisted of enterprises, which accounted for 84% of the membership. Universities and other entities within the higher education and science system made up 6% of the membership, regional government units accounted for 5%, business support institutions comprised 4%, and the "other" category, including educational institutions, health facilities, and individuals, represented 1%. In total, there were 3,534 enterprise members in the surveyed clusters (an increase of over 400 compared to the previous edition), 237 universities and entities in the higher education and science system (a decrease of 5), 182 business support institutions (a decrease of 13), and 40 local government units (no change).

Graph 3. Characteristics of clusters participating in benchmarking - type of entities

Source: own elaboration based on research involving cluster coordinators (N=41).

The structure of enterprises within the surveyed clusters was further analyzed according to size categories. The largest group within the clusters consisted of micro-enterprises, accounting for 38% of the membership. Small enterprises followed closely behind, representing 32% of the membership. Medium-sized and large entities held similar shares in the cluster structure, accounting for 18% and 12%, respectively. It is noteworthy that the proportion of medium-sized and large entities within the clusters was higher compared to their representation among all registered enterprises in the country[54].

Graph 4. Characteristics of clusters participating in benchmarking - structure of members (entrepreneurs)



Source: own elaboration based on research involving cluster coordinators (N=41).

Although they are relatively few in number, business support institutions play a crucial role in clusters by carrying out diverse functions. A vital aspect of their role is coordination, particularly visible through regional agencies and advisory bodies. They assist in various facets of cluster activities, notably in education, technological consulting, and project engineering. These institutions facilitate project implementation across its entire lifecycle, starting from securing financing and offering support during execution, to ultimately achieving material and financial closure.

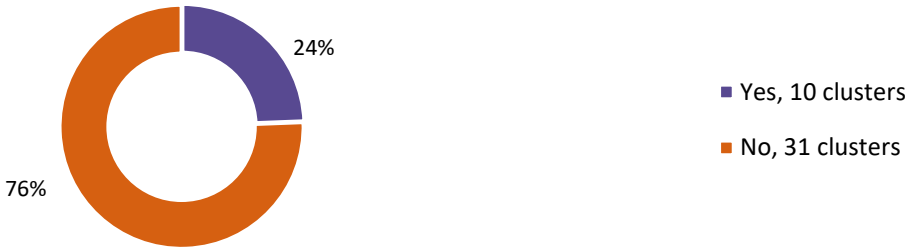
[54] Based on the data of the Central Statistical Office, at the end of 2022, the percentage of medium-sized enterprises in the country was 0.54%, and that of large enterprises was only 0.08%.

The business support institutions represented within clusters can differ in their level of development and the quality of services they provide. A key indicator of a reputable institution is its accreditation as an innovation center by the Ministry of Tourism and Technology, or possessing the status of a Digital Innovation Hub (DIH), European Digital Innovation Hub (EDIH), or candidate status for EDIH.

Innovation centers encompass entities that specialize in technology transfer and provide pro-innovation services while fostering collaboration with businesses. Their primary objective is to stimulate innovation in both product and process aspects. Accreditation as an innovation center is granted by the Ministry of Development and Technology, with the most recent recruitment process concluding on December 31, 2021[55].

It may be difficult to answer whether there is an accredited innovation center in the cluster. It should be emphasized that innovation centers (in particular regional development agencies) usually form quite extensive organizational structures. Often, the entire innovation center is not a member of clusters, but only its organizational unit or subsidiary. Taking into account the answers of cluster coordinators, supplemented by additional verification of the team of authors (including detailed verification of member lists for the presence of accredited innovation centres), 10 clusters with the participation of such entities were identified. It is worth mentioning that the participation of an accredited innovation center among cluster members is one of the scoring elements at the stage of substantive evaluation in the KKK competition[56]. It is advisable to make efforts to incorporate such centers into their structures, particularly for clusters considering applying for the status of a National Key Cluster (KKK).

Graph 5. Characteristics of clusters participating in benchmarking – at least one accredited innovation center is a member



Source: own elaboration based on research involving cluster coordinators (N=41) and analysis of existing data.

[55] Innovation Centres, Ministry of Entrepreneurship and Technology, www.gov.pl/web/ Rozwoju-technologia/osrodki-innowacji (accessed on April 19, 2023).
[56] According to the competition documents from the call for proposals for the KKK announced on June 27, 2022, www.gov.pl/web/ Rozwoju-technologia/konkurs-o-status-krajowego-klastra-keyowego (accessed on April 19, 2023).

Cluster members, typically business support institutions, can also hold the status of digital innovation hubs (DIH, EDIH, or candidates for EDIH). These members serve as a vital link between entities that require digital transformation services, such as entrepreneurs and public administration, and the existing supply of such services, which includes providers of ready-to-implement technologies, educational and support service entities, and startups.

It is worth noting that among the cluster members who participated in the benchmarking, the proportion of organizations with DIH, EDIH, or candidate status was relatively small, with confirmed participation from only six clusters.

Graph 6. Characteristics of clusters participating in benchmarking - at least one DIH, EDIH or EDIH candidate is a member

Source: own elaboration based on research involving cluster coordinators (N=41) and analysis of existing data.

At the same time, it was noted that several clusters, which did not participate in the current benchmarking edition, included organizations of this type among their members. These clusters were often characterized by a technological focus but lacked certain criteria for participation in the study.

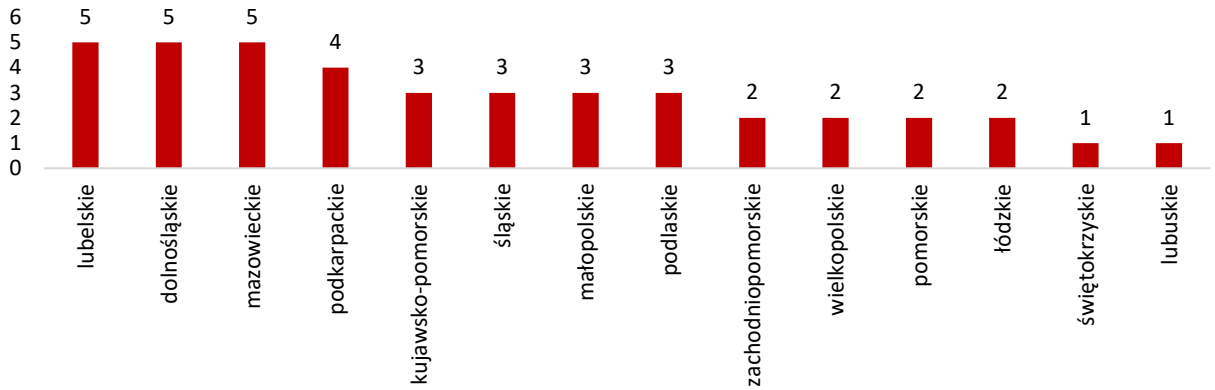
To ensure comprehensive regional representation, the study considered the geographic distribution of clusters based on the coordinators' locations. Efforts were made to include at least 4 clusters from each geographical area. Consequently, further analysis was conducted based on macroregions, with the central macroregion encompassing Mazowieckie, Łódzkie, and Świętokrzyskie voivodeships. Among the macroregions, the eastern macroregion stood out as the most populous, consisting of 12 clusters. It covered the Podlaskie, Lubelskie, and Podkarpackie regions. Notably, all clusters in this macroregion were established by 2014.

Graph 7. Characteristics of clusters participating in benchmarking - location of the coordinator's seat, broken down by macroregions

Source: own elaboration based on research involving cluster coordinators (N=41).

As part of the research, efforts were made to include clusters from each province in Poland. However, it was found that certain regions have low cluster activity, resulting in the absence of two voivodeships (Warmińsko-Mazurskie and Opolskie) from the benchmarking study. Among the represented regions, the most numerous were Lubelskie, Dolnośląskie, and Mazowieckie, each with 5 clusters participating in the study.

Graph 8. Characteristics of the clusters participating in the benchmarking - seat of the cluster coordinator

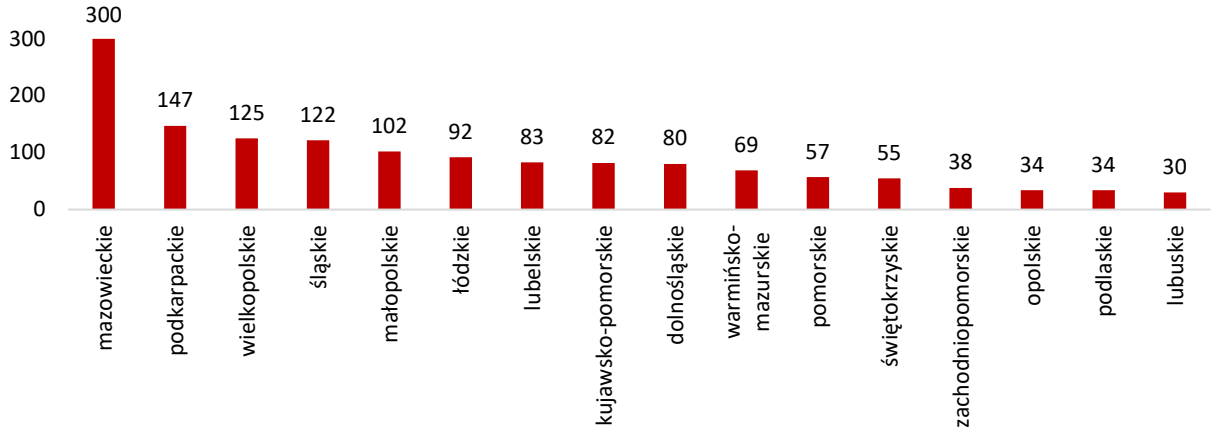


Source: own elaboration based on research involving cluster coordinators (N=41).

The geographical concentration of clusters, broken down by voivodeships, is an important aspect to consider. The clusters examined in the study continue to exhibit a significant level of geographical concentration. On average, 70.7% of the cluster members are situated in the province where the coordinator is based, with a median of 74.0%. Clusters with lower concentration levels are typically those that have a large number of members (over 100) or those with a narrow technological specialization, such as photonics, composite technologies, or information technologies in construction. In the latter case, these clusters tend to concentrate leading centers in the respective technology from across the country.

When considering the number of members from regions outside the coordinator's province, the region of Mazowieckie stands out with 300 members, followed by Podkarpackie (147), Wielkopolskie (125), and Śląskie (122). It is worth noting that the list also includes member entities from Warmińsko-Mazurskie (69) and Opolskie (34) regions, despite the absence of clusters that meet the formal requirements for participation in the benchmarking study from these regions. The data is presented in the graph below.

Graph 9. Characteristics of clusters participating in benchmarking - number of members from a region other than the seat of the cluster coordinator



Source: own elaboration based on research involving cluster coordinators (N=41).

Only seven clusters include foreign entities among their members, and their number is minimal compared to the total number of cluster members, accounting for less than 0.5%. The presence of foreign members in Polish clusters is mainly observed from neighboring countries such as Ukraine, Germany, and the Czech Republic.

Regarding the European Clusters Excellence Labeling badge (EUCLES)[57], only a relatively small number of clusters (10) surveyed have obtained this certification. The study's authors believe this presents an area where cluster coordinators can enhance their efforts. It is worth noting that, in the past, KKK coordinators could receive co-financing for the certification process through sub-measure 2.3.7 of the Operational Program Smart Growth. Additionally, both KKK clusters and supra-regional growth clusters will have the opportunity to benefit from the planned measure 2.17 of the European Funds for Modern Economy[58].

[57] Labeling Excellence Structure (EUCLES) took over the responsibility for the cluster distinction system previously signed by ESCA (European Secretariat for Cluster Analysis).

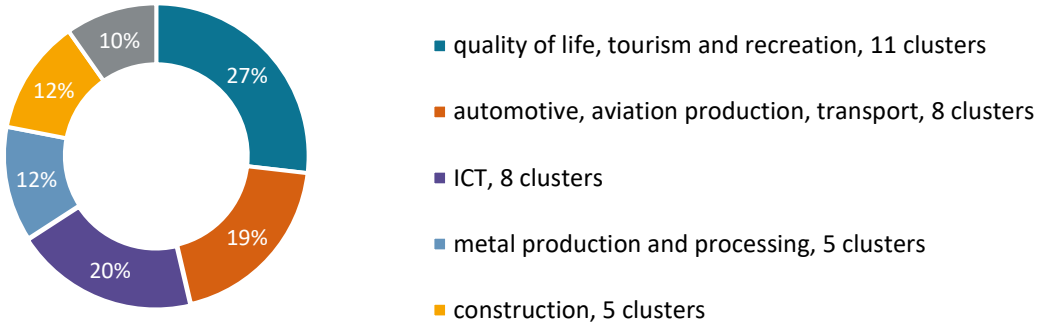
[58] Recruitment for this activity, along with the applicable documentation and rules, will be announced on April 25, 2023, www.parp.gov.pl/harmonogram-naborow (accessed on April 19, 2023).

Graph 10. Characteristics of clusters participating in benchmarking - having a quality badge

Source: own elaboration based on research involving cluster coordinators (N=41).

The clusters surveyed were categorized into six groups based on their industry focus. The largest representation was found in sectors related to quality of life, tourism, and recreation, with eleven clusters operating in this domain. The industrial processing and transport sector was also well-represented, with thirteen clusters specializing in metalworking, automotive, aviation, and transport. Additionally, there were eight clusters focused on ICT (Information and Communication Technology). Other sectors included construction, with five clusters, and four clusters operating in the fields of chemistry, bioeconomy, materials engineering, and energy.

Graph 11. Industry specialization of clusters participating in benchmarking



Source: own elaboration based on research involving cluster coordinators (N=41).

The clusters included in the study also fall under one or more National Smart Specializations (KIS)[59]. The analysis was based on the list of 13 KIS, valid from January 17, 2022, to February 12 2023[60]. All surveyed clusters identified at least one KIS that aligns with their areas of activity.

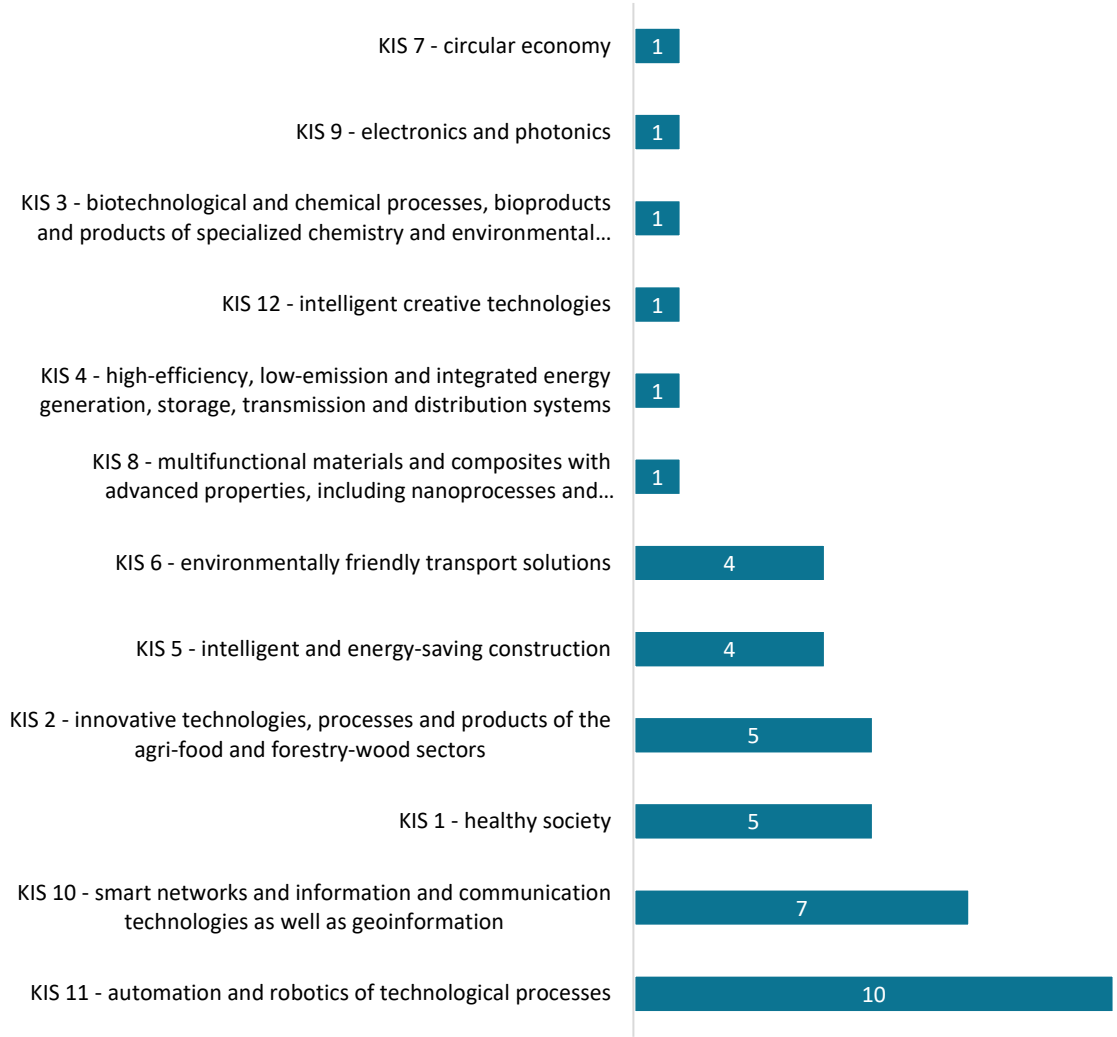
[59] National smart specializations are industries whose development will ensure: creating innovative socio-economic solutions, increasing the added value of the economy and increasing its competitiveness on the international arena.

[60] www.gov.pl/web/ Rozwoju-praca-technologia/national-intelligent-specializations (accessed April 19, 2023).

Additionally, three clusters indicated involvement in at least six secondary KIS, representing activities beyond a single sector or industry.

In terms of the dominant KIS area, the highest number of clusters identified automation and robotics of technological processes as their primary focus, with 10 clusters operating in this field. Smart networks and information and communication technologies were also prominently represented, with several clusters involved (exact number not specified). Another significant area of focus was geoinformation technologies, with 7 clusters indicating involvement in this domain.

Graph 12. Number of clusters participating in benchmarking – dominant KIS in which the cluster is included



Source: own elaboration based on research involving cluster coordinators (N=41).

5. The research results

The report first presents the results of general data, and then, in the subsequent sub-chapters, it provides detailed results within individual areas and sub-areas. Firstly, the obtained values for synthetic indicators across the five analyzed areas were compared between the current edition of the benchmarking and the previous one from 2020[61]. The comparison was made using unitarized[62] values as follows:

- **Benchmark** – obtained indicator values for the best cluster in a given area.
- **Median –** divides clusters into two equal parts in terms of size (weaker and stronger for a given area).

Due to changes in indicators between editions, comparing the values determined in this manner introduces certain estimation errors. To achieve complete accuracy in comparative analysis, it is necessary to analyze the same group of clusters using the same set of indicators. However, this is not feasible because of the differences in indicators between editions. Therefore, it is important to acknowledge the limitations and potential errors when comparing the results from different editions of the study.

The analysis was made for the following criteria:

1. **Cluster status:** classified as a National Key Cluster, with no current status along with plans to obtain and no status without plans to obtain.
2. **Cluster size:** in this study categories are defined as small (20-47 members), medium (48-77 members), large (78-120 members), and very large (121 or more members).
3. **Cluster age:** mature (created before 2010), clusters created between 2010 and 2014, and young (created after 2014).
4. **Cluster location:** the division was made according to macroregions in Poland[63].
5. **Having a cluster strategy:** having a strategy and updating it.
6. **Industry:** the researched clusters were divided into six industries:

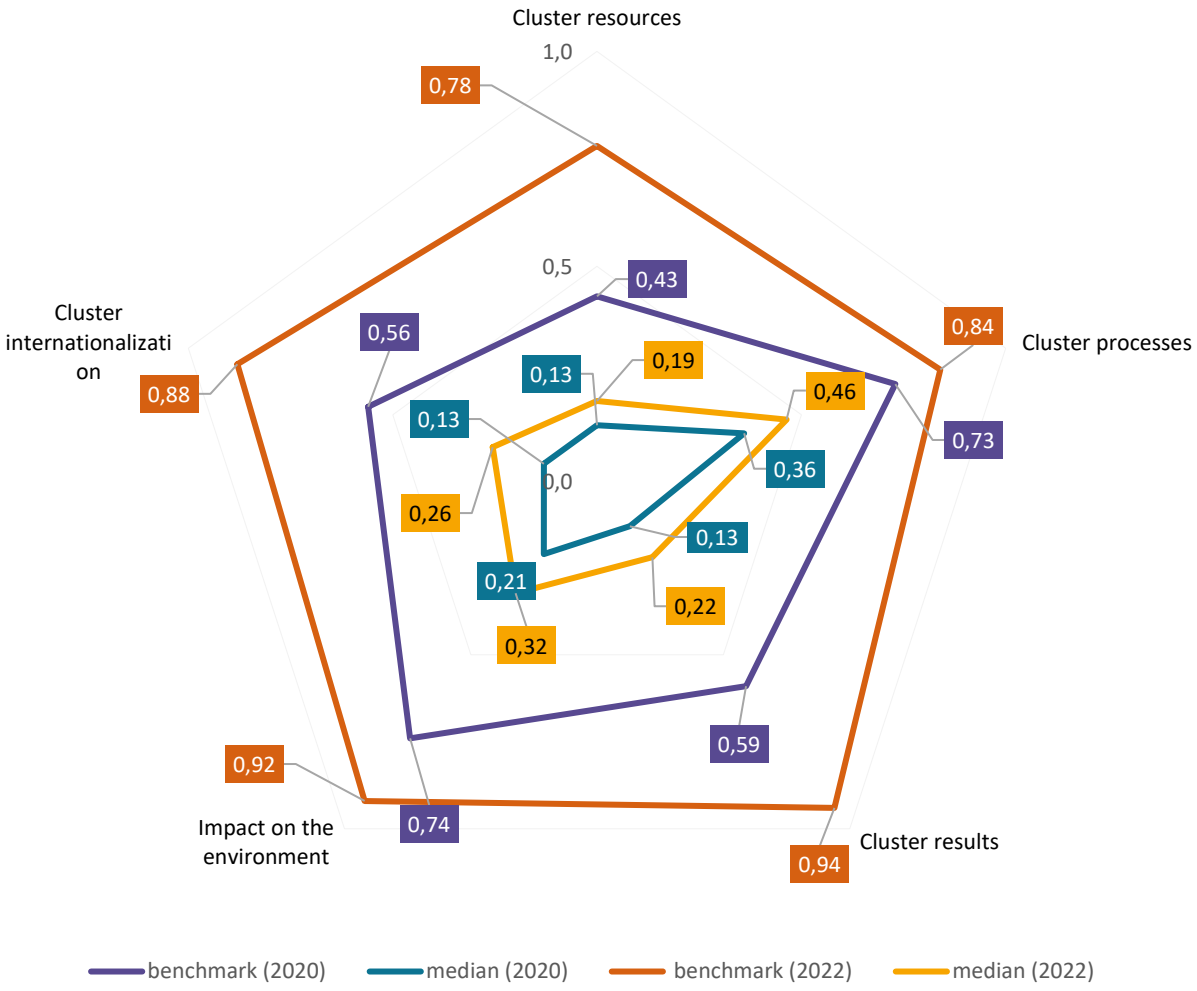
[61] In the current benchmarking edition, there are 88 partial indicators, whereas the 2020 edition had 114 indicators. Due to differences in indicators, calculation methods for benchmarks, and a different set of clusters, direct comparison of results between editions is not reliable. Comparisons between individual areas can still provide valuable insights.

[62] The unitarization process is employed to normalize variables, ensuring they have a uniform range of variability, with a difference of 1 between their maximum and minimum values. More details can be found in the statistical annex.

[63] According to the NUTS classification in Poland, 7 macro-regions can be distinguished (as of January 1, 2021). Despite the fact that the Mazowieckie Voivodeship has the status of a separate macroregion, clusters from this area were analyzed together with units from the central macroregion (Łódź and Świętokrzyskie Voivodships) to simplify the analysis.

First, the analysis was conducted for the KKK and other clusters. For each criterion, the KKK achieved better results, measured by both the median and the benchmark, than the other clusters. Analyzing the median values, the most significant difference in cluster development was in the area of resources and results, while the smallest difference was in internationalization. When examining the benchmark values, it is notable that within the examined group of clusters, there are structures that attain very high results in resources and processes. This indicates that highly developed clusters do not necessarily desire or have not yet attained the status of KKK.

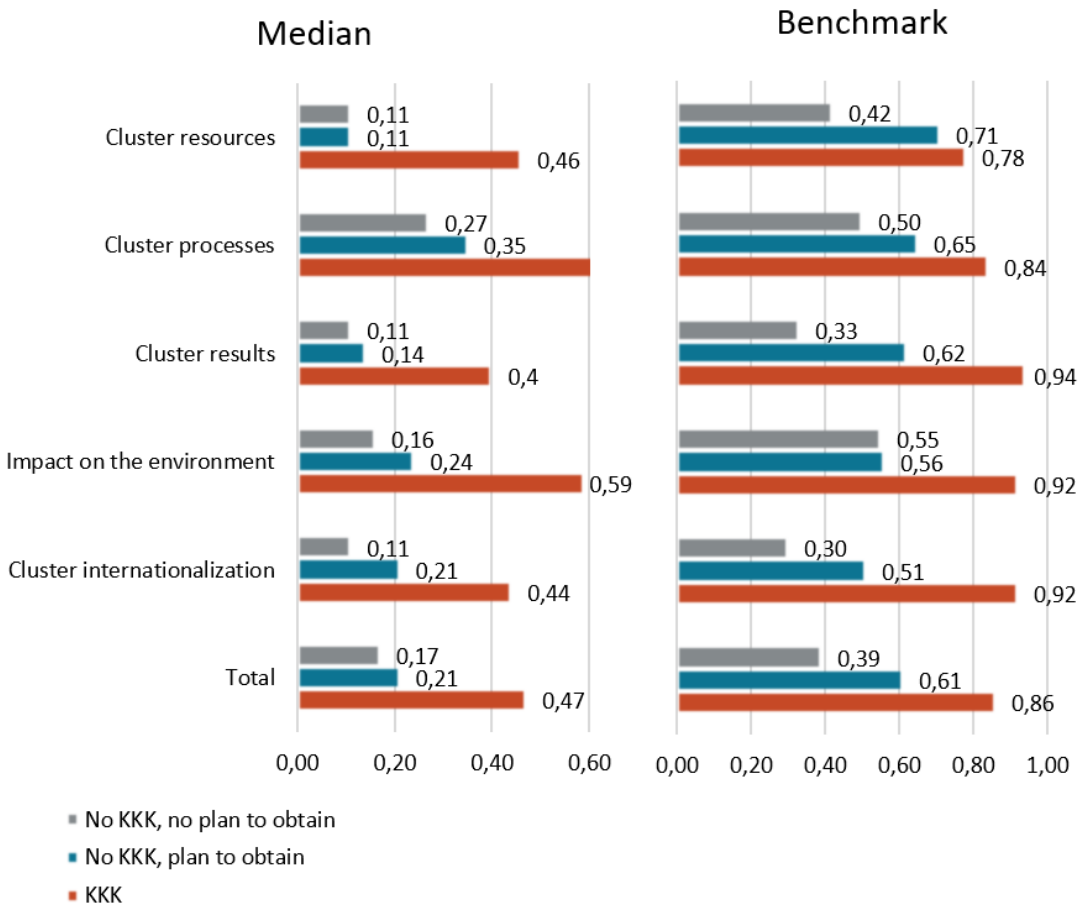
Graph 13. Median and benchmark values for the 2020 and 2022 study editions.



Source: own elaboration based on research involving cluster coordinators (N=41).

Initially, the analysis focused on comparing the KKK cluster with other clusters based on various criteria. The results indicated that KKK outperformed the other clusters in both median and benchmark values. The most significant disparity between clusters was observed in the areas of resources and results, while the smallest difference emerged in internationalization. It is noteworthy that within the examined cluster group, there are other highly developed structures that achieve exceptional results in resources and processes, even though they may not have attained the same status as KKK. This suggests that highly developed clusters may not necessarily aspire to or have achieved KKK status thus far.

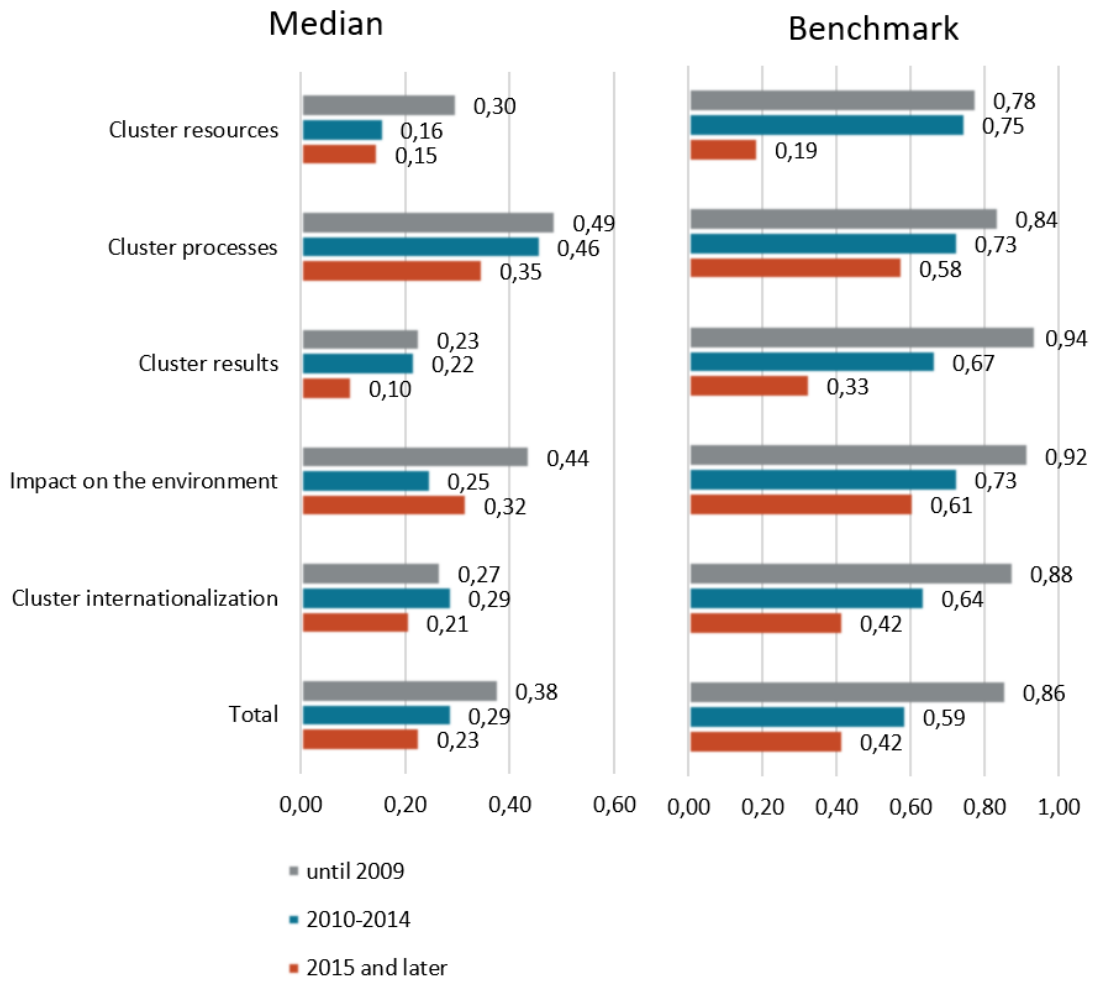
Graph 14. Values of the median and synthetic benchmarks by KKK and other clusters



Source: own elaboration based on research involving cluster coordinators (N=41).

The age of the clusters was also considered a criterion in the analysis, revealing a noticeable impact of the clusters' operational periods on the results across different areas. The most substantial differences were observed between young clusters established in 2015 and later and other clusters. These differences were particularly pronounced in the areas of cluster resources (median), cluster internationalization, and cluster performance (benchmark). The significant gaps between the median and benchmark values indicate that a specific group of clusters, particularly the young ones, achieved a remarkably high level of development that exceeded the overall average and median for all clusters. Further analysis examines the characteristics of these top-performing clusters in specific areas.

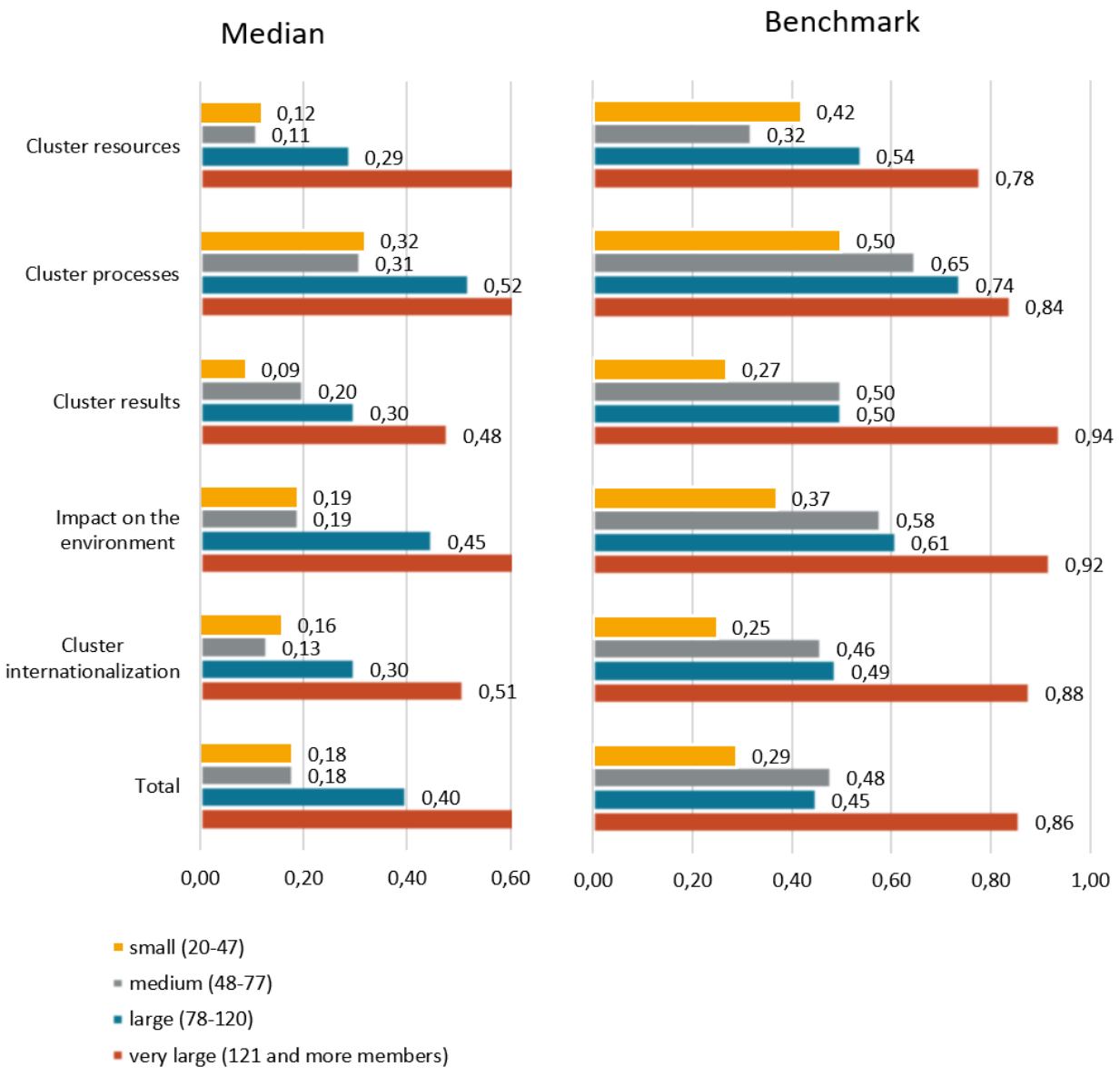
Graph 15. Values of the median and synthetic benchmarks, considering the year of establishing the clusters



Source: own elaboration based on research involving cluster coordinators (N=41).

The analysis also explored the relationship between the number of cluster members and the benchmarking results. Clusters were categorized into four groups based on their size: 20-47 members, 48-77 members, 78-120 members, and 121 members or more. It was observed that clusters with a small number of members tended to perform poorly in areas such as cluster internationalization and cluster performance. In contrast, clusters with over 121 members consistently achieved high positions across all researched areas. Interestingly, smaller structures excelled in terms of processes within the cluster.

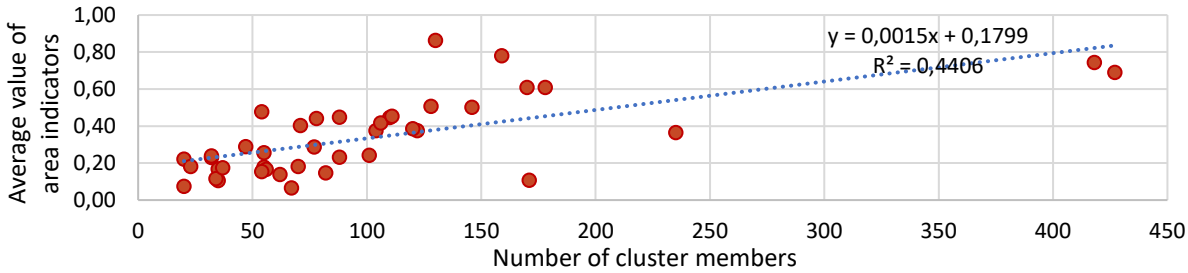
Graph 16. Median values and synthetic benchmarks by area and number of members



Source: own elaboration based on research involving cluster coordinators (N=41).

The earlier findings are reaffirmed in the diagram depicting the connection between member count and the average values of synthetic indicators across different areas. Each point on the table corresponds to one cluster included in the analysis. The trend line is distinct, revealing that only a handful of clusters with less than 50 members attained favorable benchmarking outcomes. Additionally, it's important to note that the parameter with the "x" variable, which represents the number of cluster members, has increased in value compared to the previous study edition. This underscores the growing importance of cluster size in the overall benchmarking evaluation.

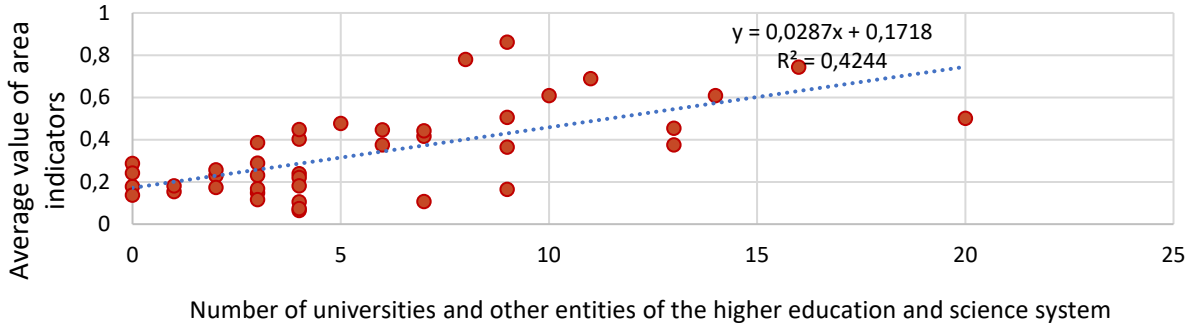
Graph 17. Relationship between the number of cluster members and the average cluster score for benchmarking areas



Source: own elaboration based on research involving cluster coordinators (N=41).

There is a positive correlation between the number of universities and other entities in the higher education and science system within a cluster, and the average value of synthetic indicators for each area. However, it is interesting to note that among the four clusters that participated in the study, none included any universities or entities from the higher education and science system. In the previous edition of the study, there was only one cluster with such members. Surprisingly, the cluster with the highest number of these members (20) scored relatively low in benchmarking, contradicting the observed trend.

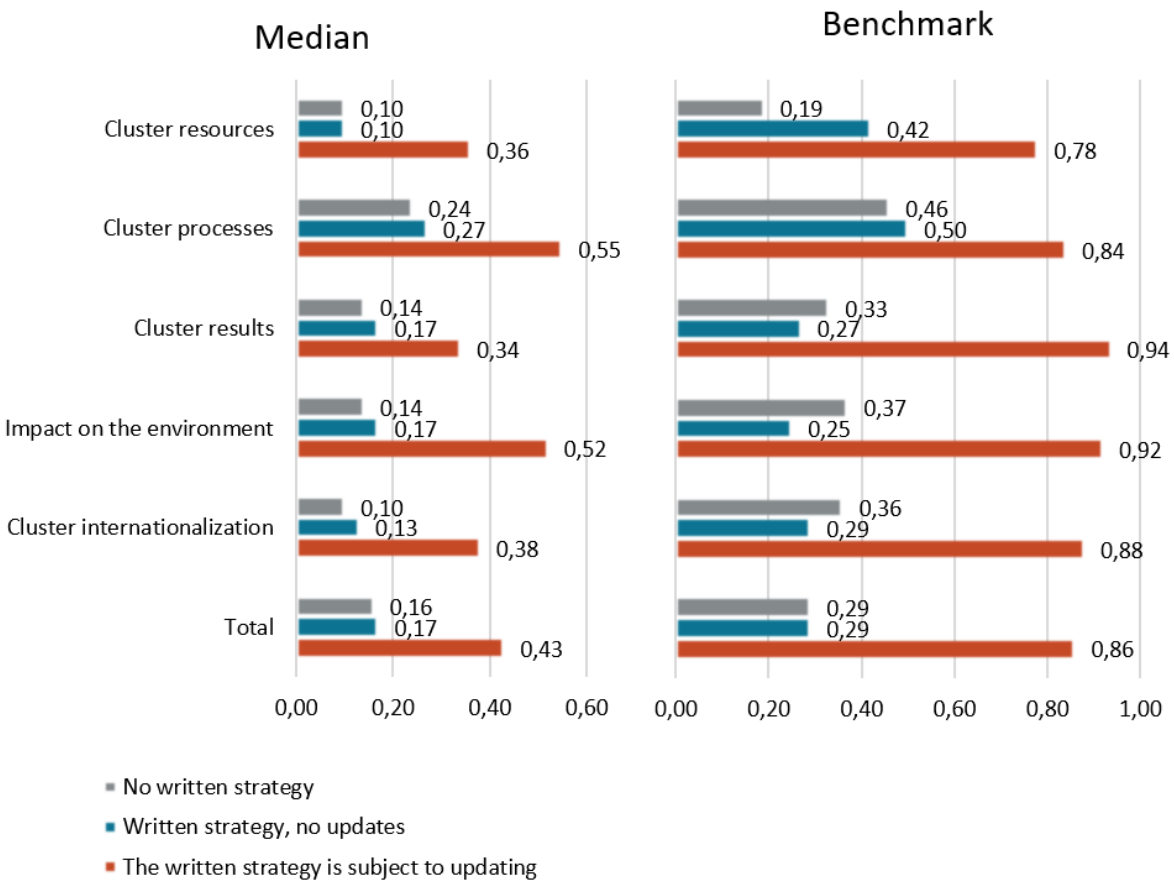
Graph 18. Relationship between the number of scientific units in a cluster and the average cluster score for benchmarking areas



Source: own elaboration based on research involving cluster coordinators (N=41).

In the current edition of the study, clusters are categorized into three groups based on their activity strategy and its update: clusters with a written strategy that is updated (26 clusters), clusters with a strategy that is not updated (9 clusters), and clusters without a written strategy (6 clusters). A comparison of their results clearly shows that clusters with an updated strategy achieve significantly better outcomes than the other groups. None of the clusters without a strategy or with an unupdated strategy attained a high position in the study, as indicated by their low benchmark values. Interestingly, there is no notable difference between clusters without a strategy and those with a strategy but lacking updates. It is concerning that the majority of clusters in this group (12 out of 15) were established before 2015, indicating medium-aged and mature clusters. This suggests that despite their long period of operation, these clusters were unable to establish a solid foundation for their activities, resulting in average or low performance in benchmarking.

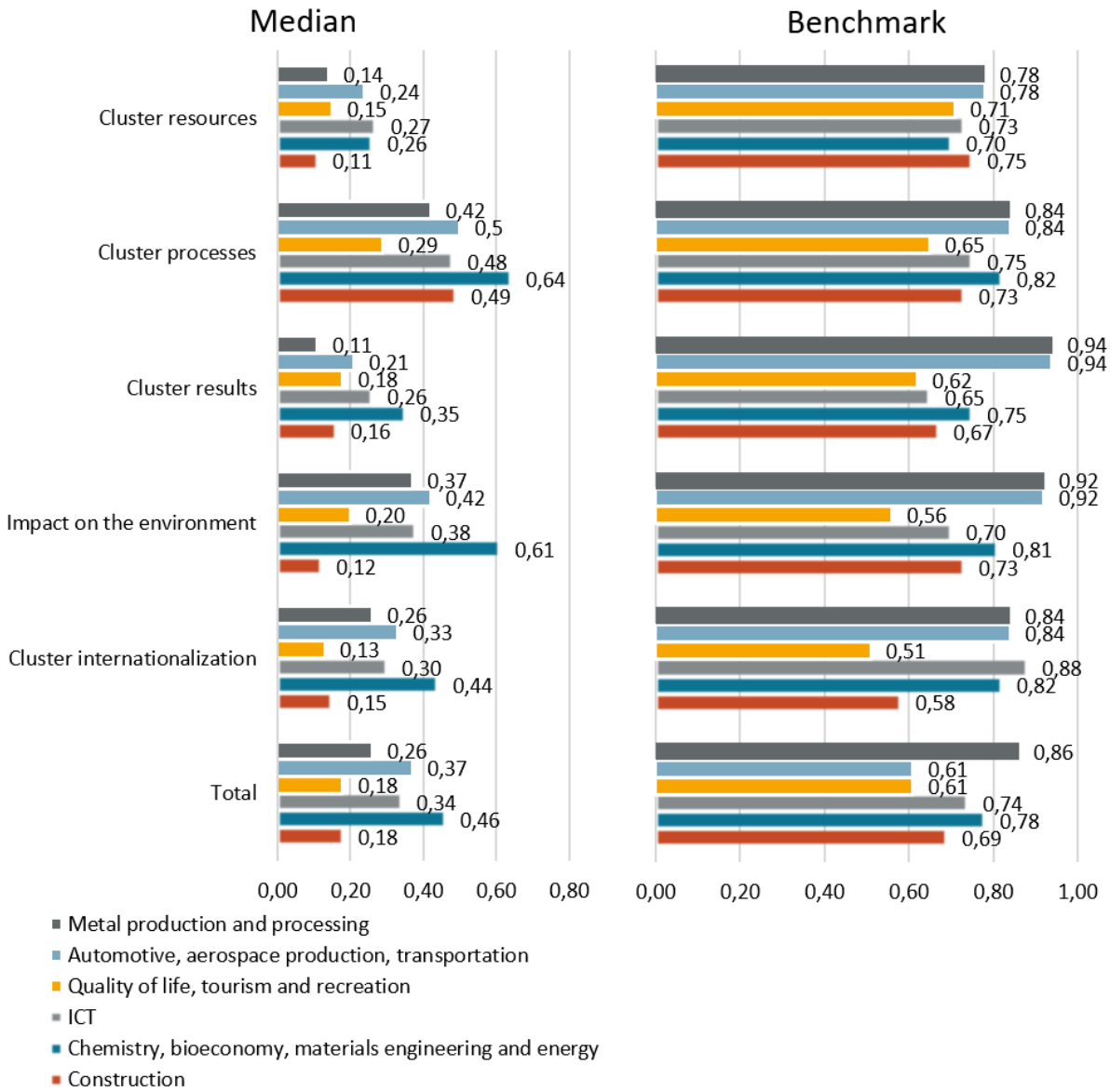
Graph 19. Values of the median and synthetic benchmarks, considering having a cluster strategy and its update



Source: own elaboration based on research involving cluster coordinators (N=41).

The final area of comparison focused on the industry represented by each cluster, divided into six industry groups. In terms of median results, the chemical, bioeconomy, material engineering, and energy industries demonstrated the highest performance, receiving the best grades in four out of five areas. Conversely, the construction industry and the quality of life, tourism, and recreation industries performed poorly, receiving low scores in most areas. However, when considering the benchmark analysis, the situation was more balanced. This indicates that within each sector, there is at least one cluster achieving very high scores in benchmarking, suggesting strong performance.

Graph 20. Median values and synthetic benchmarks by industry



Source: own elaboration based on research involving cluster coordinators (N=41).

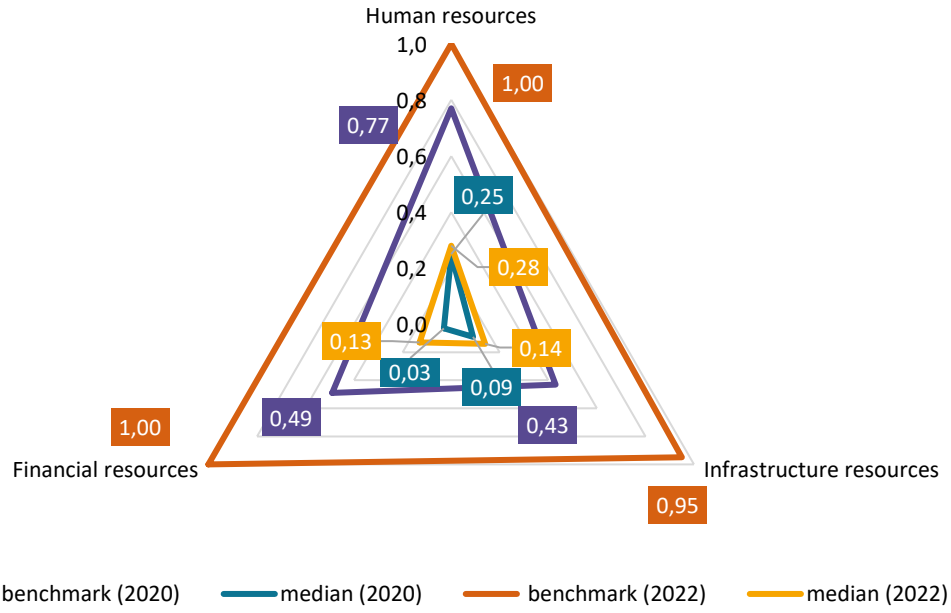
5.1. Cluster resources

For the study, "Cluster resources" were assessed in three sub-areas:

- **Human resources –** employment in all cluster member entities was surveyed, including the number of people working in cluster enterprises, the number of research workers involved in cluster work, and the coordinating staff delegated to support the cluster.
- **Infrastructure resources –** within the sub-area, the availability and adaptation of research, production, and IT infrastructure to meet the needs of cluster members were assessed.
- **Financial resources** – in this sub-area, the cluster's budget was examined, encompassing self-financing, public financing, and the availability of financial instruments for cluster members.

In terms of "Cluster resources," the benchmark values for two out of three areas reached the maximum score of 1.00, indicating that one cluster in the surveyed population achieved the highest scores across most indicators. The median score for this area was 0.28. Among the three sub-areas, the human resources aspect of the cluster received the highest ratings, with a benchmark value of 1.00 and a median score of 0.28. This represented an improvement compared to the values obtained in the 2018 edition of the study, with an increase of 0.03 in the median score and 0.23 in the benchmark score.

Graph 21. Values of subsynthetic indicators in the area of cluster resources for the 2020 and 2022 research editions.

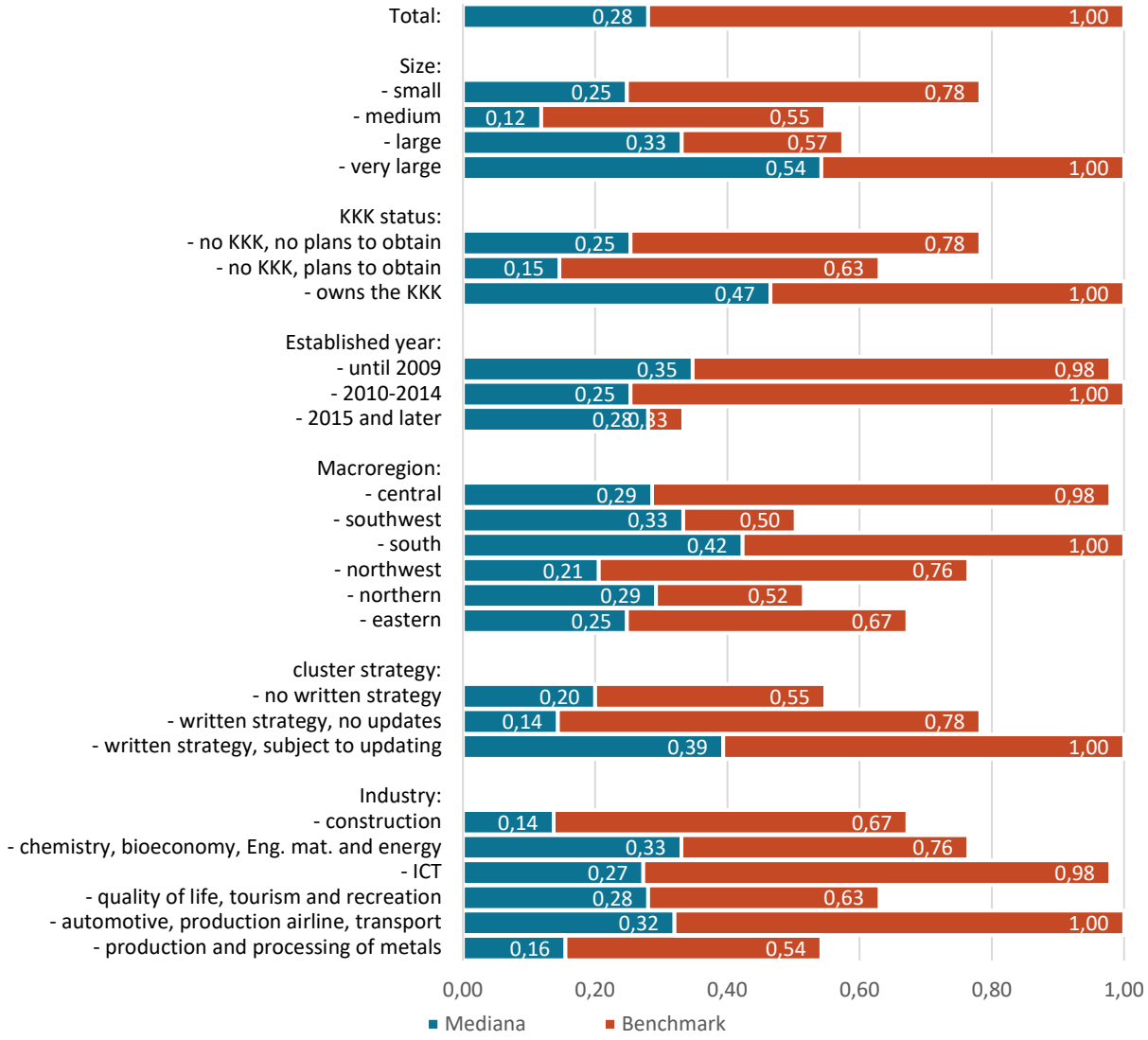


Source: own elaboration based on research involving cluster coordinators (N=41).

5.1.1. Human resources

The assessment of human resources within clusters was conducted based on the median and benchmark values, considering the most important criteria relevant to clusters. The data provides insights into the performance of clusters in this particular sub-area. The median score for human resources indicated that clusters, particularly very large clusters, achieved a relatively higher score of 0.54, suggesting better performance in terms of human resource-related criteria. Additionally, KKK clusters obtained a median score of 0.47, reflecting their positive performance in this aspect.

Graph 22. Median and benchmark for the human resources sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

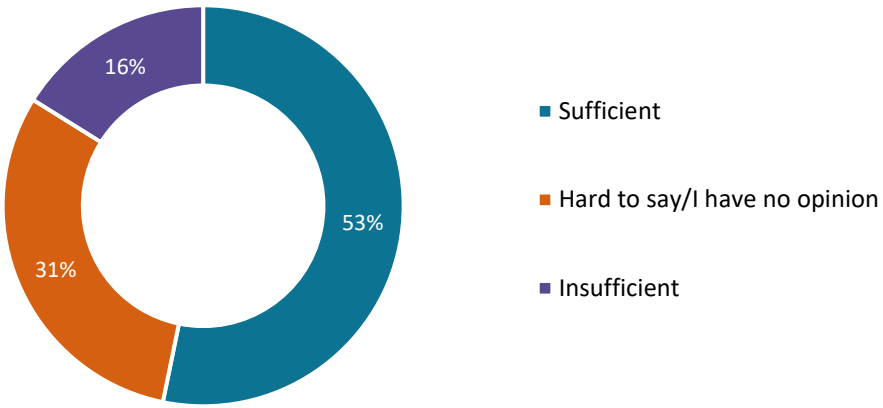
The findings indicate that the timing of cluster establishment does not significantly impact the results obtained regarding human resources. Even the youngest clusters had sufficient time to develop an appropriate level of human resources. However, clusters with a written strategy that is subject to updates demonstrate a clear advantage in this area.

In terms of geographical location, clusters from the southern and south-western macroregions achieved the highest scores in human resources, with median values of 0.42 and 0.33, respectively. Conversely, clusters in the construction and metal production and processing industries were found to be weaker in terms of human resources.

The benchmark values indicate that the top-performing cluster in terms of human resources achieved a perfect score of 1.00. This signifies that there was a cluster within the surveyed population that attained maximum scores across all partial indicators in the human resources sub-area. This specific cluster was established between 2010 and 2015, held the status of KKK, and consisted of over 120 members.

Regarding the satisfaction of cluster members with the number of employees in the cluster coordinators' staff, 53% of respondents deemed it sufficient, while approximately 16% expressed the opposite opinion. Expectations have risen compared to the previous edition, where 58% found the staff sufficient and 11% considered it insufficient. It is noteworthy that cluster coordinators account for this aspect by analysing members' opinions as part of their own survey.

Graph 23. Evaluation of the coordinator's staff dedicated to servicing cluster entities



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 3. Analysis of partial indicators for the human resources sub-area

Indicator	Comment
Employment across all cluster members	Average: 18.0 thousand people, median: 13.2 thousand people, benchmark: 105.8 thousand people[64]. Only two clusters had total employment that did not exceed 1,000 people. Conversely, one cluster appeared in the ranking with total employment of nearly 106,000 people. Significant differences in employment among cluster members can be observed in terms of this indicator.
Number of people working in cluster enterprises	Average: 11.8 thousand people, median: 7.5 thousand people, benchmark: 75.0 thousand people. In this case, there were five clusters with employment not exceeding 1,000 people among enterprises. This indicates that in some small clusters, employment in other types of institutions (primarily universities and other entities of the higher education and science system, as well as local government units) plays a significant role.
Number of researchers involved in the cluster's activities	Average: 22.3 people, median: 10.0 people, benchmark: 300.0 people. The highest result was obtained by a cluster that does not have the status of a KKK but can boast a significant involvement of the university in its activities. In the case of three clusters, the involvement of scientists was not indicated, and for the next twelve clusters, this number did not exceed five people.
Number of employees in the cluster coordinator team	Average: 6.1 people, median: 4.0 people, benchmark: 18.0 people. Five clusters are operated by one or two people. This may indicate increased activity among the majority of cluster coordinators (in the previous edition of the study, the employment of one to two persons per coordinator was the case for nearly half of the clusters). For nine clusters, the number of people coordinating activities was greater than or equal to ten (but for none of the clusters did it exceed twenty).

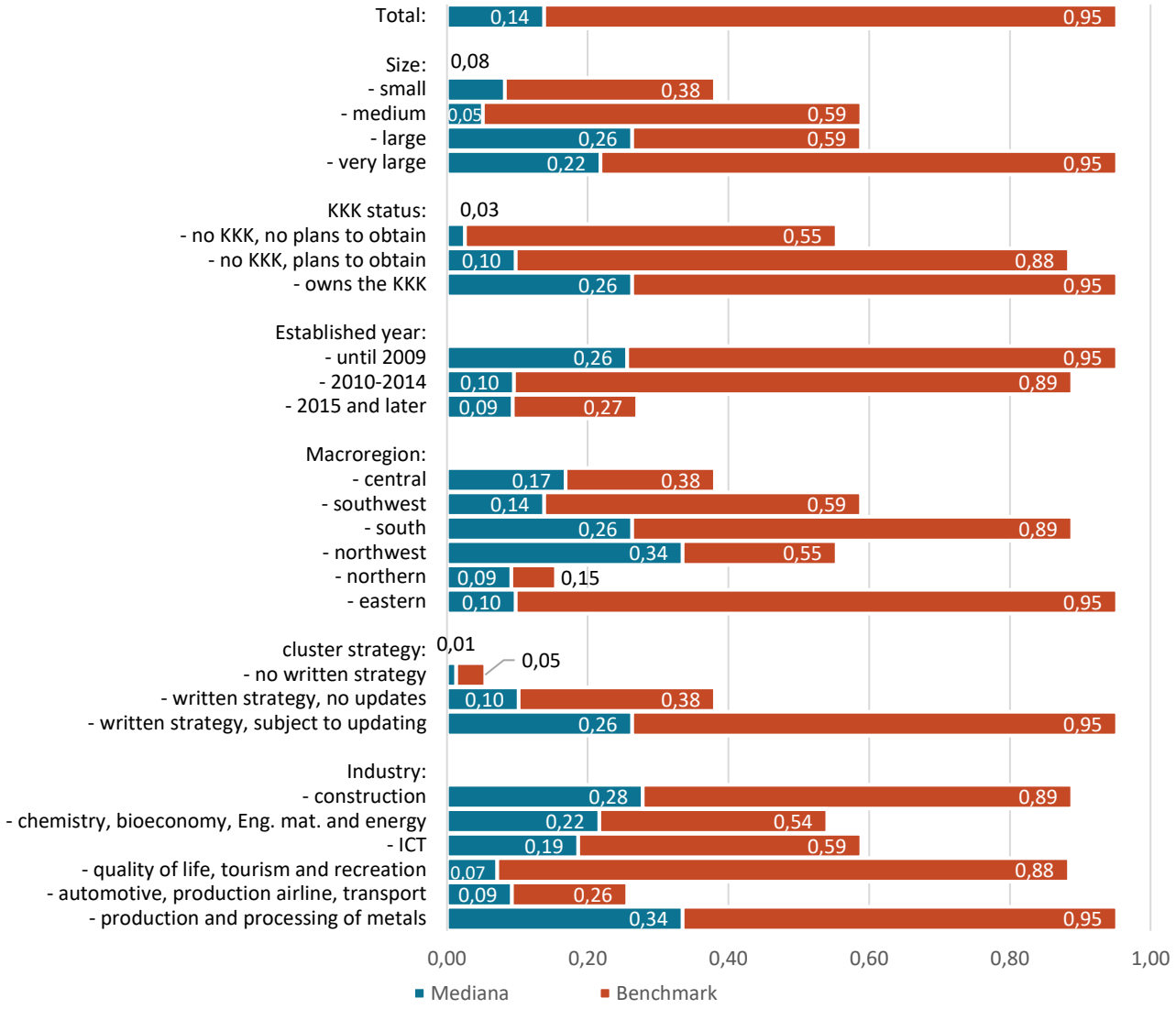
Source: own elaboration based on research involving cluster coordinators (N=41).

[64] The study acknowledges the presence of extreme values in certain indicators, which can lead to an overestimation of the average value and a concentration of unitary variables towards lower values. To address this issue, a method was employed to cut off extreme values using quartiles (Q1 and Q3) and the interquartile range (IQR). Specifically, the upper cutoff for extreme values was set at Q3 + 1.5 times the IQR. This approach is commonly used in statistical and econometric literature and helps mitigate the influence of extreme values on the analysis. By implementing this method, the study aims to reduce the dominance of specific clusters and create a more balanced representation across different cluster groups (poor, average, good).

5.1.2. Infrastructure resources

In the analysis of infrastructural resources, it is clear that the median values are generally low, indicating a significant number of clusters with a low level of development in this area. This trend mirrors the findings of the previous edition of benchmarking. Notably, clusters located in the north-western (0.34) and southern (0.26) macroregions performed relatively better compared to the overall median value (0.14). Furthermore, clusters established before 2009 (0.26) and those with the status of KKK (0.26) received relatively higher scores. Conversely, clusters without a written strategy scored very low, close to zero. In terms of industry, construction clusters (0.28) and metal clusters (0.34) achieved the highest median levels for infrastructural resources.

Graph 24. Median and benchmark for the infrastructural resources sub-area

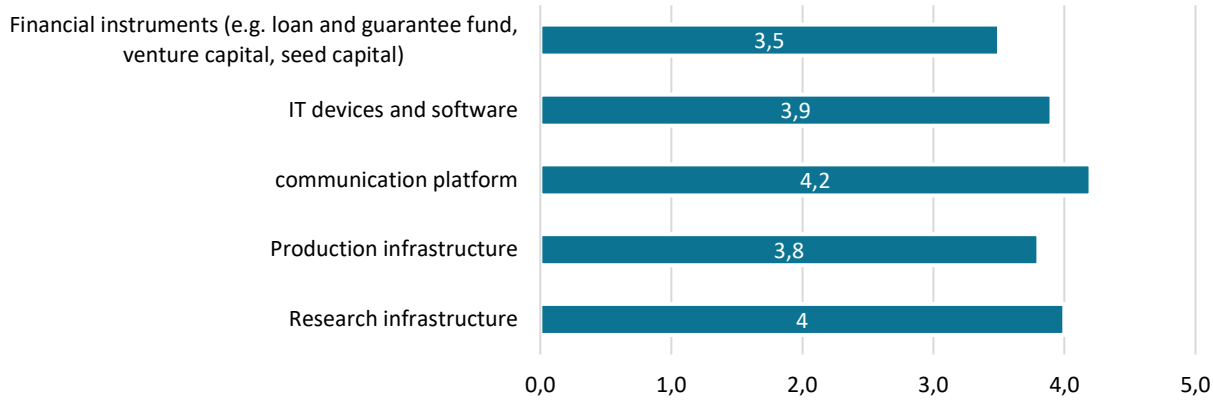


Source: own elaboration based on research involving cluster coordinators (N=41).

In the benchmark analysis, the highest scores for infrastructural resources were achieved by a very large cluster with over 120 members, holding the status of KKK and established before 2010. This indicates that such clusters have successfully developed strong infrastructural resources within their operations. Additionally, surveys were conducted to gather the opinions of cluster members regarding the availability of resources. The respondents used a rating scale of low, average, and high to assess the availability of these resources. These ratings were converted into numerical values, and the average scores for each type of infrastructural resource were calculated. According to the survey results, the accessibility of the premises of the communication platform received the highest rating, with an average score of 4.2. This indicates that the majority of respondents rated this resource as high in terms of availability. Similarly, research infrastructure was also rated highly, with an average score of 4.0.

On the other hand, the availability of financial instruments received the lowest rating, with an average score of 3.5. This indicates that there may be opportunities for improvement in this area. Cluster coordinators could consider strengthening their efforts in collaborating with industry-dedicated funds or exploring other avenues to enhance the availability of financial resources within the cluster.

Graph 25. Evaluation of the availability of resources in the cluster according to the surveyed organizations



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 4. Analysis of the values of partial indicators for the sub-area of infrastructural resources

Indicator	Comment
Research infrastructure available to the cluster, either owned or provided under contract	Average: 3,616 m2, median: 77 m2, benchmark: 100,000 m2. Research infrastructure is provided by 22 clusters. In the case of 12 of them, the available area does not exceed 1,000 m². The average value is significantly increased by two clusters declaring over 20,000 m² of available space. In turn, the low value of the median is related to the fact that 19 clusters did not declare any available research infrastructure.
The value of investments in research infrastructure available to the cluster, whether owned or provided through contracts[65]	Average: 11,094.1 thousand PLN, median: PLN 0.0 thousand PLN, benchmark: PLN 120.0 million PLN. Twenty-two coordinators declared that they had research infrastructure. Most of them (16) invest funds in its development simultaneously. The amounts vary dramatically, ranging from several thousand zlotys to over one hundred million zlotys.
Area of production infrastructure available for the cluster, owned or provided through agreements for cluster members	Average: 1,651 m2, median: 0 m2, benchmark: 38,000 m2. The median at the level of 0 m² indicates that more than half of the clusters do not offer production infrastructure. Among the 16 clusters providing production infrastructure, the majority were production clusters. The exceptions are two clusters focused on quality of life and one in the ICT area, which also reported making production infrastructure available to their members.
The value of investments in production infrastructure available to the cluster, whether owned or provided through contracts.	Average: 3,990.5 thousand PLN, median: PLN 0.0 thousand PLN, benchmark: 40.0 million PLN. Only nine clusters declared investments in production infrastructure. Notably, for five clusters, the value of investments exceeded PLN 10 million.
The number of features available in the IT platform cluster.	Average: 2.7, median: 3.0, benchmark: 7.0. From the list of 5 functions, the following were most frequently indicated: communication (83%), knowledge repositories (51%), and cooperation management (41%). Further positions were held by educational functions, such as e-learning (32%) and a group ordering platform (29%). The benchmark value exceeded the number of platform functions, as some clusters indicated additional functions. These include, among others: innovation exchange, job exchange,

[65] Unless otherwise specified in the question or comment, the inquiries about the report on the value of a specific indicator in the cluster (as in the case of investments in research infrastructure) involve totalling the value of the indicator for the analyzed periods of 2020 and 2021.

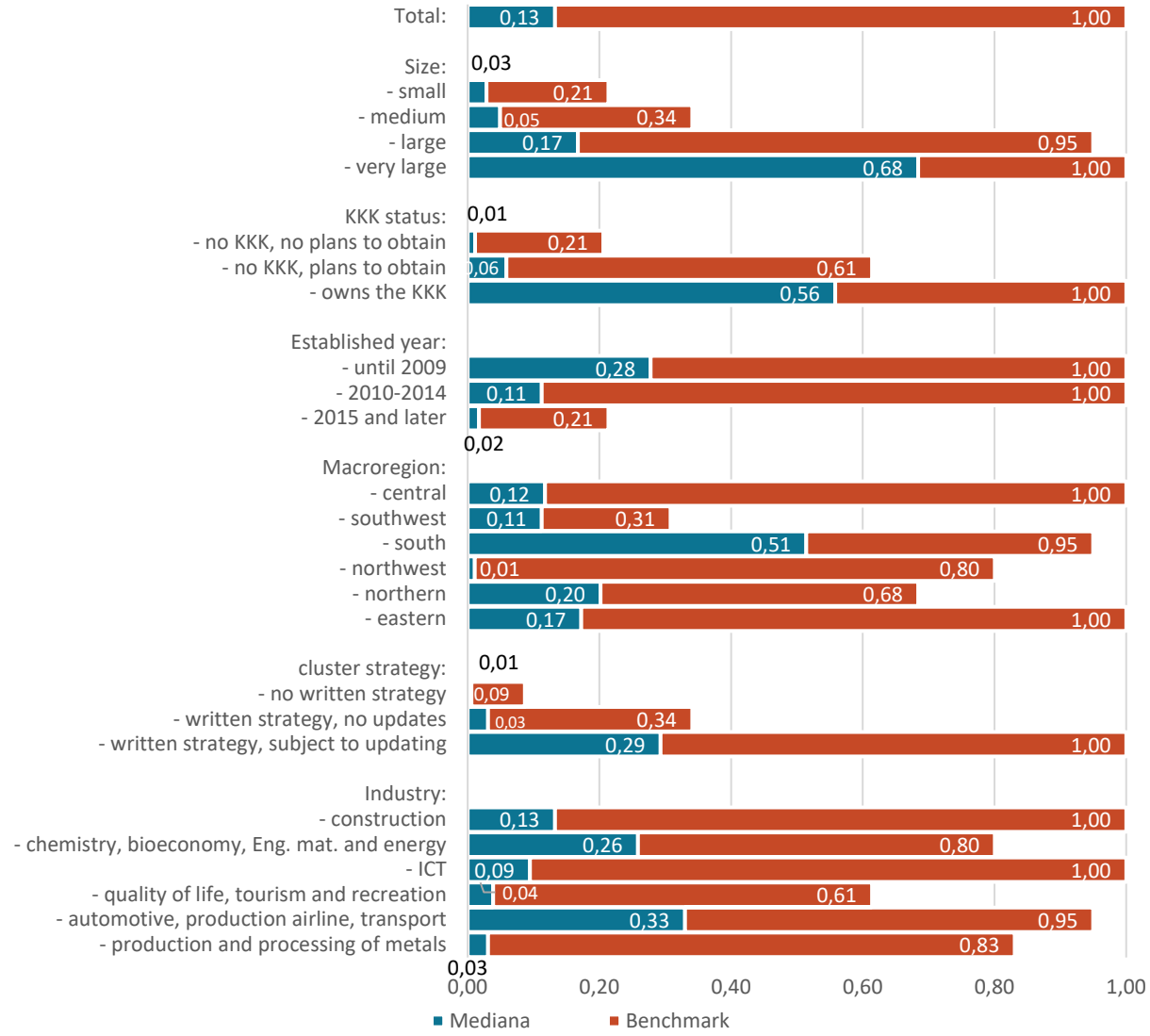
Indicator	Comment
	room rental, sales platform, spare production capacity management, or project management.
The value of investing in the cluster's IT infrastructure	Average: 1,812.6 thousand PLN, median: PLN 650.0 thousand PLN, benchmark: 50.0 million PLN. Twenty-two clusters recorded expenditures on IT infrastructure. The declared amounts vary widely, ranging from several hundred zlotys for small office equipment and computers to as much as PLN 50 million.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.1.3. Financial resources

The analysis of financial resources reveals a notably low median value across all clusters (0.13) and for most cluster categories. This indicates that a significant portion (at least half) of the examined clusters performed poorly compared to the top-performing dozen or so clusters in terms of financial resources. However, certain clusters stood out concerning financial resources. Very large clusters, consisting of over 120 members, had a median score of 0.68, indicating a stronger financial position. Similarly, clusters with KKK status achieved a median score of 0.56, showcasing their relatively robust financial resources. Additionally, clusters that have been operating since at least 2009 displayed higher median scores in this area.

Graph 26. Median and benchmark for the financial resources sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

Consistent with previous findings, clusters with a written strategy that is subject to updates received relatively higher ratings in terms of financial resources, achieving a median score of 0.29. This emphasizes the importance of having a well-defined and regularly reviewed strategy to enhance financial capabilities within the cluster.

In the studied group of clusters, two clusters achieved maximum scores (benchmark of 1.00) in the area of financial resources. These clusters, classified as very large clusters with over 120 members, demonstrated exceptional performance and effectiveness in managing their financial resources. This indicates that these clusters have successfully secured significant funding, whether through self-financing, public financing, or other means, and have established a solid financial foundation to support their activities.

Analysis of partial indicators for sub-areas

Table 5. Analysis of partial indicators for the financial resources sub-area

Indicator	Comment
Total cluster budget available to the coordinator for 2020 and 2021	Average: 2,342.0 thousand PLN, median: 150.0 thousand PLN, benchmark: PLN 37,950.0 thousand PLN. Clusters' budget, similarly to the previous edition, is characterized by great diversity. For 13 clusters, the available budget for the indicated two years exceeded 1 million PLN; however, for 11 clusters, the budget did not exceed 100,000 PLN. It is worth noting that in 2020, the average budget was PLN 1,048.8 thousand, while in 2021 it was already 1293.2 thousand (an increase of over 23%).
The value of the cluster's own funds	Average: 4,238.2 thousand PLN, median: PLN 122.3 thousand PLN, benchmark: 150,000 thousand PLN. As in the case of the budget, a large variation in the amount of the cluster's own funds can be observed. This is also evidenced by a significant disproportion between the mean and the median. The low value of the medians indicates that half of the clusters have own funds not exceeding PLN 122,000 zloty. The leader is a cluster in the area of automotive, aviation production, and transport with funds exceeding PLN 150 million.
The value of the cluster's public funds	Average: 2,762.0 thousand PLN, median: 45.0 thousand PLN, benchmark: PLN 36,385.6 thousand PLN. 25 clusters successfully obtained public funds for their activities. The value of the funds varied greatly, ranging from a few thousand zlotys to amounts equal to or exceeding PLN 20 million (three clusters).

Indicator	Comment
Financial instruments accessible to cluster members via the cluster (option request)	Average: 0.7, median: 0.0, benchmark: 4.0. From the list of four instruments, the following were most frequently indicated: loan fund (19%) and venture capital (19%). Additional positions included: guarantee fund (10%) and seed capital (10%). This is an area worth considering by cluster coordinators as a potential development area.

Source: own elaboration based on research involving cluster coordinators (N=41).

Area summary

- The analysis of "Cluster resources" encompassed three sub-areas: human, infrastructural, and financial resources. Overall, the assessment of human resources was relatively favourable, whereas the evaluation of financial resources was rated the lowest.
- In terms of human resources, the number of employees on the cluster coordinator's team, including those dedicated to supporting the cluster, was assessed. A considerable portion of clusters had 1-10 individuals serving as their coordinators. Cluster members generally evaluated this aspect positively, with only 16% viewing the number of personnel involved in cluster management as insufficient.
- It is worth highlighting that over 90% of clusters reported the involvement of research workers, indicating a positive sign of these clusters' activity. The engagement of research workers in clusters can play a crucial role in fostering R&D cooperation between enterprises and representatives from the science sector.
- Regarding infrastructural resources, cluster members generally rated the availability of these resources well, especially concerning the communication platform and research infrastructure. However, it is important to note that these assessments were mainly provided by cluster members who had actual access to such infrastructure.
- Across all sub-areas analyzed, very large clusters with a minimum of 120 members, KKK status, and a track record dating back to at least 2009 demonstrated an advantage. Regarding financial resources, the disparities between these clusters and the rest of the group were relatively significant, similar to the previous edition of the study.
- Cluster coordinators showed great activity in ensuring access to additional external sources of financing, including financial instruments. This proactiveness reflects their efforts to secure funding for cluster activities and initiatives.
- According to the opinions of cluster members, participation in the work of the cluster yielded substantial benefits, with 53.6% of respondents expressing positive views. Negative responses indicating no benefits accounted for only 2.8%. Additionally, a majority of surveyed cluster members (51.0%) believed that the premiums paid were commensurate with the benefits of participating in the cluster. Only 10.7% of respondents expressed a willingness to pay higher fees for additional services provided by the coordinator.

5.2. Cluster processes

The "Cluster processes" area focused on both internal and external activities conducted within the cluster. Several sub-areas were examined within this domain, including:

- **Management processes –** involve having strategic and operational documents, establishing specialized management bodies, researching the needs and satisfaction of cluster members, and implementing quality standards in cluster enterprises.
- **Cluster communication –** encompasses direct contacts within clusters (meetings) and the use of communication tools.
- **Market activity –** includes cooperation within the value chain (such as joint procurement and distribution), revenues generated by cluster members, and the value of online sales.
- **Marketing activity –** refers to media presence, joint promotional and marketing initiatives, including collaborative fair and exhibition activities.
- **Innovative activity –** entails the availability and use of pro-innovation services in clusters, the presence of institutions that support technology transfer, the acquisition of knowledge and technology for cluster needs, and the assessment of technological potential in cluster companies.
- **Cluster digitization –** indicates the degree of digitization among cluster members, specifically the use of IT systems and Industry 4.0 technological solutions.

Processes within the cluster were analysed using a set of 24 indicators.

The updated analysis in dynamic terms shows some changes in the performance of clusters in the "Cluster processes" area compared to the previous edition of the study. Specifically, there has been an increase in the median values in five sub-areas: management processes, market activity, marketing activity, innovative activity, and digitization of the cluster.

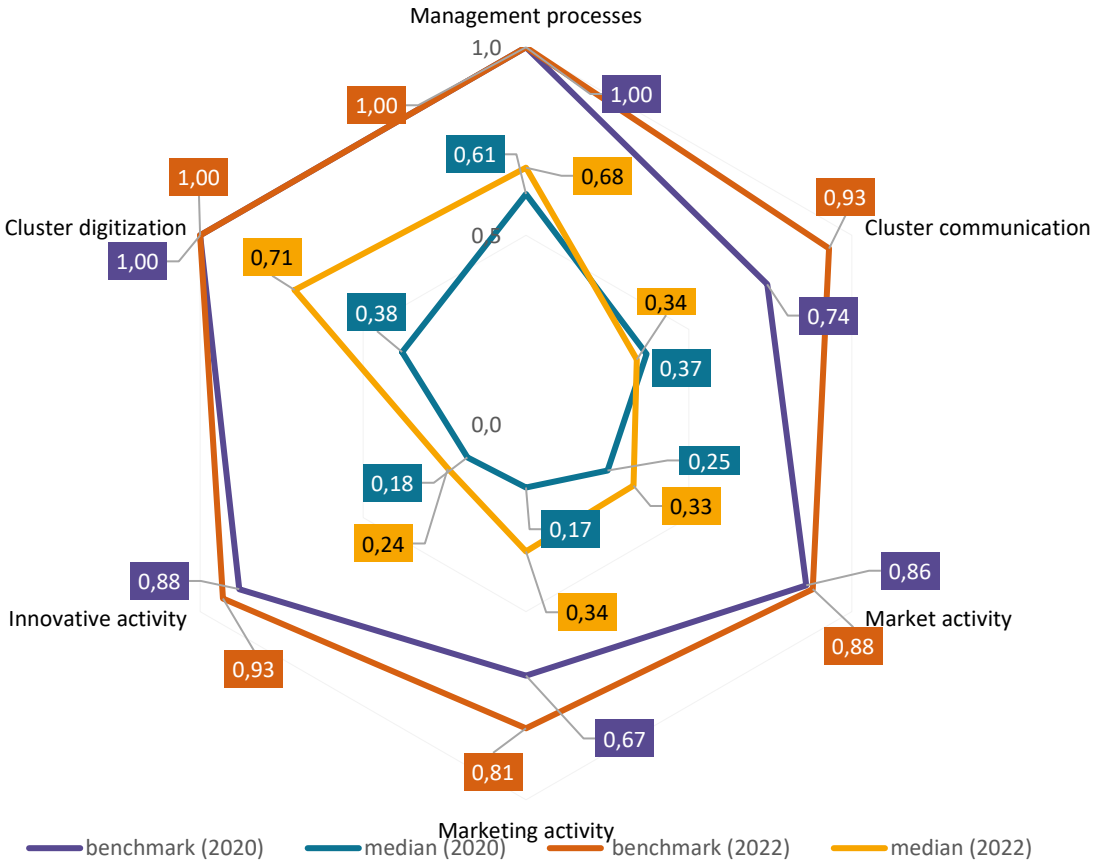
The sub-area of digitalisation within the cluster currently has the highest rating, with a median value of 0.71. This indicates that clusters have made significant progress in adopting digital technologies and utilising them for their operations and activities.

Furthermore, the benchmark analysis reveals that certain sub-areas have achieved very high scores, either equal to or close to 1. This indicates the presence of several clusters within the surveyed population that have attained maximum or near-maximum scores for the indicators within those sub-areas. Specifically, the sub-areas of digitization of the cluster and management processes stand out with such high benchmark values.

Comparing the current results to those of the 2020 edition, there has been an overall increase in performance in each sub-area within the "Cluster processes" domain. This suggests that

clusters have advanced in various aspects related to management, market engagement, innovation, communication, and digitization.

Graph 27. Values of subsynthetic indicators in the area of processes in the cluster for the 2020 and 2022 editions of research[66]



Source: own elaboration based on research involving cluster coordinators (N=41).

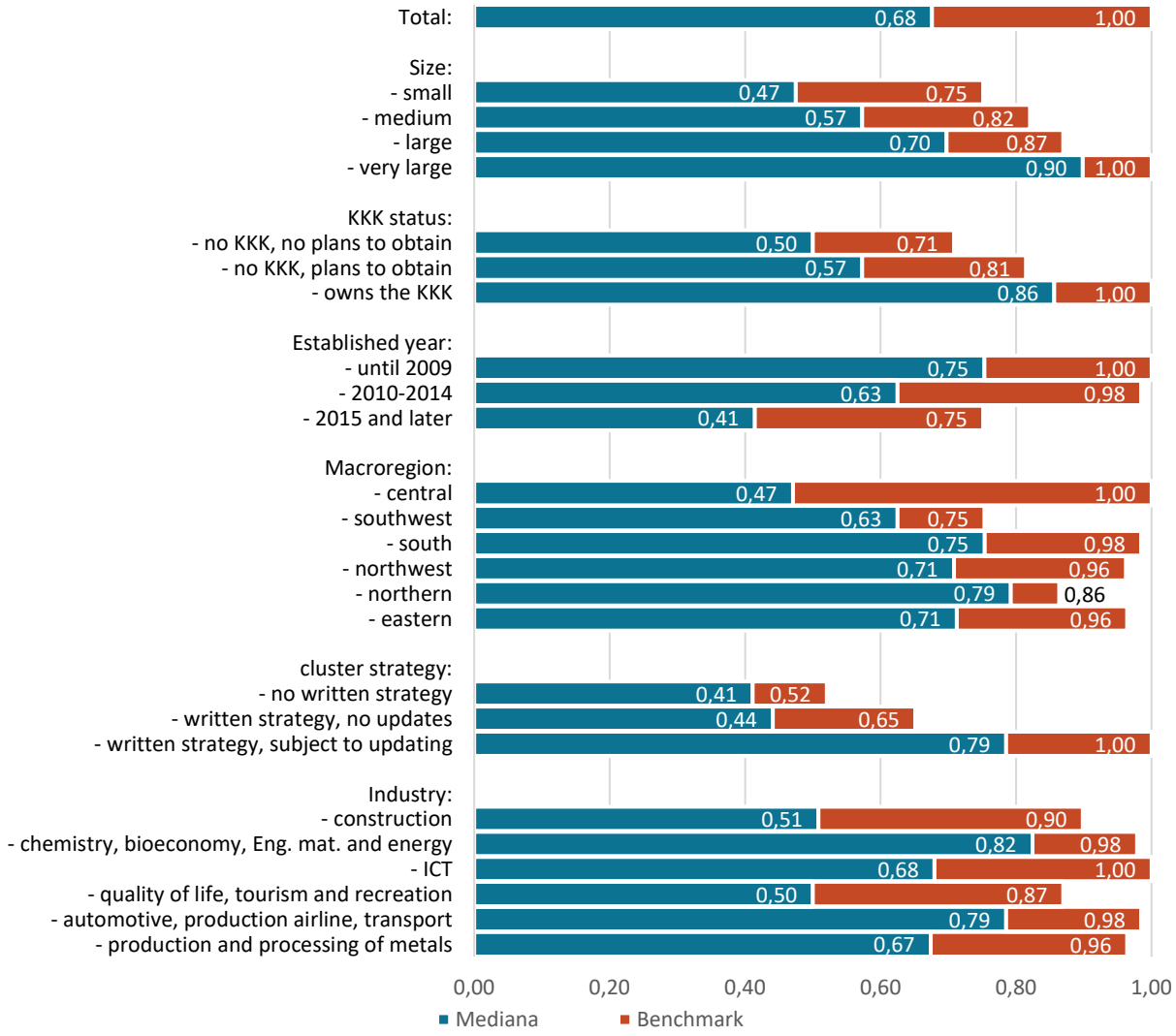
The analysis of the cluster digitization sub-area reveals that clusters have achieved a very high level of digitization. This is indicated by the median value of 0.71, which signifies significant progress in adopting digital technologies and integrating them into cluster operations and activities. Additionally, the maximum benchmark value of 1.00 suggests that there were clusters within the surveyed population that demonstrated exceptional performance in terms of digitization. Furthermore, the absence of clusters categorized as very weak or not undertaking any digitization activity indicates a positive trend. It suggests that clusters have recognized the importance of digitization and have taken proactive measures to incorporate digital technologies and processes into their operations.

[66] In the 2020 edition of the study, the sub-area "Cluster digitization" was equivalent to the "Cluster digitization" sub-area.

5.2.1. Management processes

The management processes sub-area showed relatively high median values across the entire sample and different cluster types. This indicates that the performance gap between the top clusters and the others in this sub-area was minimal. Specifically, clusters classified as KKK recorded a median index of 0.86, reflecting strong management processes. Likewise, clusters with a written strategy for updates (median 0.79), those operating for at least 10 years (median 0.75), and clusters with a minimum of 121 members (median 0.74) also yielded favorable management process results. In the benchmarking analysis, the top scores were achieved by a particular cluster that satisfied several criteria: it was a very large cluster with over 121 members, held KKK status, was established before 2010, and had a written strategy for updates.

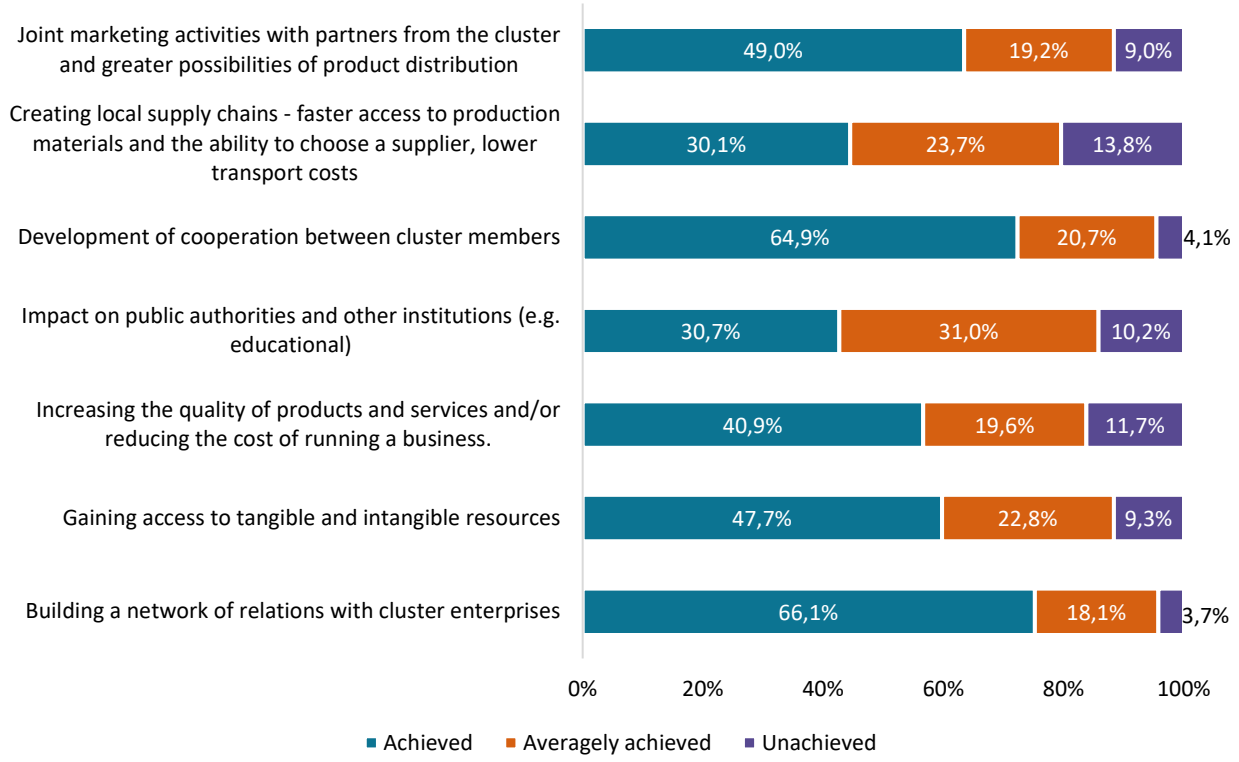
Graph 28. Median and benchmark for the management processes sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

According to the assessment of cluster members, management processes were evaluated based on their perceived achievement of goals. The highest positive ratings were given to the areas of building a network of relations with cluster enterprises, with 66% of respondents providing positive assessments, and the development of cooperation between cluster members, with 65% positive ratings. These results indicate that cluster management was successful in fostering collaboration and establishing productive relationships within the cluster. On the other hand, the lowest scores were observed in the implementation of objectives related to creating local supply chains, where only 30% of respondents provided positive assessments and 14% expressed negative evaluations, the highest negative value recorded. Similarly, in the areas of improving the quality of products and services or reducing the costs of doing business, 30% of respondents rated it positively, while 12% gave negative assessments. Additionally, the impact on public authorities and other institutions received 31% positive ratings and 10% negative ratings.

Graph 29. Degree of achievement of development goals in the cluster from the point of view of the examined organization



Source: own elaboration based on a survey of cluster members (N=642).

The majority of respondents (70%) expressed that their participation in the cluster was associated with substantial benefits. This indicates a favourable perception of the value and advantages that cluster membership provides. Notably, this percentage has increased

compared to the previous edition of the survey, where 50% of respondents believed that participation in the cluster was highly beneficial. This suggests an enhancement in the perceived value and positive outcomes experienced by cluster members over time. Furthermore, it's important to highlight that the percentage of respondents who held the opposing view, suggesting that the benefits of cluster participation were minimal, decreased from 41% in the previous edition to 26% in the current edition of the survey.

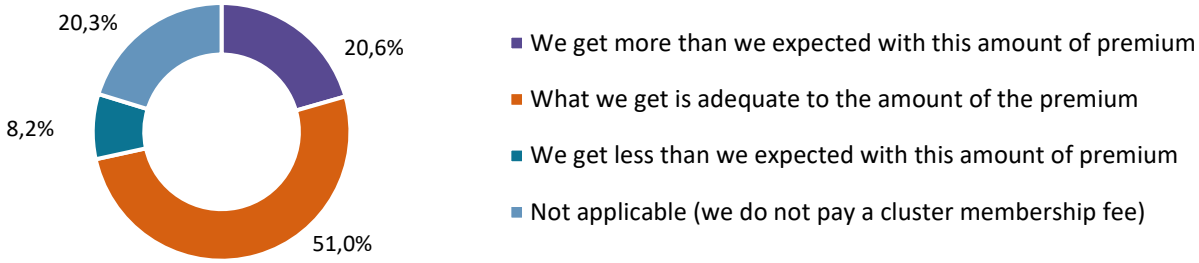
Graph 30. Scale of benefits from participation in the cluster

Source: own elaboration based on a survey of cluster members (N=642).

It is notable that more than half of the cluster members (51%) believed their contribution, typically in the form of membership fees, was appropriate relative to the benefits they derived from participating in the cluster. This indicates general satisfaction with the value proposition and perceived return on investment from being part of the cluster.

In contrast, only 8% of respondents believed that the benefits gained from cluster participation were not commensurate with the membership fee.

Graph 31. Adequacy of the premium amount to the benefits obtained



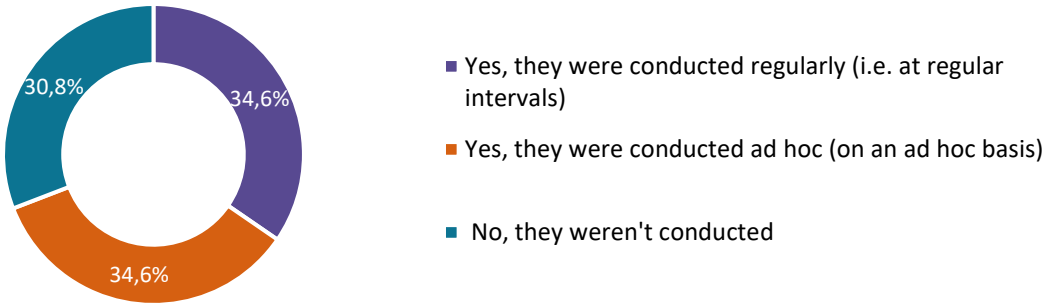
Source: own elaboration based on a survey of cluster members (N=642).

It is interesting to note that a relatively small percentage of cluster members (10.7%) expressed their willingness to pay higher fees to receive additional services from the cluster coordinator. This indicates that, while there is some demand for additional services, the majority of members may consider the existing membership package sufficient for their needs.

Among the members willing to pay higher fees, the average amount they were prepared to pay was PLN 10.5 thousand per year. This indicates the financial expectations of these members regarding the value they seek in exchange for increased fees. The additional services most frequently mentioned by cluster members as potential areas for improvement included promotion, marketing support, internationalization activities, training (including specialized training), networking opportunities within the cluster, and networking with external entities.

Cluster members' opinions provide valuable insights into the quality of cluster coordination. Two-thirds of surveyed cluster coordinators actively seek feedback through needs and satisfaction surveys. Among cluster members, 34% reported that regular surveys were conducted in their cluster over the past two years, while 35% indicated that ad hoc surveys had taken place. These findings align with the results from the 2020 edition, demonstrating consistency in survey practices.

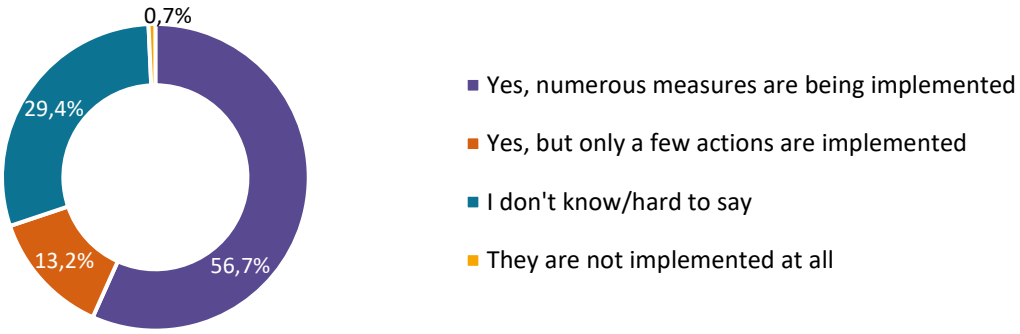
Graph 32. Research on the needs or satisfaction of cluster participants



Source: own elaboration based on a survey of cluster members (N=642).

More than 29% of respondents were uncertain or found it challenging to determine whether improvement actions were implemented based on research results to better address participant needs and increase satisfaction within the cluster. However, 57% confirmed the implementation of numerous improvement activities. Only 1% of members believe that coordinators do not take any action to improve the cluster.

Graph 33. Implementation of improvement actions



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 6. Analysis of the values of partial indicators for the sub-area of management processes

Indicator	Comment
Formulating and updating the cluster strategy	Sixty-three per cent of clusters have a written strategy that is subject to updating. Another twenty-two per cent of clusters have a written strategy but do not update it. Fifteen per cent of clusters do not have a written strategy. In addition to general provisions, the strategy may also address various specific areas of cluster operation. In this regard, the strategy's provisions most commonly include digitization of the cluster (49%), green reorientation/transformation (39%), and care for society (ESG or equivalent, e.g., CSR, CSV) (22%). As in the previous edition of the survey, nearly fifty-four per cent of the members participating confirmed their involvement in shaping the cluster's strategy. This indicates that over forty-six per cent of cluster members do not actively engage in shaping the strategy.
Possession of operational documents (action plan for a specific time period)	Fifty-six per cent of clusters have detailed documents, while another forty-one per cent of clusters maintain a high level of generality. Only one cluster lacks organizational documents.
Number of specialized cluster bodies (e.g., management board, cluster council, audit committee, cluster office, program and scientific council, etc.)	The examined clusters primarily feature complex management structures; 68% of clusters have 3 or more specialized bodies, while another 22% have 1 or 2 authorities, and 10% of clusters have no authorities. The most frequently indicated bodies are: president/management board, cluster council/program council, assembly of members, audit committee, and secretariat/cluster office. In some clusters, there were bodies performing substantive functions (e.g., working groups/thematic groups). However, the participation of cluster members in the work of these bodies is relatively low. Only 26.5% of the surveyed members reported delegating employees to participate in activities within at least one cluster body.

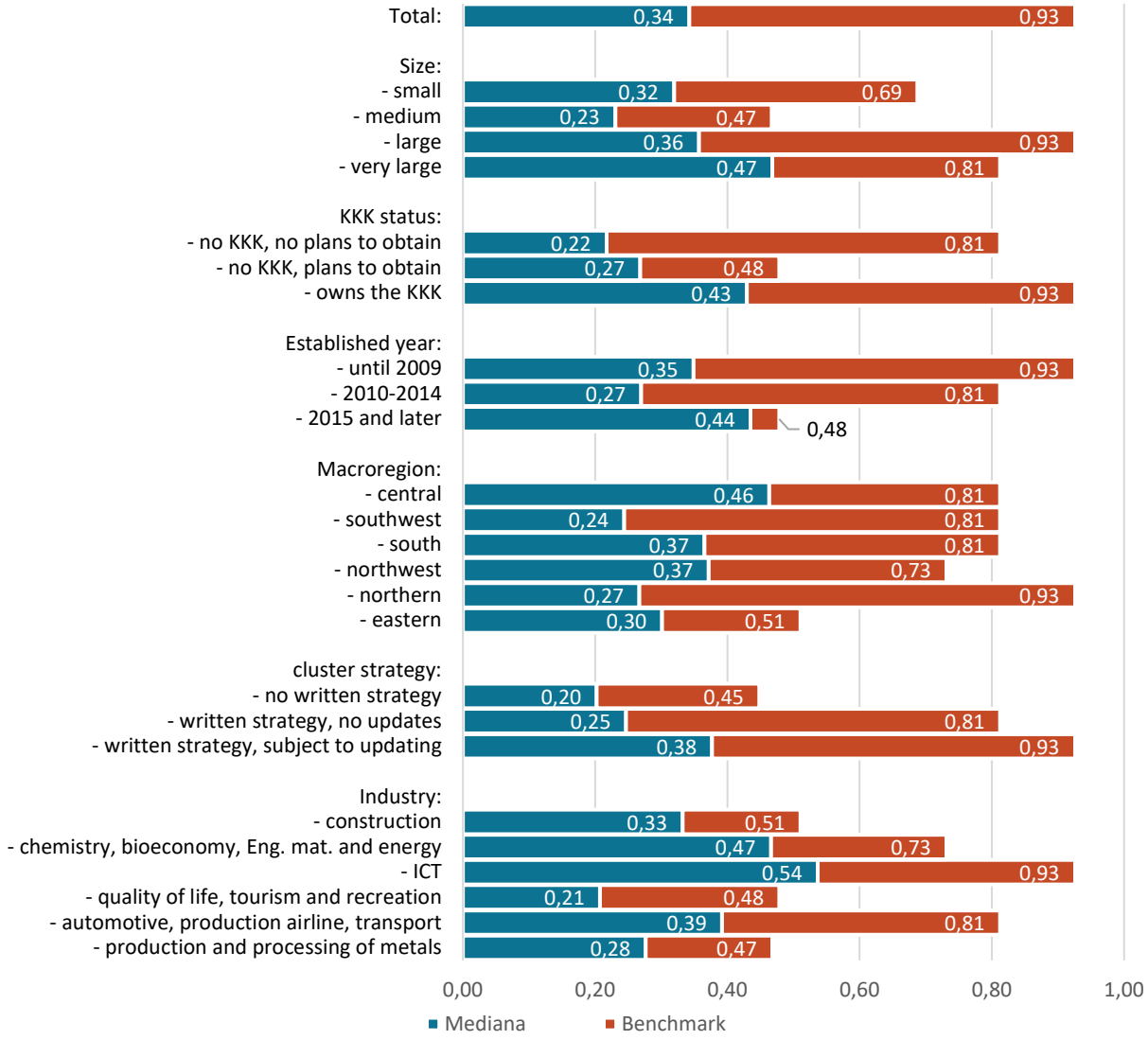
Indicator	Comment
Cyclic nature of research on the needs and satisfaction of cluster members	34% of clusters conduct research on a cyclical basis (at least once a year). Another 61% of ad hoc clusters (on an ad hoc basis); 5% of clusters do not conduct research.
The number of companies in the cluster that have adopted ISO standards.	Average: 42.8%, median: 43.6%, benchmark 92.6%. Due to significant differences in the number of cluster members, data were presented in the form of the share of enterprises implementing ISO within the entire population. On one hand, the largest number of enterprises with implemented ISO was recorded in a very large cluster (293 cases). On the other hand, the highest percentage of implemented ISO standards occurs in one of the smaller clusters participating in the study, amounting to nearly 93%.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.2.2. Cluster communication

When considering communication within the cluster, the overall median as well as the specific cluster types were relatively high. However, variations existed among different categories of clusters. Nonetheless, clusters with at least 121 members (median 0.47), holding the status of KKK (0.43), and possessing a regularly updated written strategy (0.38) remained the most favorable. A benchmark score of 0.93 was achieved by a cluster established before 2010, registered as KKK, with over 121 members, and maintaining an updated written strategy.

Graph 34. Median and benchmark for the communication sub-area in the cluster



Source: own elaboration based on research involving cluster coordinators (N=41).

Analysis of partial indicators for sub-areas

Table 7. Analysis of the values of partial indicators for the sub-area communication in the cluster

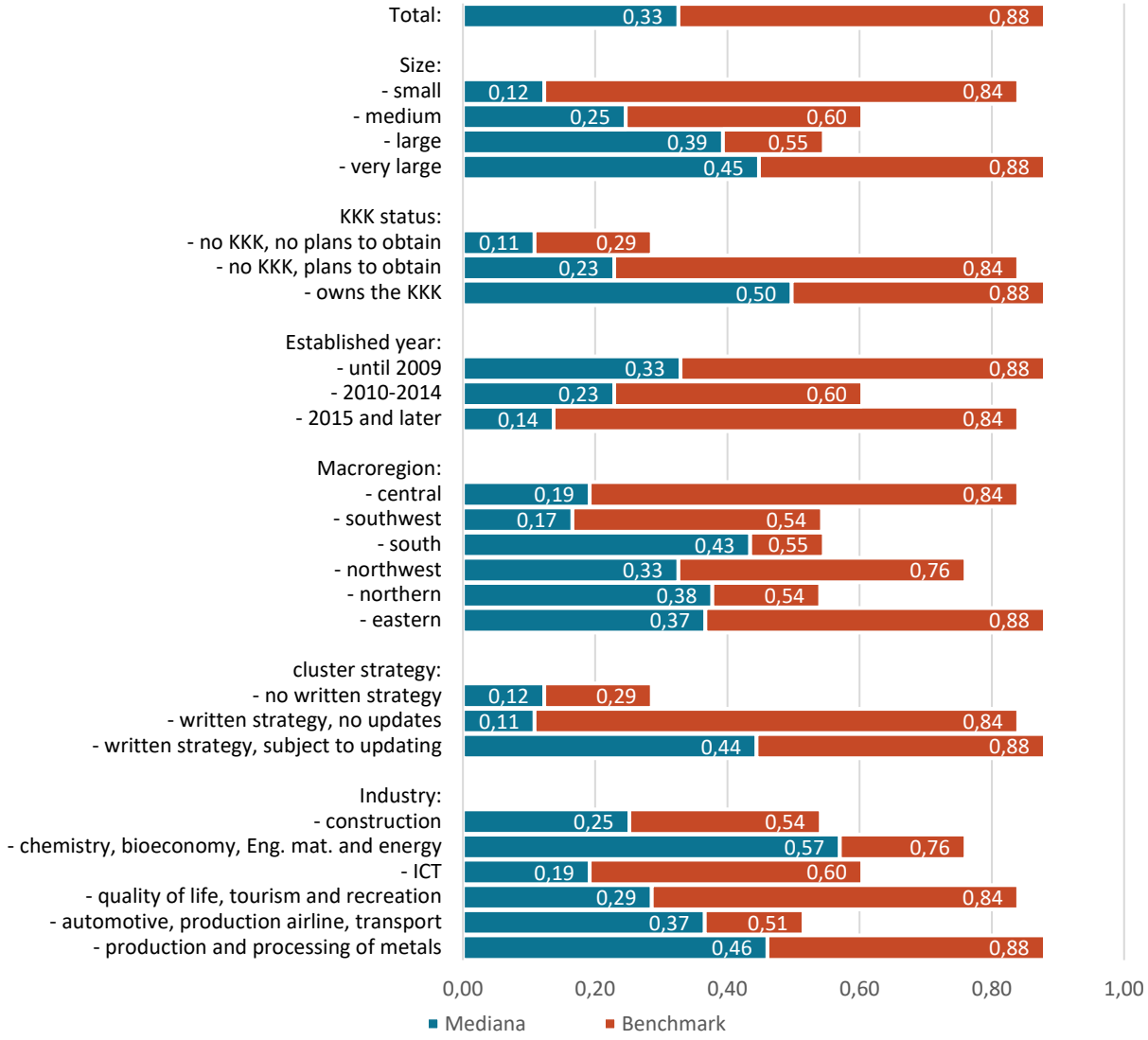
Indicator	Comment
Number of meetings organized in the cluster	Average: 20, median: 8, benchmark: 121. Only one cluster did not declare the organization of meetings. It is worth mentioning that 2020 was a period of numerous restrictions on face-to-face meetings (due to the COVID-19 pandemic). For this reason, several meetings were held online. In 2021, the number of organized meetings in all clusters was approximately 18% higher than in 2020.
The number of communication tools used in the cluster	Average: 3.7, median: 4.0, benchmark: 8.0. From the list of five tools, the following were most commonly indicated: a website (90%), social networking sites (85%), and newsletters (73%). The range of possible answers included five items, as well as internal communication platforms (49%) and discussion forums/groups (46%). It is worth mentioning that the clear leaders among social networking sites are Meta (Facebook) (78.0%) and Linkedin (73.2%). They are followed by Twitter (26.8%) and Instagram (17.1%). Some clusters indicated additional tools, such as online meetings, dedicated communication software created for their needs, a project management platform, or messengers.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.2.3. Market activity

In market activity, a significant difference was noted between the median and the benchmark values. The median remained relatively high at 0.33 overall. The highest scores were achieved by clusters established before 2010 (0.33), those classified as KKK (0.50), those that maintained an updated written strategy (0.44), and those with at least 121 members (0.45). Clusters located in the southern macroregion showed significantly higher scores. In the benchmark analysis, the top results came from a very large cluster (over 121 members) that was classified as KKK, established before 2010, and maintained an updated written strategy. In contrast, the highest benchmark score was recorded by clusters in the eastern and central macroregions, differing from the median results.

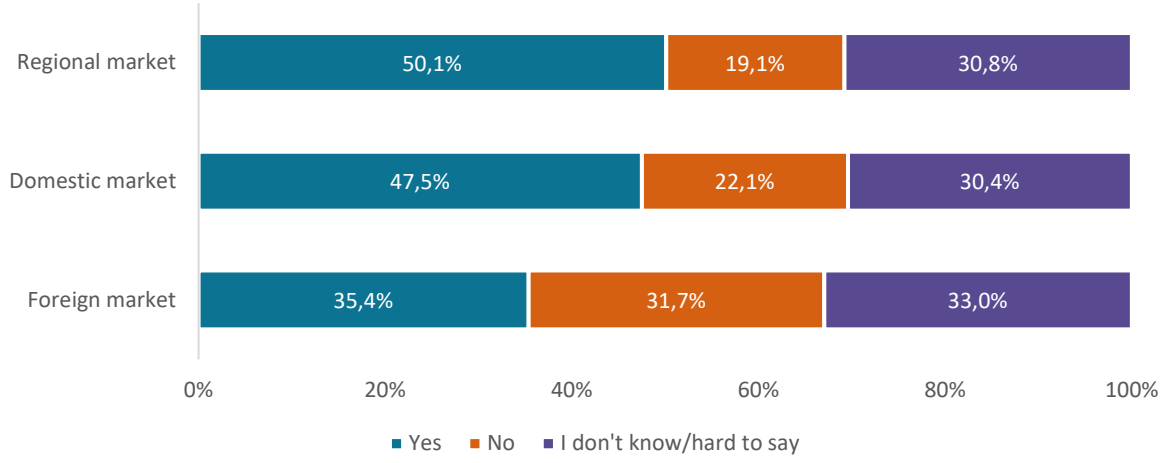
Graph 35. Median and benchmark for the market activity sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

When examining the opinions of cluster members, it became clear that their participation in clusters primarily resulted in increased engagement in regional markets, as reported by 50% of respondents. Additionally, 47.5% noted heightened activity in national markets. Although slightly lower, foreign market activity remained significant at 35.4%. These figures represent a 3-5 percentage point improvement compared to the previous benchmarking edition.

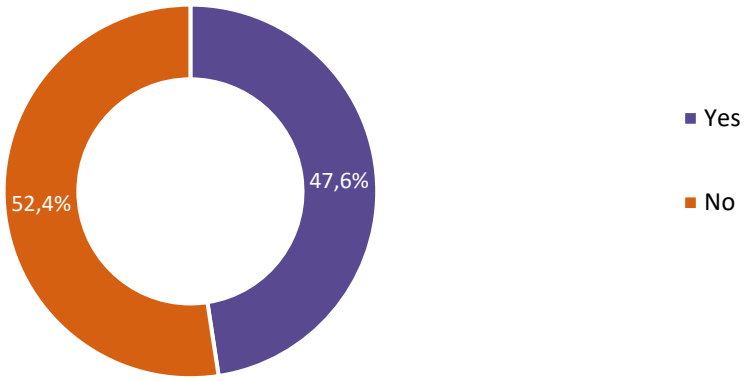
Graph 36. Improvement of the organization's activity on the market in the context of its participation in the cluster



Source: own elaboration based on a survey of cluster members (N=642).

More than 48% of respondents reported that their organization formed business connections with international partners as a result of their cluster involvement. This reflects a significant increase compared to the previous survey edition, where the percentage was 33%.

Graph 37. Participation in a cluster and establishing business relations with foreign partners



Source: own elaboration based on a survey of cluster members (N=642).

Clusters can play an important role in supporting the cooperation of their members within the value chain. The value chain, as defined by ME Porter is: *a systematized sequence of activities aimed at providing the final user with the expected product and accompanying management and consulting activities. This division is intended to enable an analysis that allows to identify the sources of costs, profits and potential competitive advantages*[67].

The value chain encompasses a series of interconnected activities, including procurement, production/service delivery, marketing and sales, distribution, export activities, after-sales service, and product planning and development. Each of these elements can serve as a basis for collaboration within a cluster. Notably, only two cluster coordinators reported no knowledge of jointly implemented value chain stages, marking a significant improvement compared to previous benchmarks (12 coordinators in 2020 and 19 coordinators in 2018). Cooperation primarily focused on 1, 2, 3, or all 7 stages of the value chain, with seven clusters involved in each category. It is worth highlighting that in the previous study, only one cluster reported engagement in all 7 stages of the value chain.

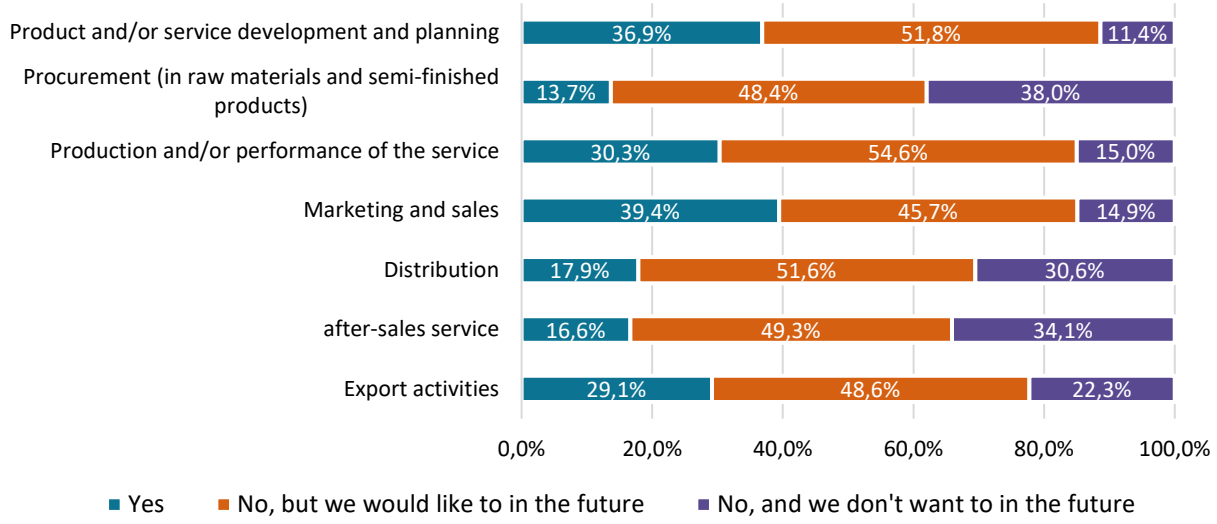
Graph 38. Number of jointly implemented stages of the value chain in all clusters participating in the study

Source: own elaboration based on research involving cluster coordinators (N=41).

[67] Porter M., Competitive Advantage. Achieving and maintaining better results, Helion, Gliwice 2006.

The commonly identified market activities in which cluster members participated were primarily "Marketing and sales" (39%), followed by "Development and planning of products and/or services" (37%), "Production and/or provision of services" (30%), and "Export activities" (29%). The least common activity reported was "Procurement (in raw materials and semi-finished products)" (14%).

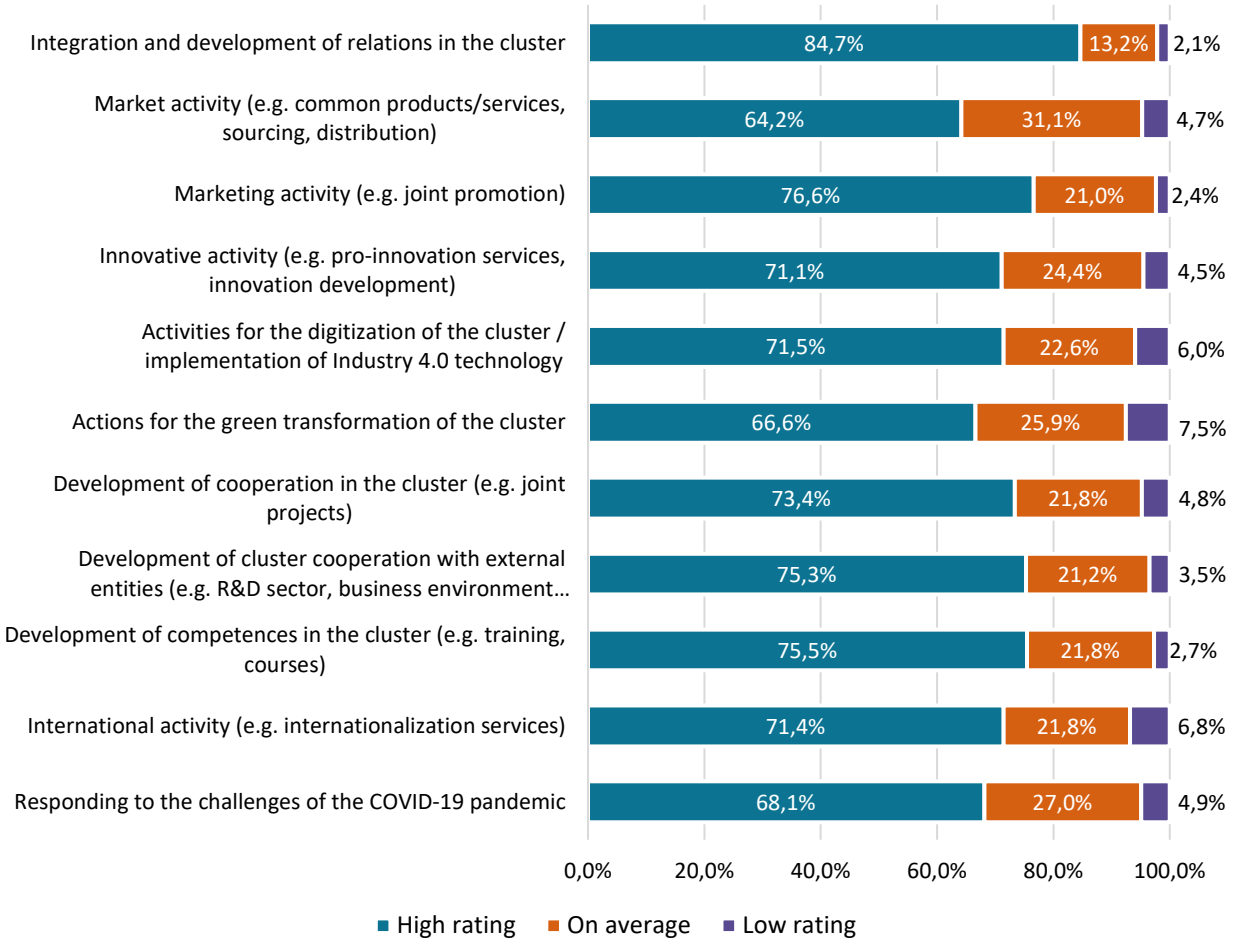
Graph 39. Participation of cluster members in jointly implemented stages of the value chain in all clusters participating in the study



Source: own elaboration based on a survey of cluster members (N=642).

The satisfaction level with cluster coordinators' activities was high among the surveyed cluster members, as indicated by the positive ratings across each area. The integration and development of relationships within the cluster received the highest favorable rating (84.7% of high scores), followed by the development of competencies in the cluster (75.5%) and the development of cooperation in the cluster (75.3%). These results aligned with the findings from the previous edition of the study, showing no significant differences.

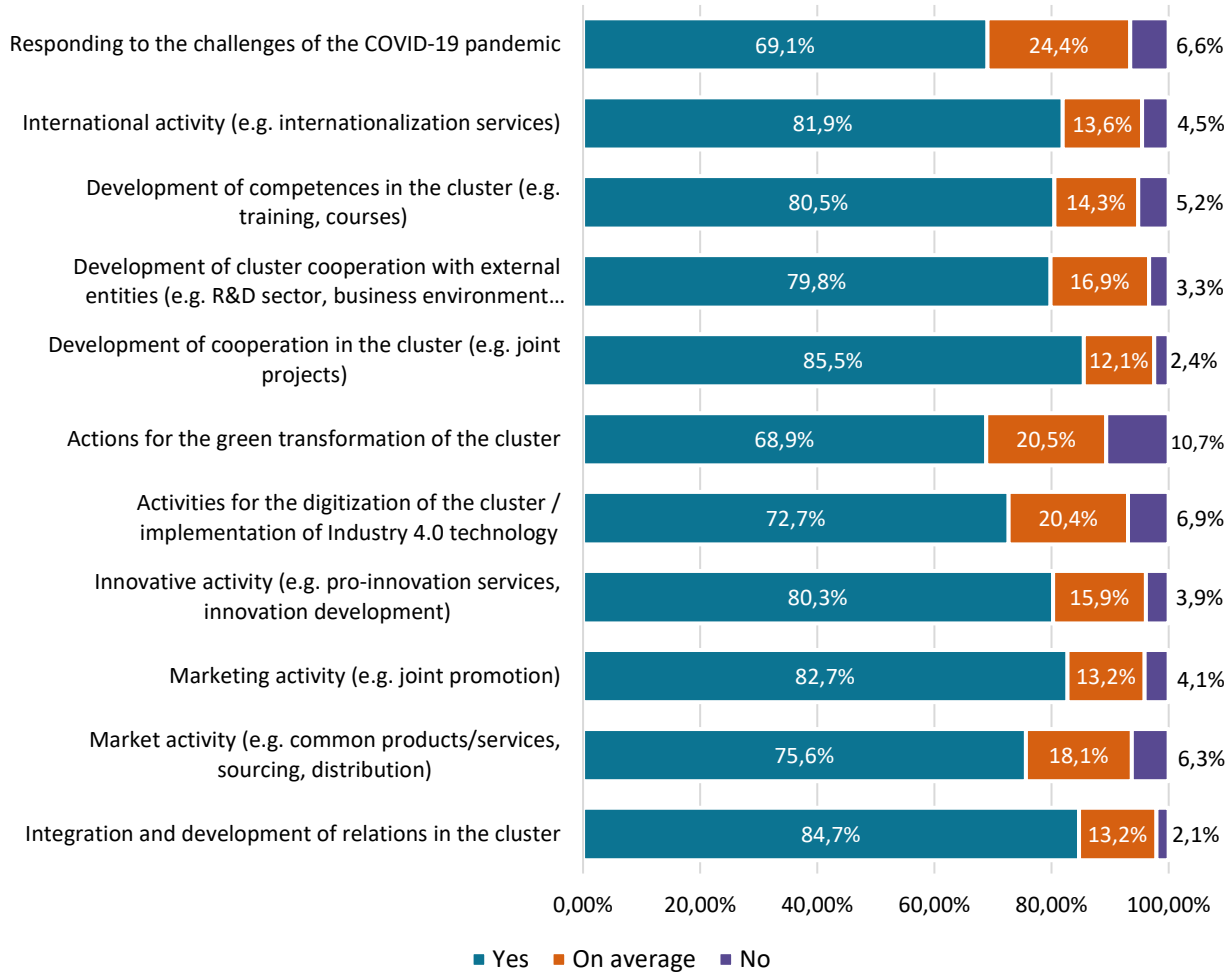
Graph 40. Evaluation of activities of cluster coordinators in selected areas



Source: own elaboration based on a survey of cluster members (N=642).

According to cluster members, the most important areas in the next two years will be the development of cooperation in the cluster (85.5%), integration and development of relations within the cluster (84.7%), marketing activities (82.7%), and international activities (81.9%). These results indicate high expectations from cluster members regarding the role and activities of coordinators. The analysis excluded responses of "I don't know"/"It's hard to say" as they did not provide significant insights (approximately 10% for each category). It is worth noting that the perceived significance of these areas is higher by 3-8 percentage points compared to the previous edition of the survey.

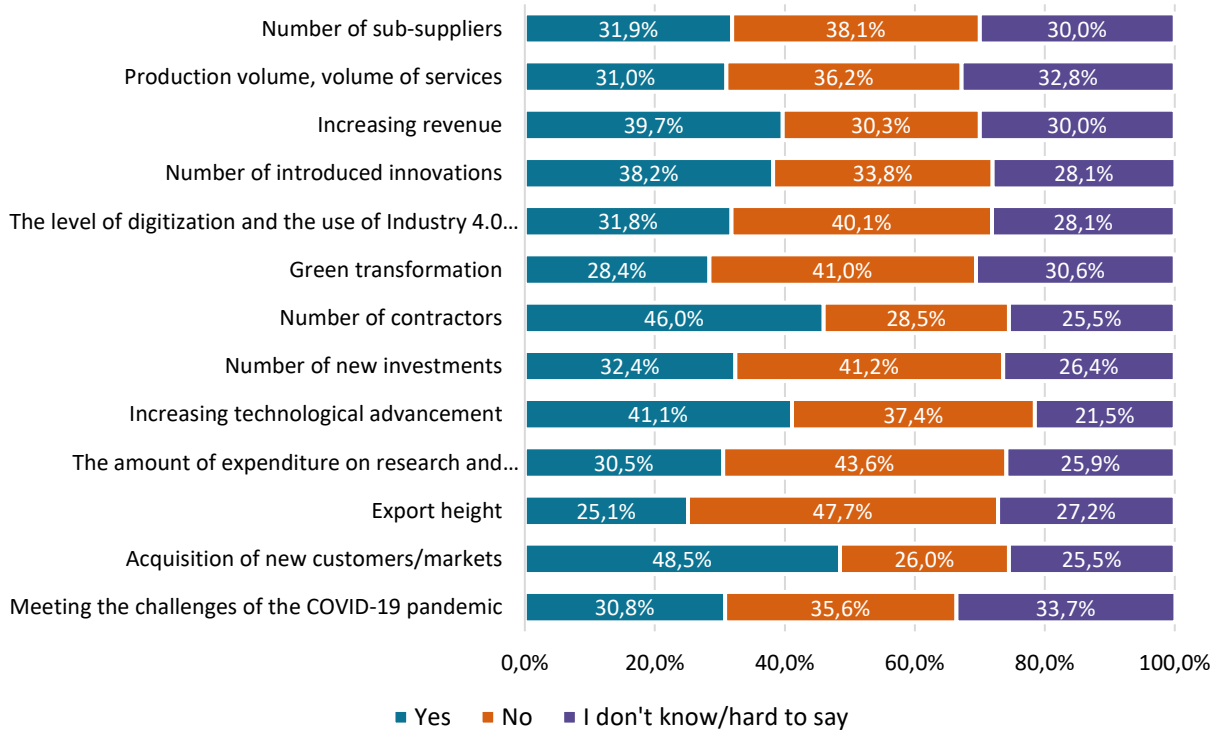
Graph 41. Significance of areas in the next two years (according to cluster members)



Source: own elaboration based on a survey of cluster members (N=642).

According to the respondents, participation in the cluster enhanced the functioning of various areas in the surveyed entities. It had a positive impact on acquiring new customers and markets (48.5%), contractors (46%), and increasing technological advancement (41.1%). However, the indicators related to the volume of exports (25.1%) and the green transformation (28.4%) received lower ratings. It is important to note that the latter encompasses principles aligned with the *European Green Deal*[68], such as adopting circular economy concepts, obtaining and implementing environmental certifications, conducting energy efficiency audits, engaging in R&D activities for low-carbon technologies, promoting innovations in the green economy, producing and distributing renewable energy, and executing low-carbon economy projects by the coordinator or cluster members. Furthermore, nearly 31% of cluster members reported that their participation in the cluster helped them better navigate the challenges posed by the COVID-19 pandemic.

Graph 42. Improvement of the functioning of the organization in selected areas



Source: own elaboration based on a survey of cluster members (N=642).

[68] The European Green Deal is a plan of action and policy initiatives from the European Union, aiming to transform the EU into a modern, resource-efficient, and competitive economy while achieving climate neutrality by 2050. It also seeks to enhance the quality of life for European Union citizens through a cleaner environment, more accessible energy sources, and new job opportunities. Investments in the renewable energy sector and improvements in energy efficiency are also part of the European Green Deal.

Analysis of partial indicators for sub-areas

Table 8. Analysis of the values of partial indicators for the sub-area of market activity

Indicator	Comment
The number of stages in the value chain jointly implemented in the cluster designated by the coordinator[69]	Average: 3.5, median: 3.0, benchmark: 7.0. Of the 7 possible stages of the value chain, the following were most frequently indicated: marketing and sales (78%), development and/or planning of products and/or services (66%), production operations and/or service provision (54%), and export activities (54%). In the case of 13 clusters, the coordinators reported cooperation in 5 or more stages of the value chain. Conversely, only 2 clusters did not report any jointly implemented stage of the value chain.
The total number of categories of products and/or services acquired in the cluster through joint group purchases	Average: 1.4, median: 1.0, benchmark 5.0. From the list of four categories of products and services obtained in the cluster as part of joint group purchases, expert, consulting, and training services were the most frequently indicated (61%). The other categories were less significant: raw materials and production components (27%), consumables (20%), and energy (15%). The clusters had the option to indicate additional categories of products and services, so the benchmark value exceeds the number of predefined categories. Additionally, insurance services, organization of trips to fairs, courier services, and hotel services were mentioned.
The number of common distribution channels in the cluster	Average: 1.7, median: 1.0, benchmark: 5.0. From the list of seven distribution channels, the most frequently indicated were joint stands, e.g. at fairs (73%), and joint offers in tenders (24%). Less popular were jointly hiring an agent or exporter in international markets (17%), joint delivery to retail and/or wholesale chains (15%), joint sales via the Internet (12%), wholesale channels (7%), and common points of sale (7%).

[69] Unless specified otherwise, questions regarding the occurrence of a specific situation in the cluster concern the coordinator and at least 2 cluster members or at least 3 cluster members without the coordinator.

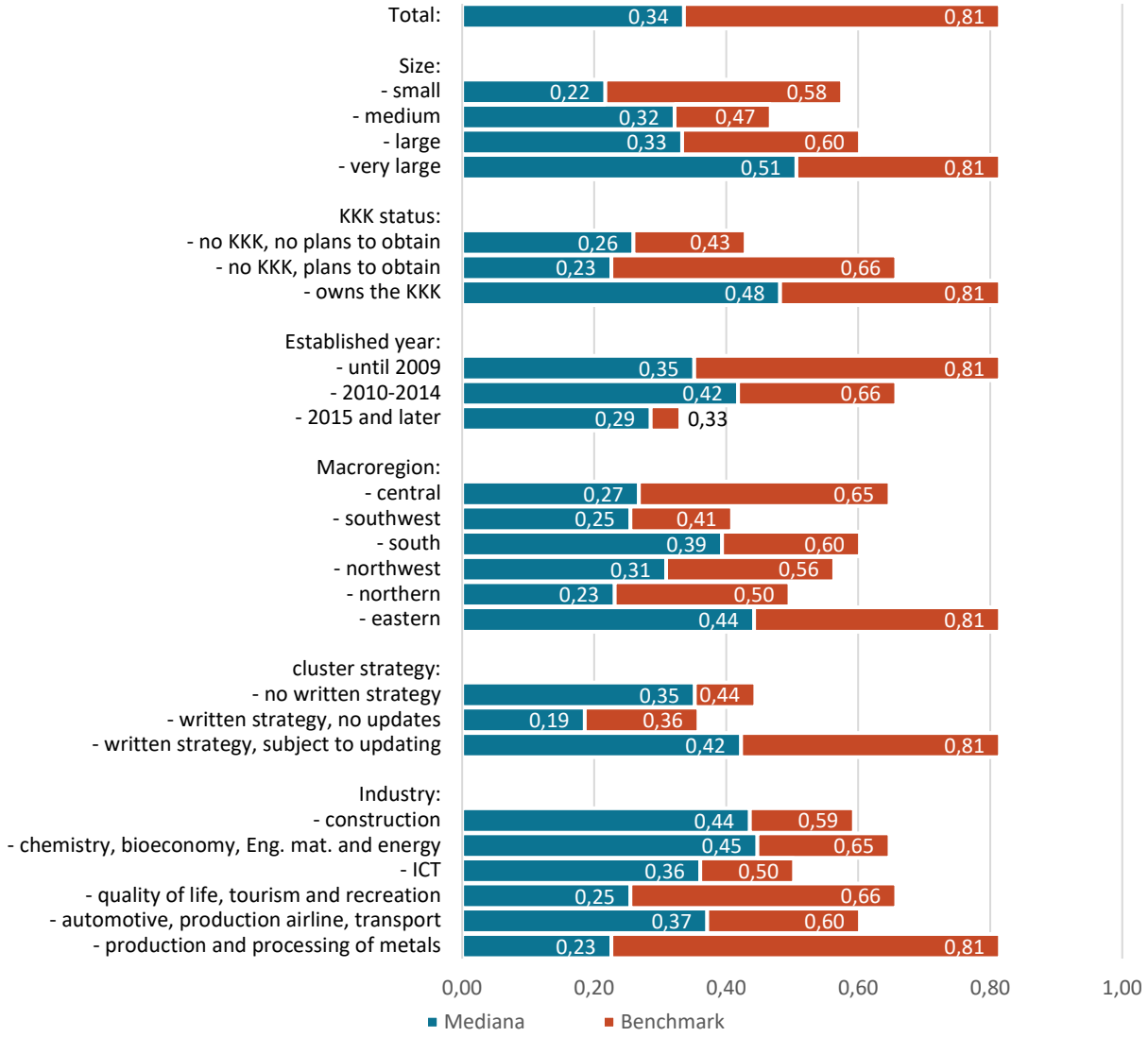
Indicator	Comment
The total sales revenue value of enterprises in the cluster (change in revenue value due to the COVID-19 pandemic)	Average: 1,318.2 million PLN, median: 225.3 million PLN, benchmark: 36,996.5 million PLN. The indicator included the measurement in absolute values (PLN) of total revenues from the sale of enterprises between 2020 (the year of the epidemic and the largest restrictions) and 2021 (the year of loosening restrictions). It is worth noting that the clusters recorded a significant increase in the value of the indicator (for all clusters, it was 22.7%). The direction of changes aligns with the behavior of the entire economy, as the Central Statistical Office data indicates that the revenues of enterprises from total activity and revenues from the sale of products increased by approximately 23%. There are significant differences between the sectors regarding changes in total sales revenue, which is presented in more detail in Chapter 8. In the opinion of the coordinators, 33% of cluster enterprises experienced increased revenues as a result of the COVID-19 pandemic, while 32% saw a decrease (the remaining ones reported no change). The assessment of this situation by cluster members is slightly more favourable: 39.7% declared an increase in revenues, while 39.7% noted a decrease.
Value of sales of products and services from cluster enterprises through electronic commerce (e-commerce)	Average: 89.7 million PLN, median: 0.0 million PLN, benchmark: 3,240.3 million PLN. Only 12 cluster coordinators reported the revenue values from sales through e-commerce by cluster enterprises.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.2.4. Marketing activity

The sub-area of marketing activity demonstrated a relatively high median value of 0.34. Clusters with KKK status, larger size, and an updatable written strategy performed more favorably compared to others. Notably, clusters in the chemical, bioeconomy, material, energy engineering, and construction sectors achieved the highest median levels. Interestingly, clusters from the eastern macroregion had an advantage in this area. The benchmark score was also relatively high at 0.81, showing similar results to the median analysis. The best ratings were obtained by a large cluster, with over 121 members, KKK status, established before 2010, and possessing an updatable written strategy.

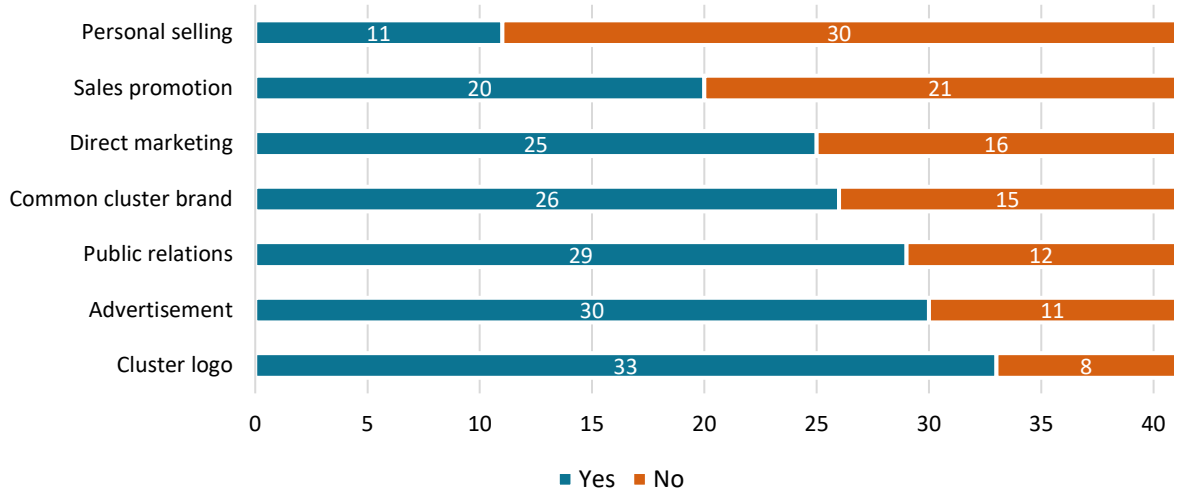
Graph 43. Median and benchmark for the marketing activity sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

When it comes to marketing activities in clusters, several joint efforts are commonly employed. The most prevalent actions include creating a common cluster brand and logo (33 clusters), engaging in advertising activities (30 clusters), and implementing public relations initiatives (29 clusters). This sequence of actions remains consistent with the previous edition of the survey. However, sales activities are less frequently utilized by the clusters.

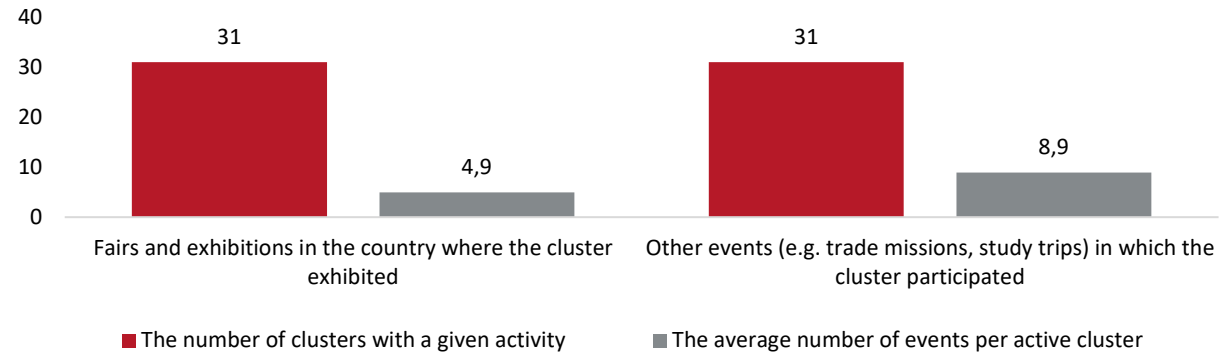
Graph 44. Number of clusters with joint activities in the field of cluster promotion and its members



Source: own elaboration based on research involving cluster coordinators (N=41).

Approximately 75% of the clusters reported active participation in national fairs and exhibitions, as well as organising joint domestic trips such as study trips and trade missions. The clusters collectively attended 153 exhibitions and fairs, averaging about 4.9 per active cluster in this area. Additionally, they organized 277 other joint domestic trips, averaging around 8.9 trips per cluster.

Graph 45. Joint activities to promote the cluster and its members



Source: own elaboration based on research involving cluster coordinators (N=41).

Analysis of partial indicators for sub-areas

Table 9. Analysis of the values of partial indicators for the sub-area of marketing activity

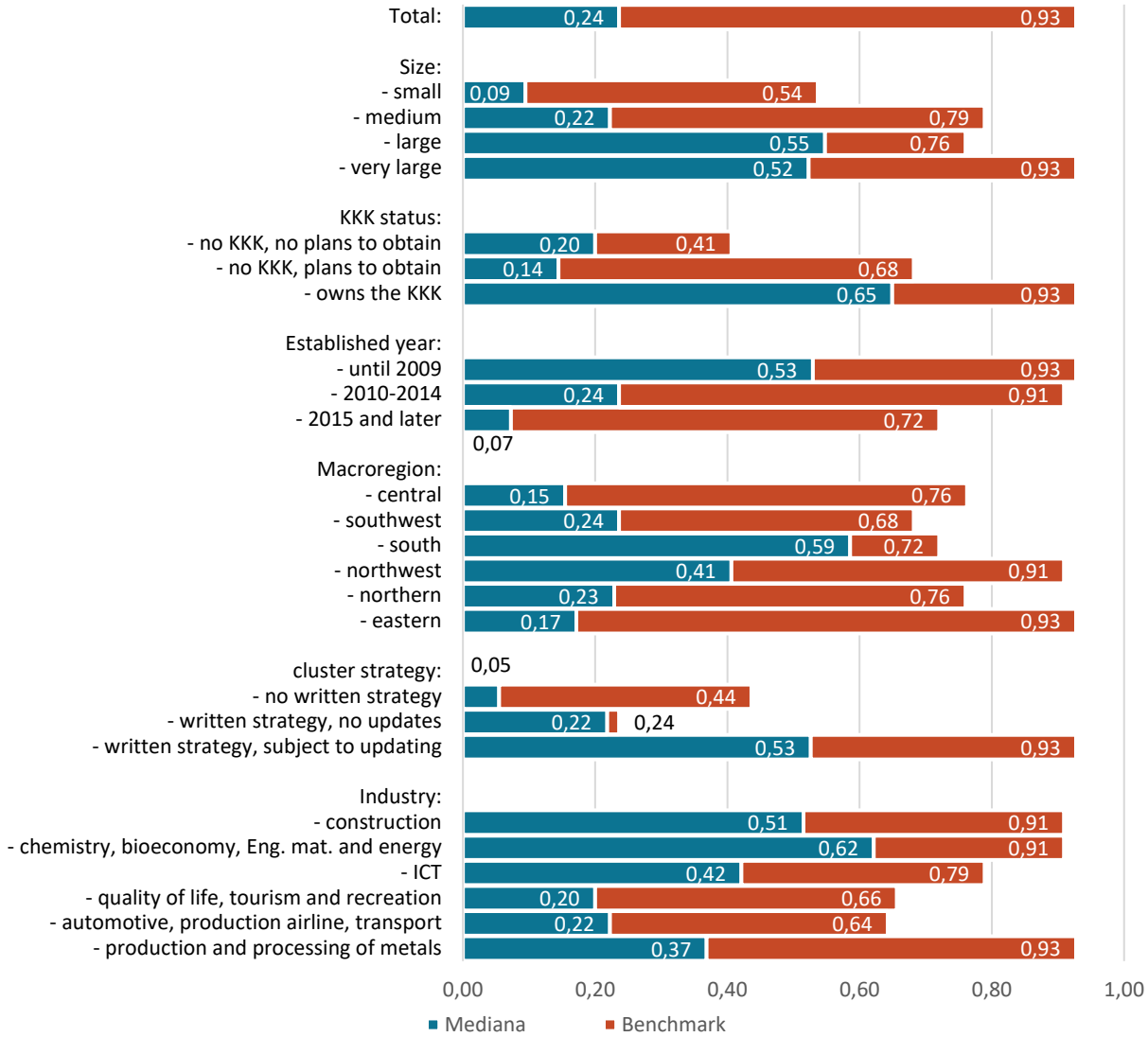
Indicator	Comment
The number of results for "cluster name" recorded in the web browser	Average: 2,410, median: 1,380, benchmark: 21,000. The number of results was determined using the Google search engine. Other search engines (including Bing and Yahoo) often produced inflated results. The best results were achieved by clusters with relatively simple and short names.
Number of visits to the cluster's website	Average: 79.8 thousand, median: 8.6 thousand, benchmark: 1,143.3 thousand. Only some clusters (approximately 60%) were able to provide the number of visits to the website, while others do not maintain statistics in this regard.
The number of joint activities aimed at promoting the cluster and its members.	Average: 4.4, median: 5.0, benchmark: 6.0. From the list of six activities (with an option to indicate others) in the field of promotion, the following were the most frequently indicated: cluster logo (80%), advertising (73%), and public relations (71%). The following were used to a lesser extent: common cluster brand (63%), direct marketing (61%), and sales promotion (49%). Only one in four clusters (27%) employed personal selling, understood in this case as a direct form of communication between the cluster coordinator and the external environment for the purpose of promoting the cluster and its members. This includes sending informational materials on the product offerings of the cluster and its members to potential contractors. Clusters could also indicate additional actions taken. In this respect, items such as participation in educational and similar events or conducting open webinars have emerged.
Number of fairs and exhibitions in the country where the cluster exhibited	Average: 3.7, median: 2.0, benchmark 28.0. Only nine clusters recorded no activity in this area. Three clusters participated in more than ten fairs and exhibitions.
The number of other events in the country (e.g., trade missions, study trips) in which the cluster participated	Average: 6.8, median: 2.0, benchmark: 56.0. Ten clusters with no activity in this area were recorded. Simultaneously, seven clusters reported organising more than ten events.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.2.5. Innovative activity

The sub-area of innovation activity revealed a notable disparity between the median (0.24) and the benchmark (0.93), indicating significant variation among the studied clusters in this regard. KKK clusters emerged as the most advantageous, with a median of 0.65 compared to other clusters' median of 0.20. Interestingly, clusters from the southern macroregion displayed a more favorable performance in this comparison. The benchmark was set at a very high level, signifying the identification of a leading cluster characterized as a very large cluster established before 2010, with the status of KKK and a written strategy subject to updating.

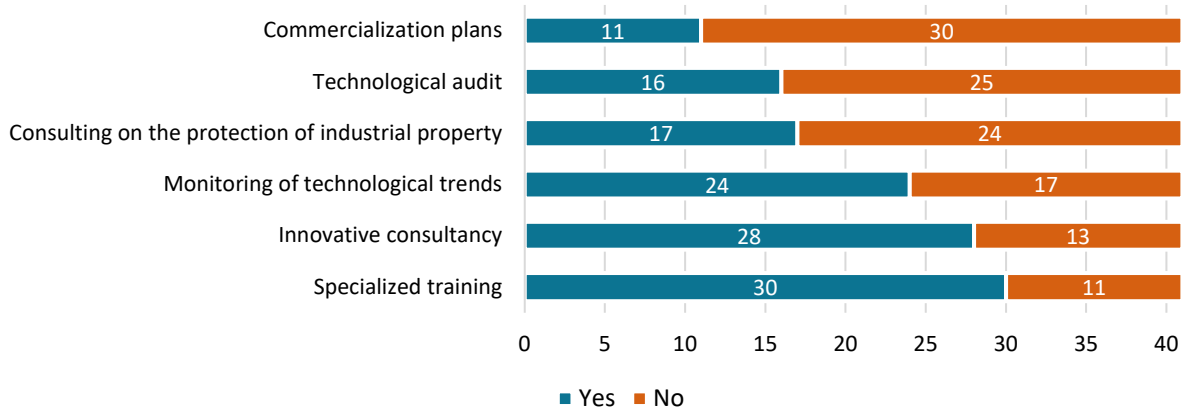
Graph 46. Median and benchmark for the sub-area of innovative activity



Source: own elaboration based on research involving cluster coordinators (N=41).

The surveyed clusters implemented various measures to facilitate access to pro-innovation services within the cluster. However, the approach to offering these services varied significantly among the clusters. Services were typically provided directly by the cluster coordinator, by selected cluster members (such as business support institutions), or outsourced to external entities. The most commonly offered services included specialized training (30 clusters), innovative consulting (28), and technological trend monitoring (24). Notably, there was a significant increase in the provision of technological trend monitoring services compared to the previous benchmarking edition, with 6 out of 18 additional clusters offering this service.

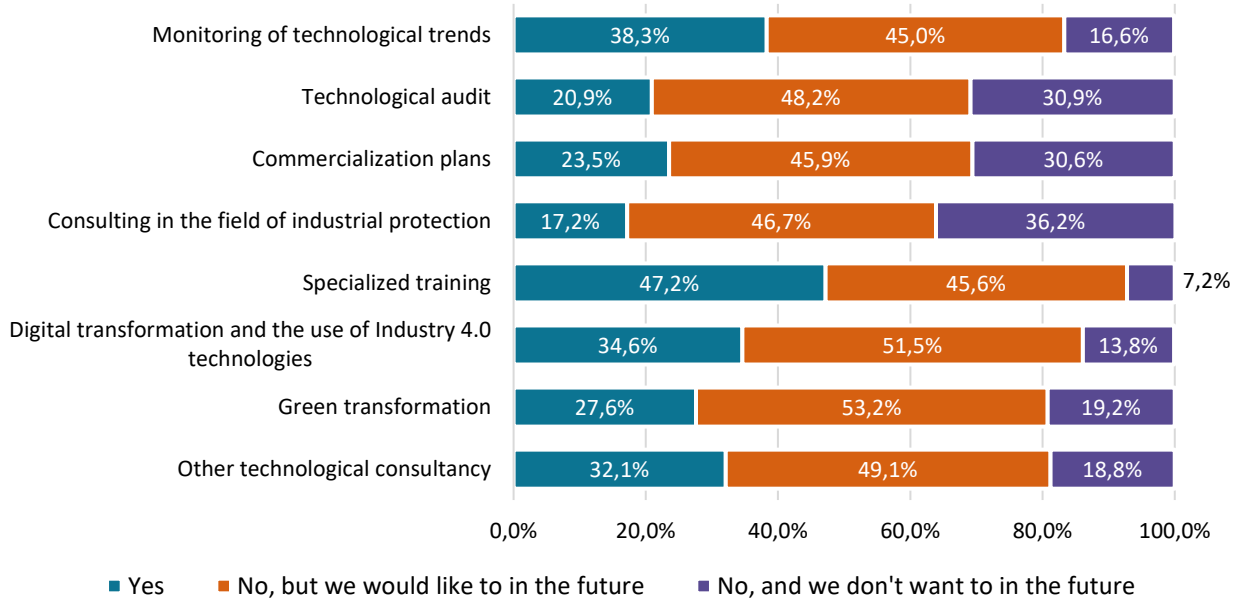
Graph 47. Ensured access to pro-innovation services in the cluster



Source: own elaboration based on research involving cluster coordinators (N=41).

In 2020-2021, most surveyed cluster members utilized the pro-innovation services offered within the cluster or facilitated by it in two main areas: specialized training (47.2% of members) and monitoring technological trends (38.3%). These services played a significant role in supporting members' innovation efforts and keeping them updated on the latest technological advancements.

Graph 48. Using pro-innovation services provided in the cluster or through the cluster



Source: own elaboration based on a survey of cluster members (N=642).

Alongside the commonly mentioned pro-innovation services, the surveyed coordinators highlighted several additional categories of services provided within their clusters. These included:

- Industry 4.0 demonstration services;
- incubation of early-stage projects;
- specialized services within the European Digital Innovation Hub, covering areas such as AI/ML, IoT, VR/AR, Industry 4.0, Intralogistics, KDM, Big Data, and Cloud
- advisory support for building business models;
- networking services for innovation creation and developmentknowledge and technology transfer;
- technology optimization;
- laboratory tests.

Analysis of partial indicators for sub-areas

Table 10. Analysis of partial indicators for the sub-area of innovative activity

Indicator	Comment
Number of pro-innovation services available in or through the cluster	Average: 5.2, median: 3.0, benchmark 86.0 (including additional items from outside the cafeteria that the coordinator could indicate). Only 4 out of 41 coordinators indicated a lack of available pro-innovation services in the cluster. From the list of 6 pro-innovation services, the following were indicated most frequently: specialized training (73% - an indicator calculated for all 41 clusters), innovative consulting (68%), and monitoring technological trends (59%). A significant number of services (80) was reported by the cluster whose coordinator operates in the European Digital Innovation Hub cooperation network. More details can be found in chart no. 46 and the accompanying commentary.
The function of an institution that supports technology transfer between cluster members and/or with external entities (e.g., consulting, development of databases containing cooperation offers, etc.)	In 61% of clusters, there is an institution that supports technology transfer.
Acquisition of knowledge and technology for the needs of the cluster (licences, know-how)	Knowledge and technology are acquired in 34% of clusters.
Number of cluster members utilising pro-innovation services available within or through the cluster.	Average: 13.4, median: 3.0, benchmark 80.0. Members of 26 clusters utilised pro-innovation services. However, in 11 clusters, despite the creation of an offering of pro-innovative services, none of the members took advantage of them (see the comment on the number of pro-innovation services in the cluster). In the case of 8 clusters, more than 20 members accessed pro-innovation services.
Number of technological audits conducted in cluster entities through the cluster	Average: 5.5, median: 0.0, benchmark 78.0. In 59% of clusters, technological audits are not conducted (hence the zero median). Moreover, only 4 clusters reported more than 10 audits.

Source: own elaboration based on research involving cluster coordinators (N=41).

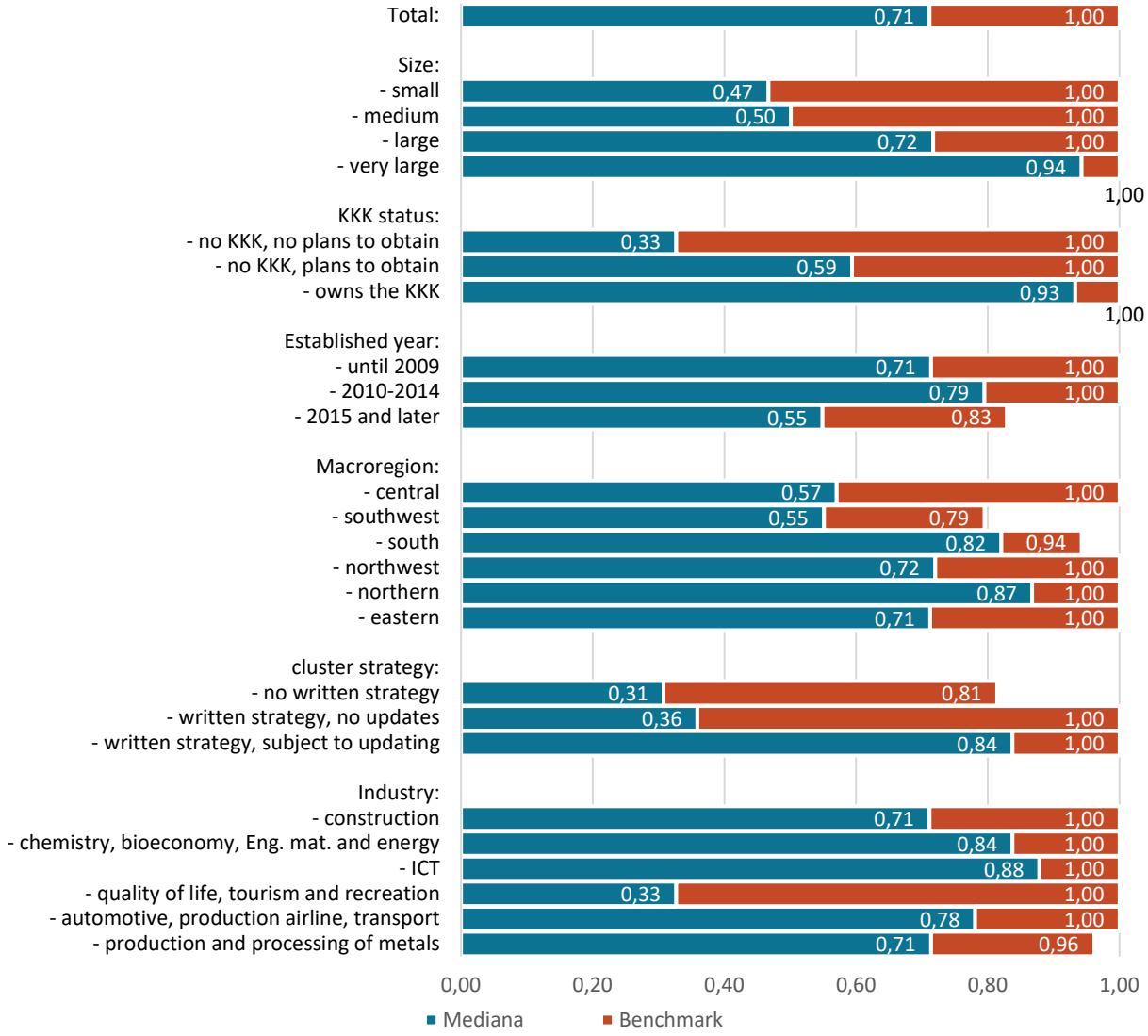
5.2.6. Cluster digitization

The assessment of cluster digitization focused on two indicators: the utilization of IT systems at different stages of development and the adoption of Industry 4.0 technology. Digitization of the economy refers to the increasing integration of IT systems among enterprises, public institutions, NGOs, employees, and consumers citizens[70]. It aligns with the concept of Industry 4.0, which aims to customize products to meet customer expectations while maintaining cost-effectiveness, high quality, and efficiency. This is accomplished through the application of technologies such as digital platforms, blockchain, the Internet of Things (IoT), artificial intelligence (AI), big data processing, and machine learning. The analysis evaluated the penetration of IT systems and these technologies within clusters.

As only two indicators were used, the results showed slight variations, with seven clusters achieving the maximum score of 1.00, serving as the benchmark. Clusters with a long operating history, KKK status, large size, and an updated written strategy attained the highest median scores. Geographically, the northern macroregion performed exceptionally well, with a median score of 0.87, possibly due to industry characteristics specific to clusters in that area. The southern region also recorded high scores (0.82), attributed to the presence of large and very large clusters with a high level of overall development. Notably, clusters in the ICT industry received the highest score (0.88), reflecting their strong emphasis on digitization and the adoption of advanced technologies.

[70] More on the digitization of the economy and clusters in the guide: Kowalski A., Moscow A., Wojciechowski P., Parzuchowski J., Rynkiewicz S. (ed. Kryjom P.), Guide to digitization of value chains in clusters, Platforma Przemysłu Przyszłości, Warsaw 2021.

Graph 49. Median and benchmark for the cluster digitization sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

The digitization of clusters has been closely associated with the concept of Industry 4.0 for several years[71]. Industry 4.0 technology providers, primarily ICT companies, high-tech firms, and organisations in the research and development (R&D) sector, play a significant role in this context. These providers can serve as key partners in supplying Industry 4.0 solutions to other cluster members. Additionally, clusters dominated by entities from the ICT sector have the potential to offer services and solutions to both individual enterprises and other clusters.

[71] Clusters 4.0: Shaping Smart Industries, European Cluster Conference 2016; Jankowska B., Goetz M., Clusters and Industry 4.0, 43rd EIBA Annual Conference, Milan 2017.

Clusters of this nature foster ongoing technological advancements, promote greater integration between customers and producers, leverage the effective use of artificial intelligence, encourage the emergence of new business opportunities, and create new job roles in the labor market. Ultimately, these efforts strengthen innovation and enhance the competitiveness of the regional, national, and European economy economies[72].

Analysis of partial indicators for sub-areas

Table 11. Analysis of the values of partial indicators for the cluster digitization sub-area

Indicator	Comment
The number of IT systems utilised at specific stages of the value chains in the cluster	Average: 5.7, median: 7.0, benchmark 9.0. From the list of nine systems, the following were most frequently indicated: customer relationship management systems (80%), resource management systems (68%), and document management systems (66%). Further positions were taken by content management systems (63%), work time recording systems (63%), production resource management systems (59%), and supply chain management and warehouse management systems (56% each), along with business analytics (also 56%). As in the previous edition of the study, IT clusters recorded high positions. Additionally, several clusters in the field of industrial processing (e.g., automotive, metalworking) and services (e.g., medical) also achieved very good positions.
Number and type of individual Industry 4.0 technologies used in the cluster (from the list of 13 Industry 4.0 technologies, the level of their use is indicated on a scale from 1 to 3, where 1 means no use, 2 signifies the start of digital initiatives, and 3 indicates their implementation; the maximum possible score in this criterion is 39.0 points.)	Average: 30.1, median: 31.0, benchmark 39.0. From the list of 13 technologies, the most frequently mentioned are IT systems (80%), cybersecurity (73%), 3D production (71%), and cloud computing (68%). At a moderate level, big data analytics (61%), digital platforms (59%), the Internet of Things (56%), autonomous robots (54%), and the Industrial Internet of Things (51%) are used. Less than half of the clusters utilise the following technologies: simulation (49%), artificial intelligence (41%), blockchain (37%), and artificial intelligence of things (29%). It is anticipated that there will be a significant increase in the use of artificial intelligence technologies this year, driven by recent advancements such as OpenAI (chat GPT) and other AI solutions that have garnered widespread interest from both businesses and individual Internet users.

Source: own elaboration based on research involving cluster coordinators (N=41).

[72] B. Bembenek, Clusters of Industry 4.0 in a sustainable knowledge-based economy, Scientific Papers of the University of Wrocław, Wrocław 2017.

Area summary

- The analysis encompassed various sub-areas within "Cluster processes," including management processes, cluster communication, market activity, marketing activity, innovative activity, and cluster digitization.
- Similar to the previous edition, relatively high median values were observed for each sub-area, indicating the overall favorable situation of clusters in these aspects, particularly regarding cluster digitization and management processes. High benchmark values close to 1.00 demonstrated the participation of clusters that achieved maximum or near-maximum scores in the study, highlighting the exceptional performance of the best clusters.
- Member feedback indicated opportunities for improvement in areas such as supply chain creation, collaborative actions to enhance product and service quality, reduce business costs, and influence public authorities and institutions. The highest percentage of members reported not achieving the desired objectives in these areas.
- There was a significant improvement compared to the previous benchmarking edition regarding jointly implemented stages of the value chain. About 32% of coordinators indicated the implementation of five or more joint stages, including 17% of coordinators who reported implementing all seven stages. It's important to note that member responses sometimes differed from coordinator declarations, indicating that cooperation between members can occur independently of direct coordinator involvement, which can be seen as a positive aspect.
- The current study revealed that a significant percentage (70%) of cluster members acknowledged substantial benefits from cluster membership, marking a 20 percentage point increase compared to the previous survey, in which opinions were more polarized.
- Concerning marketing and innovation activities, the results remained largely consistent with the previous edition, with slight positive changes noted in most areas. In percentage-based measures, the changes generally ranged from 3 to 5 percentage points.

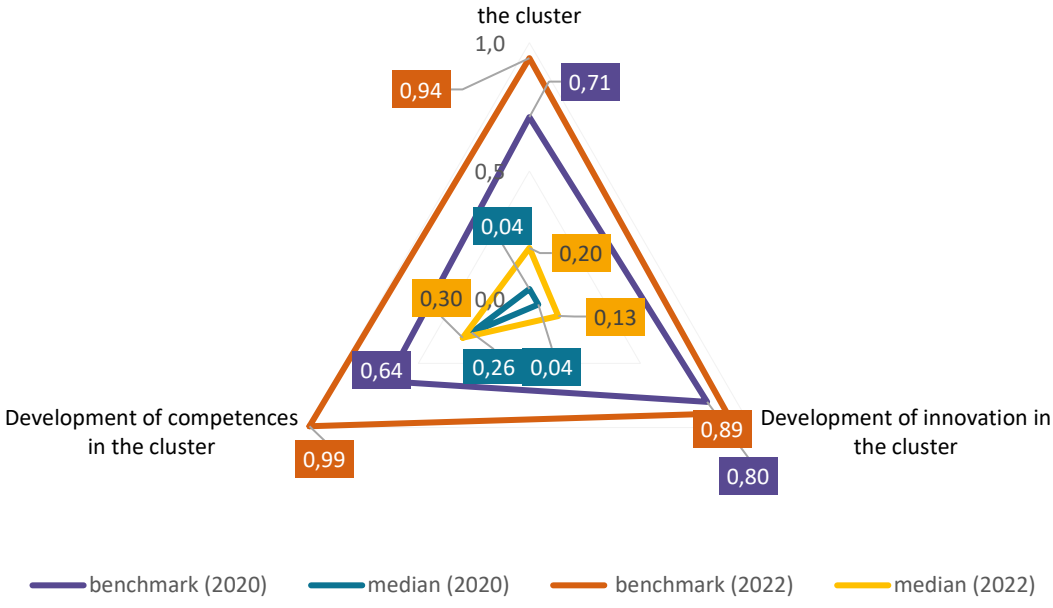
5.3. Cluster results

In the "Cluster results" area, the assessment of cluster development during 2020-2021 focused on several sub-areas:

- **Development of cooperation in the cluster** – involves the incubation of new business activities (start-ups, spin-off/spin-out companies) and their collaboration with large entrepreneurs. This includes joint implementation of projects, creating a combined market offering, joint sales, acquiring joint orders, and strengthening public-private partnerships.
- **Development of innovation in the cluster** – entails joint R&D&I activities, including the implementation of product innovations and business processes, knowledge transfers within clusters, and the protection of industrial property.
- **Development of competences in the cluster** – focuses on increasing the number of initiatives that enhance the competencies of cluster members' representatives and the coordinator's staff.

The results of the current benchmarking edition show more favorable median and benchmark values compared to the 2020 edition. However, the overall situation of clusters should be considered relatively poor, particularly in terms of innovation development. The median value for this criterion was 0.13, indicating that half of the surveyed clusters exhibited minimal activity in this area.

Graph 50. Values of subsynthetic indicators in the area of cluster results for the 2020 and 2022 research editions

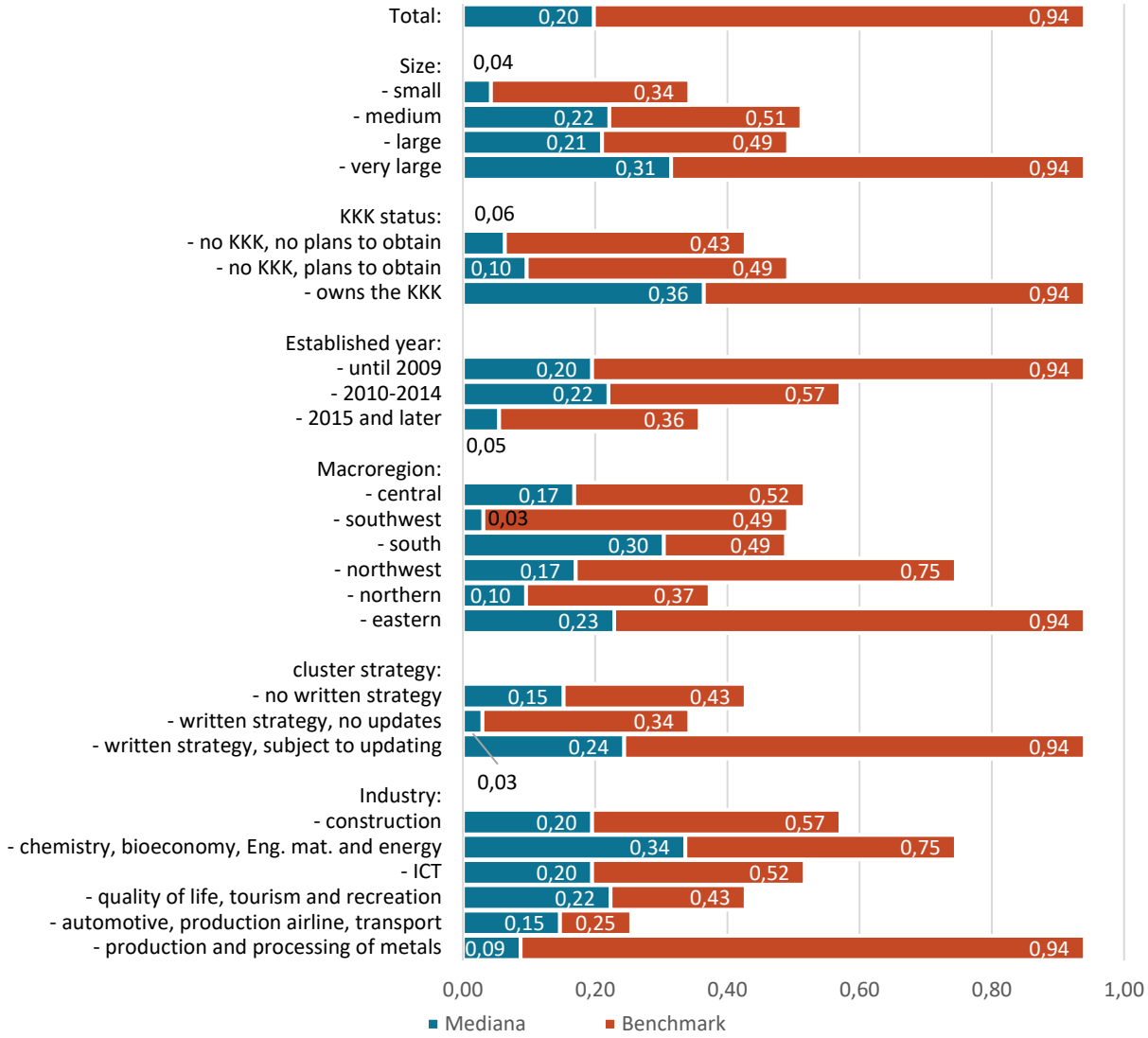


Source: own elaboration based on research involving cluster coordinators (N=41).

5.3.1. Development of cooperation in the cluster

The median value for the development of cooperation in the cluster was relatively low compared to the benchmark value, indicating that a significant number of clusters exhibited limited activity in this sub-area when compared to the top-performing clusters. Once again, the status of the cluster played an important role, with KKK clusters showing higher median values. The number of members within the cluster was also a significant factor, as very large clusters had a median value of 0.31, while smaller clusters had a median value of 0.04. The benchmark value highlights the ideal scenario where a very large cluster established before 2010, with the status of a KKK and a written strategy subject to updating, achieved the best rating in this sub-area.

Graph 51. Median and benchmark for the sub-area development of cooperation in the cluster



Source: own elaboration based on research involving cluster coordinators (N=41).

A significant proportion of surveyed cluster members, approximately 43.5%, declared their engagement in the joint implementation of cluster projects, indicating a cooperative approach within the clusters. However, this percentage showed a slight decrease of 1.5 percentage points compared to the previous edition of the study, although the difference falls within the statistical error margin. It is important to note that the concept of projects in this context is broad, encompassing both projects co-financed from EU funds and other types of initiatives.

Graph 52. Joint implementation of cluster projects

Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 12. Analysis of the values of partial indicators for the sub-area development of cooperation in the cluster

Indicator	All clusters
Number of startups, spin-offs, spin-outs, and special purpose vehicles established in the cluster	Average: 1.9, median: 0.0, benchmark 14.0. This type of activity was recorded in the case of nineteen clusters. Only in two clusters did the number of established enterprises and special purpose vehicles exceed 10.
Documented cooperation between technological start-ups and large enterprises within cluster structures	Average: 2.0, median: 0.0, benchmark: 21.0. In the case of twenty clusters, this type of activity was recorded. However, in most instances, these were single occurrences.
Number of jointly implemented projects in the cluster co-financed with public funds	Average: 3.4, median: 2.0, benchmark 20.0. Thirty-two clusters announced the implementation of joint projects co-financed by public funds. In only three clusters was the number of projects greater than or equal to ten.
Number of cluster members participating in joint projects co-financed by public funds in the cluster	Average: 18.4, median: 10.0, benchmark 160.0. About 17.5% of members from all clusters participating in the study engaged in joint projects. Only in the case of 11 clusters did the number of members exceed 20.

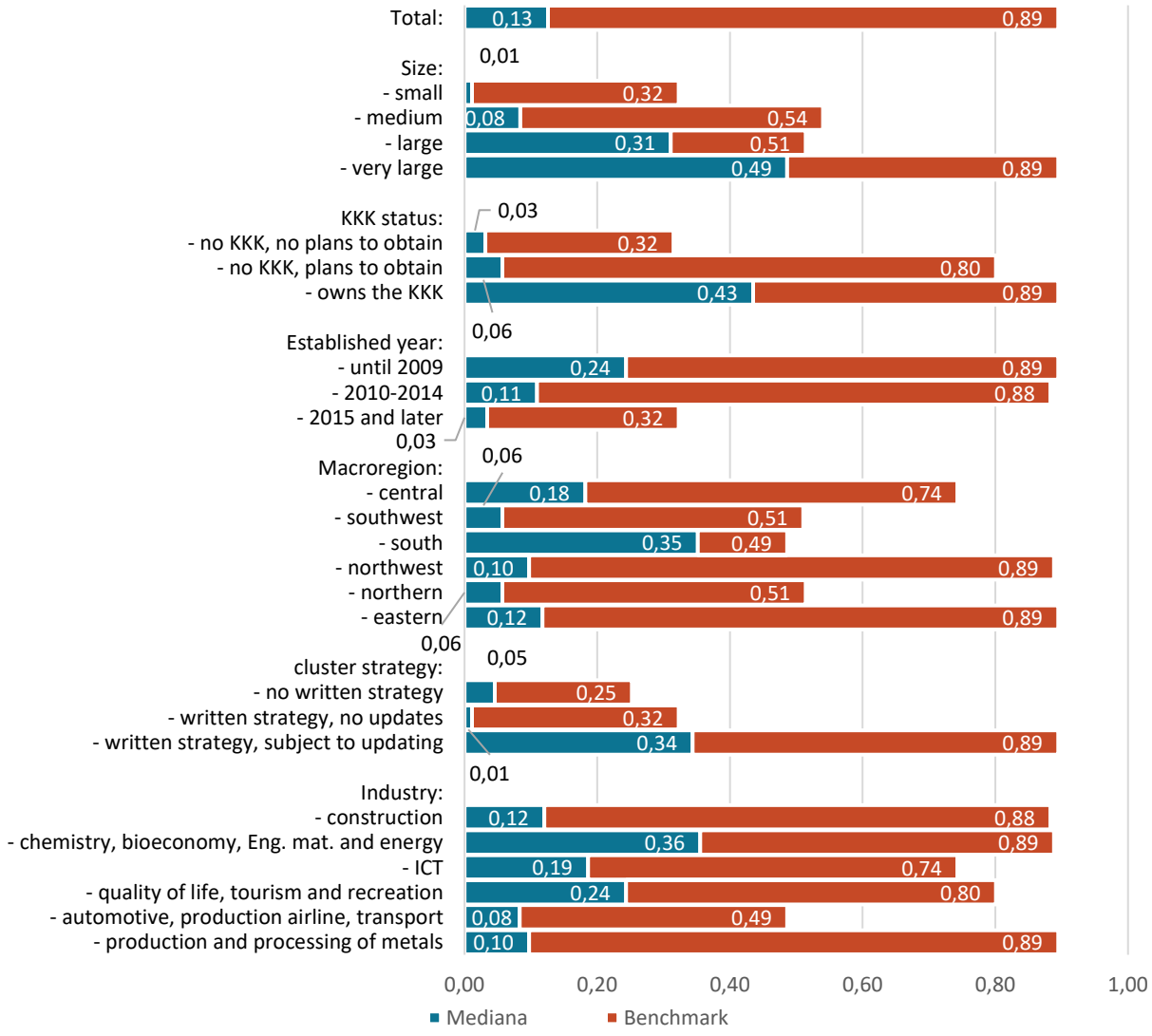
Indicator	All clusters
The value of jointly implemented projects in the cluster that are co-financed from public funds	Average: 22.8 million PLN, median: 2.1 million PLN, benchmark: 295.0 million PLN. It is worth noting that only nine clusters did not indicate the value of jointly implemented projects co-financed from public funds. On the other hand, a significant diversification in the value of these projects can be observed (the lowest ones amounted to PLN 10-20 thousand).
The number of common cluster products and services introduced to the offering	Average: 3.5, median: 1.0, benchmark: 16.0. Twenty four clusters announced the introduction of joint products and services to their offerings. In most cases, the number of products and services did not exceed 10.
Number of cluster members involved in the joint production and implementation of services	Average: 7.0, median: 3.0, benchmark: 40.0. The implementation of joint production and joint services by cluster members was indicated by 25 clusters. The total number of members involved in these activities did not exceed 300 entities, accounting for less than 7% of all members across all clusters. For this reason, it can be concluded that joint production and the implementation of joint services play a minor role in cluster activities.
The value of joint sales (common products and services) in the cluster	Average: 15.1 million PLN, median: 0.0 million PLN, benchmark: 500.0 million PLN. Only 15 clusters reported the sales value of common products or services within the cluster. Considering the previous indicator, it is likely that more cases could be recorded, but calculating them from the coordinator's perspective is quite challenging.
Number of orders obtained by the coordinator or cluster members for collaborative implementation	Average: 6.2, median: 0.0, benchmark 100.0. Nearly half of the clusters (19) reported receiving orders for joint implementation. In the case of 7 clusters, there were 10 or more orders.
Number of public-private partnership (PPP) initiatives undertaken through the cluster	Average: 0.7, median: 0.0, benchmark 7.0. Only seven clusters recorded PPP initiatives. Interestingly, one of the highest scores was achieved by a relatively poorly assessed cluster in the study. This illustrates a scenario in which each of the clusters is able to find an area in which it can achieve good results (cluster specialization).

Source: own elaboration based on research involving cluster coordinators (N=41).

5.3.2. Development of innovation in the cluster

The median value for the development of innovation in the cluster was exceptionally low, measuring 0.13. This indicates that at least half of the surveyed clusters demonstrated limited progress in this sub-area compared to a select few top-performing organizations. However, clusters with KKK status displayed a higher median value of 0.43, suggesting a relatively stronger focus on innovation. Additionally, clusters with at least 121 members and a written strategy subject to updates showcased better performance, with medians of 0.49 and 0.34, respectively. The highest-performing cluster achieved a benchmark score of 0.89, indicating near-maximum performance across various criteria. This cluster, founded before 2010, possessed KKK status, comprised over 121 members, and had a written strategy subject to updates.

Graph 53. Median and benchmark for the innovation development sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

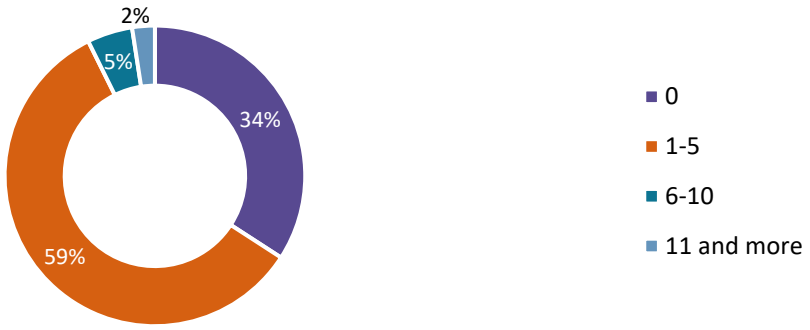
Clusters have long been recognized as significant components of innovation systems and drivers of innovation. The OECD publication of 1999 highlighted the role of clusters in fostering innovation, while the European Commission acknowledges their importance in enhancing innovation and competitiveness at the regional level economies[73]. This was reflected in the Communication of the Commission of 22/01/2014[74], in which the need to leverage the innovation potential of clusters to support the growth of innovative enterprises was emphasized. European cluster policy highlights clusters as accelerators of innovation and industrial change.

The development of innovation is a key objective of the Eurocluster initiative, which encompasses 171 partnerships from 23 countries as of September 1, 2022. These Euroclusters participate in the allocation of funds through various competitive programs that directly or indirectly support innovation. The European Commission also recognizes the inclusion of clusters as participants in Digital Innovation Hubs, providing innovative services and training[75]. At the national level, the Ministry of Development in Poland has outlined the importance of clusters as innovation centers, supporting their members, particularly enterprises, in implementing innovations. This is reflected in the document titled "Directions for the development of cluster policy in Poland after 2020."

One significant indicator of coordinator activity in the area of innovation is the number of jointly implemented innovative and R&D projects within the cluster. However, one-third of the surveyed clusters did not show any activity in this regard, while 59% of clusters reported implementing fewer than five projects. Only one cluster reported the implementation of 11 or more projects, representing a notable decrease compared to the previous edition of the survey, which featured five clusters reporting higher project numbers.

[73] www.interregeurope.eu/policylearning/news/8772/clusters-an-established-innovation-policy-for-regional-specialisation (accessed April 19, 2023).
[74] Actions for the renaissance of European industry, Brussels 2014.
[75] European Digital Innovation Hubs in Digital Europe Programme, European Commission, Brussels 2020.

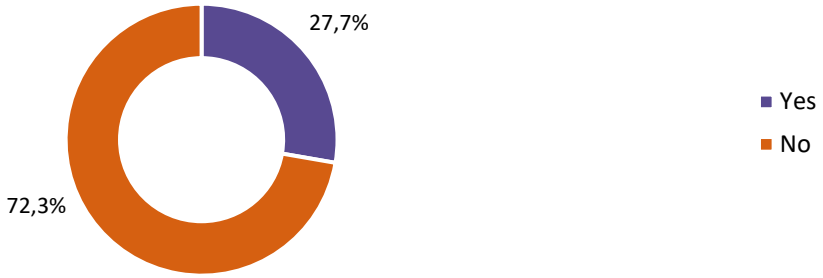
Graph 54. Number of implemented innovative and R&D projects in the cluster



Source: own elaboration based on research involving cluster coordinators (N=41).

The participation level of cluster members in innovative and/or R&D projects within the cluster, at 27.7%, can be considered moderate.

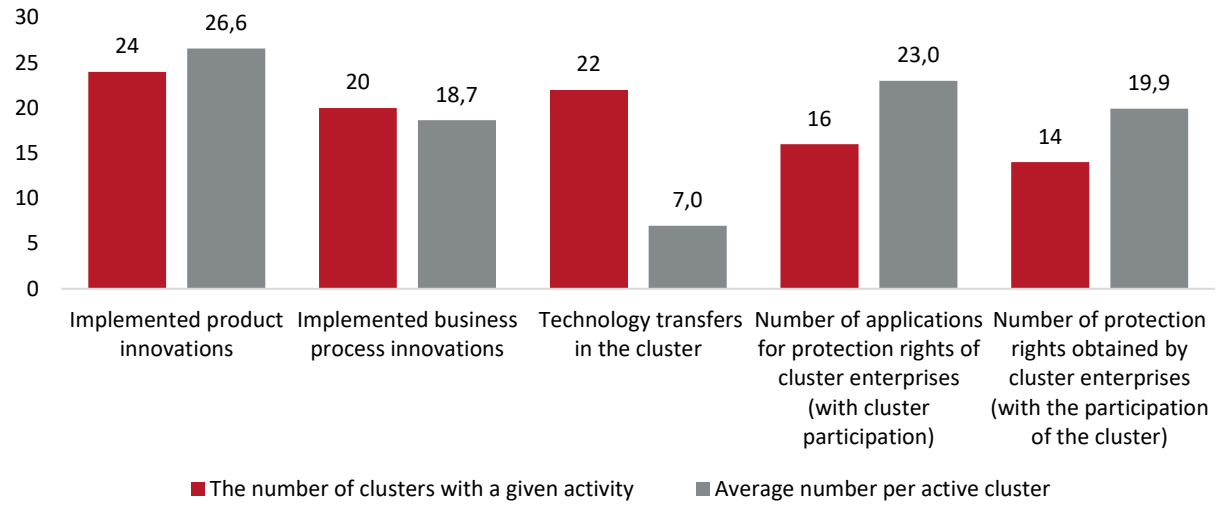
Graph 1. Participation of cluster members in the joint implementation of innovative and/or R&D projects in the cluster



Source: own elaboration based on a survey of cluster members (N=642).

The implementation of innovative R&D projects in the cluster has led to several direct effects, including the successful application of innovations, knowledge transfers, and activity in the field of intellectual property protection. It is noteworthy that 24 clusters successfully implemented product innovations, and a slightly smaller number, 20 clusters, implemented business process innovations. This represents a significant increase of nearly 50% compared to the previous survey edition, indicating a growing focus on innovation within the clusters. Moreover, the average number of innovations implemented per active cluster is notable, with an average of 26.6 for product innovations and 18.7 for business process innovations. In total, 638 product innovations and 373 business process innovations were successfully implemented across the surveyed clusters. Additionally, a considerable number of clusters (22) were involved in technology transfers, with a total of 153 transfers reported, averaging around 7 transfers per active cluster.

Graph 55. Effects of implementing innovative and R&D projects

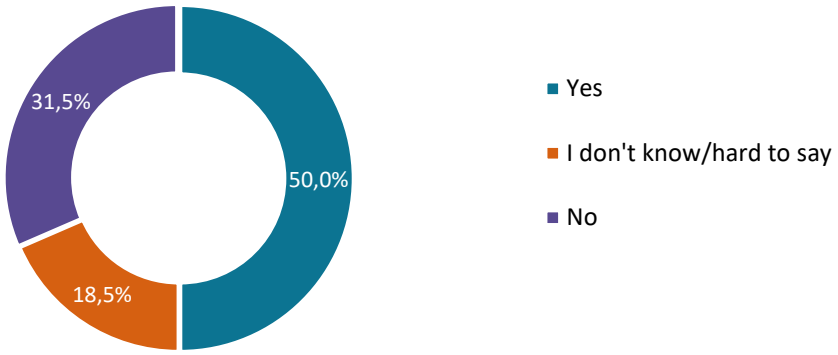


Source: own elaboration based on research involving cluster coordinators (N=41).

Activity in the field of intellectual property protection is a crucial aspect of innovation development within clusters. The survey examined the number of patents, patent applications, utility model protection rights, and industrial design registration rights sought and acquired by cluster enterprises with the cluster's involvement. The results reveal that 16 clusters indicated activity in applying for protection rights, while 14 clusters reported securing such rights. These figures are comparable to those from the previous survey edition. Overall, a total of 368 protection rights were registered, and 279 rights were secured.

Furthermore, it is important to assess the development of innovation from the perspective of cluster members. The survey found that 37.1% of cluster members introduced product innovations, and 32.4% introduced business process innovations as a result of their participation in the cluster. On the other hand, 50.9% of entities did not introduce any innovations due to their status as cluster members. Collaboration with universities and entities from the science system played a significant role in introducing innovations, with models of cooperation in this area varying widely. These ranged from non-institutional cooperation, such as individual contacts with researchers, to commissioning R&D work and/or the implementation of innovations, as well as forming partnerships and jointly implementing projects. It is worth noting that approximately 50% of cluster members participating in the study positively assessed the role of the cluster in establishing cooperation in the field of innovation. This indicates that clusters can provide valuable support and opportunities for collaboration, leading to the development of innovation among their members.

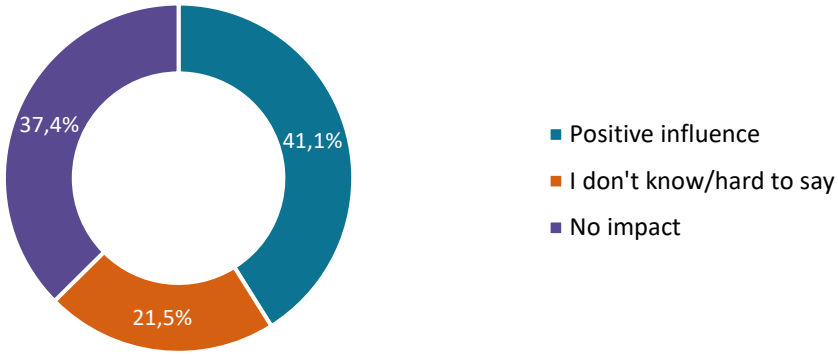
Graph 56. Impact of participation in the cluster on fostering cooperation with universities and other entities within the higher education and science system



Source: own elaboration based on a survey of cluster members (N=642).

The assessment of the impact of cluster participation on the level of technological advancement among cluster members is an important aspect to consider. The survey revealed that less than half of the surveyed cluster members (41%) positively evaluated the effect of their participation in the cluster on the technological advancement of their enterprises. This indicates that there is room for improvement in promoting technological solutions and fostering technological advancement within clusters. It is worth noting that this assessment represents a decrease of 9 percentage points compared to the previous edition of the survey.

Graph 57. Impact of participation in a cluster on the level of technological advancement



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 13. Analysis of the values of partial indicators for the sub-area of innovation development in the cluster

Indicator	All clusters
Number of jointly implemented innovative projects and R&D projects that result in or will lead to innovative products or technologies in the cluster	Average: 4.0, median: 2.0, benchmark: 73.0. Twenty-seven clusters reported the implementation of joint innovative projects. In most cases, the number of these projects did not exceed five, with only two clusters having numbers greater than or equal to ten, totalling ten and seventy-three, respectively. Finally, it is worth noting that the average calculated only for clusters implementing innovative and R&D projects (27 structures) was 6.1.
Number of cluster members participating in joint innovation and R&D projects in the cluster	Average: 9.4, median: 4.0, benchmark: 96.0. In most clusters, the percentage of members participating in projects was quite low (approximately 9.2%, considering all clusters and their members) and 14.0% if only the clusters declaring the implementation of joint projects are taken into account.
The value of collaboratively implemented innovative projects and R&D initiatives within the cluster	Average: PLN 18.1 million, median: PLN 1.1 million, benchmark: PLN 206.6 million. If we consider only twenty-seven clusters that declare the implementation of joint innovative and R&D projects, their average value increases to PLN 27.5 million.
Number of implemented innovative products	Average: 15.6, median: 2.0, benchmark 294.0. In the case of 24 clusters, the implementation of product innovations was recorded. In most instances, the number of implemented innovations did not exceed 5. A cluster emerged in the study that clearly leads this ranking, with a declaration of implementation of 294 product innovations.
Number of implemented business process innovations	Average: 9.1, median: 0.0, benchmark: 123.0. In the case of twenty clusters, the implementation of innovations in business processes was recorded. Only in 7 cases did the number of innovations exceed 10. The study included a cluster that is a clear leader in this ranking (declaration of implementation of 123 business process innovations).
The number of technology transfers in the cluster made through the cluster	Average: 3.7, median: 1.0, benchmark: 27.0. More than half of the clusters (22) reported implementing technology transfers within the cluster. For 6 clusters, this number was 10 or more.

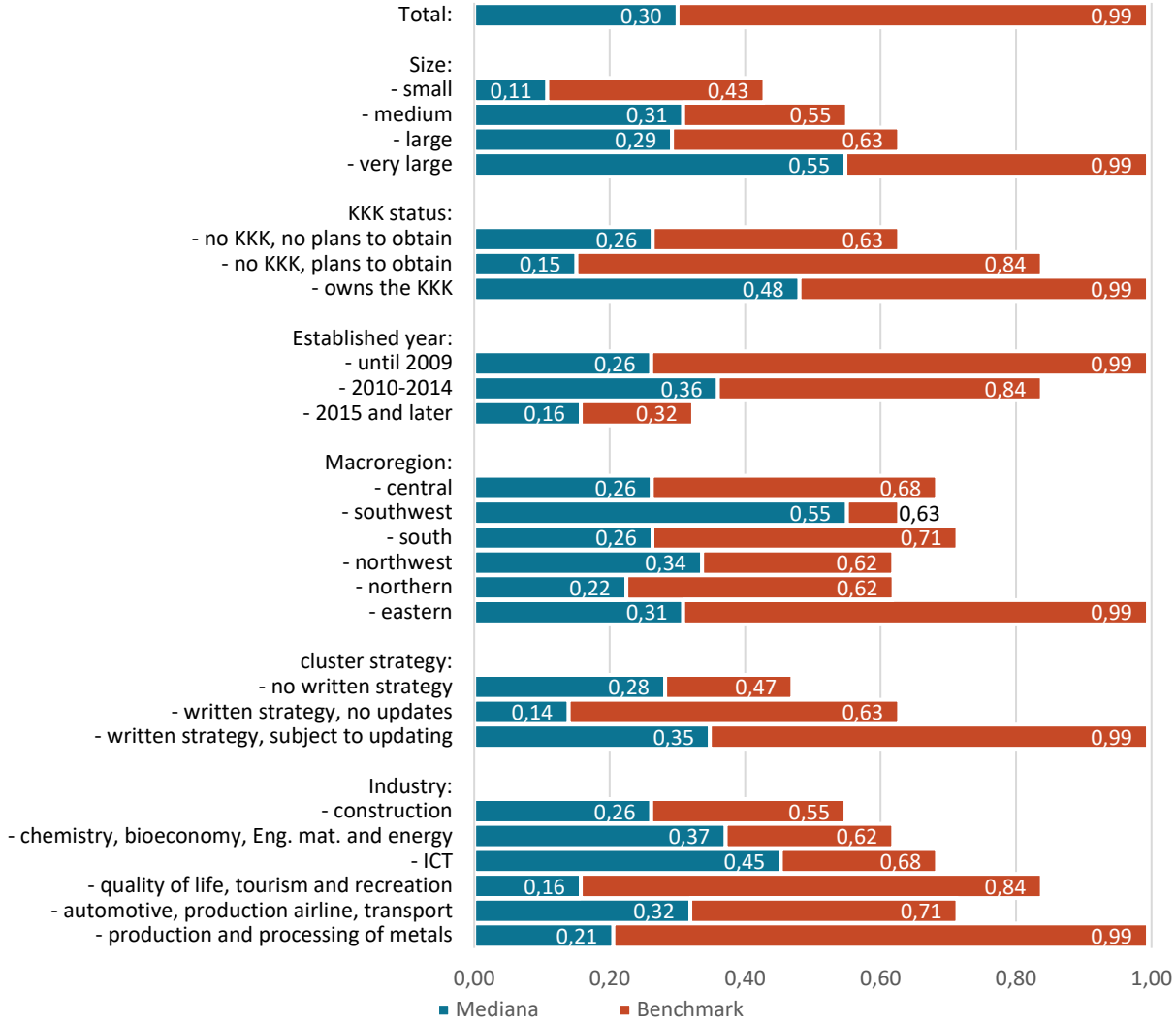
Indicator	All clusters
Number of patents, patent applications, protection rights for a utility model, and rights in registration of an industrial design filed and obtained by cluster enterprises with the participation of the cluster.	Average: 9.0, median: 0.0, benchmark: 141.0. Fewer than half of the clusters (16) recorded participation in the notification of protection rights, while 14 participated in obtaining these rights. In total, 368 notifications were made, and 279 protection rights were obtained in the surveyed clusters. Given the rather lengthy evaluation processes of submitted applications, it is impossible to directly calculate the success rate.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.3.3. Development of competences in the cluster

The median value for competence development in clusters reached a relatively high level of 0.30, indicating a fairly even involvement of clusters in this sub-area. Clusters founded between 2010 and 2014 achieved an advantage with a median value of 0.36. Additionally, clusters with the status of KKK (Klaster Key Klaster) obtained a median value of 0.48, indicating their stronger commitment to competence development. Furthermore, clusters with a written strategy subject to updating and a minimum of 121 members also performed well, with median values of 0.35 and 0.55, respectively. The benchmark value highlights the performance of a specific cluster that excelled in competence development. This cluster, established before 2010 and holding the status of KKK, with a written strategy subject to updating, was rated the best in this sub-area.

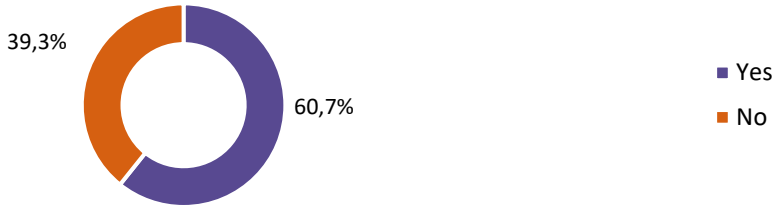
Graph 58. Median and benchmark for the competence development sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

The survey results indicate that a significant majority of cluster members, specifically over 61%, participated in joint initiatives aimed at improving competences initiated by the cluster. This demonstrates a positive trend compared to the previous edition of the survey, reflecting a 2-percentage point increase in participation.

Graph 59. Percentage of cluster entities participating in common forms of competence improvement initiated by the cluster



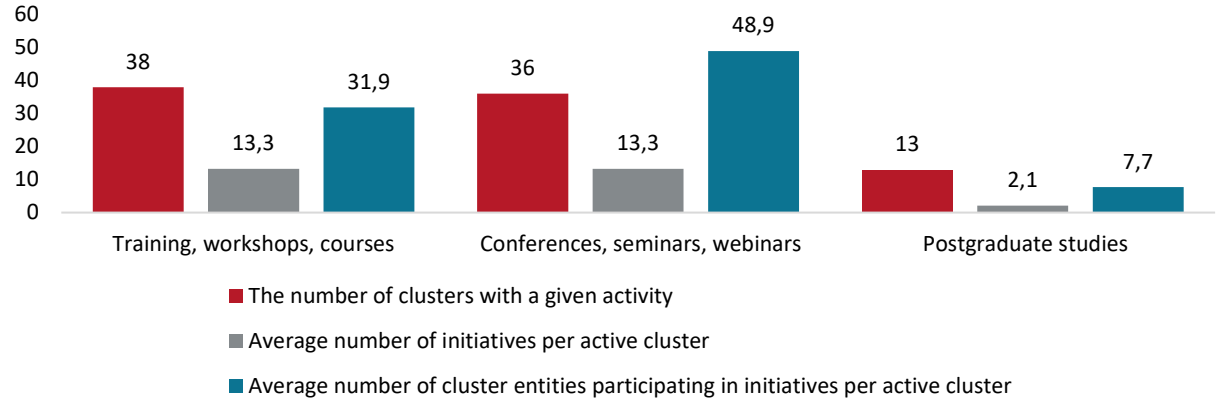
Source: own elaboration based on a survey of cluster members (N=642).

The survey findings reveal that training sessions, workshops, courses, conferences, seminars, and webinars were the most commonly used methods for improving competencies in clusters. Approximately 38 clusters reported engaging in training sessions, workshops, and courses, while 36 clusters organized conferences, seminars, and webinars. These activities attracted a significant number of cluster members, with an average participation rate of 32 members for training sessions, workshops, and courses, and 49 members for conferences, seminars, and webinars.

It is noteworthy that a significant portion of clusters (13 clusters) also provided initiatives in the form of postgraduate studies for their members. While less common compared to other types of activities, postgraduate studies offer an opportunity for cluster members to pursue specialized knowledge and skills beyond traditional training programs.

The topics covered in these competence improvement activities were diverse, encompassing both general and specialized areas. General topics included employee-related issues such as remote work and employee capital plans, marketing and promotion, competition law, quality systems, EU funds, future competencies, resource management, exports, and digital transformation. Additionally, many trainings focused on specialized subjects, including Industry 4.0 technologies, cybersecurity, and topics directly related to the cluster's industry, such as the production/testing of composite materials, the use of selected ingredients in functional food, or fiber optic technologies.

Graph 60. Initiatives aimed at improving the competences of cluster members



Source: own elaboration based on research involving cluster coordinators (N=41).

Analysis of partial indicators for sub-areas

Table 14. Analysis of the values of partial indicators for the sub-area development of competences in the cluster

Indicator	All clusters
Number of initiatives organized within the cluster aimed at improving the competences of cluster members, broken down by forms of competence improvement	Average: 25.7, median: 15.0, benchmark: 121.0. Only two clusters did not report activity regarding the improvement of the competences of their members. In most cases (26), there were 10 or more initiatives per cluster. Besides the forms of competence improvement discussed on the previous page, the coordinators also indicated implementation doctorates.
Number of cluster entities that participated in various methods of competence improvement initiated by the cluster (broken down by improvement methods)	Average: 78.9, median: 60.0, benchmark: 245.0. It is worth noting the high participation of cluster entities in joint forms of competence development, as evidenced by the high average and benchmark. In total, 3,235 entities participating in such initiatives were recorded. It should be noted, however, that the indications regarding this indicator allow for multiple counting of the same entity that took part in more than one initiative. In the case of four clusters, the number of entities exceeded 200, and for the next eight clusters, it was greater than or equal to 100. Taking into account the method of constructing the indicator, the highest activity was observed in large and very large clusters, particularly in the area of ICT.
Number of training sessions attended by cluster coordinator employees to improve their competences	Average: 5.8, median: 4.0, benchmark: 20.0. Only six clusters did not report any activity in the area of training for the coordinator's employees.

Source: own elaboration based on research involving cluster coordinators (N=41).

Area summary

- The analysis of "Cluster results" focused on three key sub-areas: the development of cooperation in the cluster, the development of innovation in the cluster, and the development of competences in the cluster. The median values for the development of cooperation and innovation indicate that approximately half of the clusters performed poorly in these areas compared to others, exhibiting limited activity. However, there were notable leaders among the clusters, primarily large or very large clusters with diverse industry profiles encompassing sectors such as ICT, construction, metal industry, chemistry, and bioeconomy.
- The involvement in implementing joint cluster projects remained relatively stable, with 43.5% of cluster members participating in such projects, reflecting a slight decrease compared to the previous edition of the study.
- The development of innovation in the cluster, particularly through joint innovation and R&D projects, received a moderate assessment. One-third of the clusters were not actively engaged in these activities, and there was a decline in the intensity of such projects compared to the previous study. The percentage of cluster members participating in these projects was relatively low at 27%.
- Despite the moderate participation in innovative and R&D projects, the implementation of innovations within clusters should be viewed positively, as there was a significant increase compared to the previous survey edition. Currently, 24 clusters have reported implementing product innovations, while 20 clusters have implemented business process innovations.
- Cluster coordinators displayed a high level of engagement in enhancing competencies within the cluster, mainly through organising training sessions and workshops. The training topics encompassed a diverse array of areas, with numerous clusters providing specialized and sector-specific training programs.

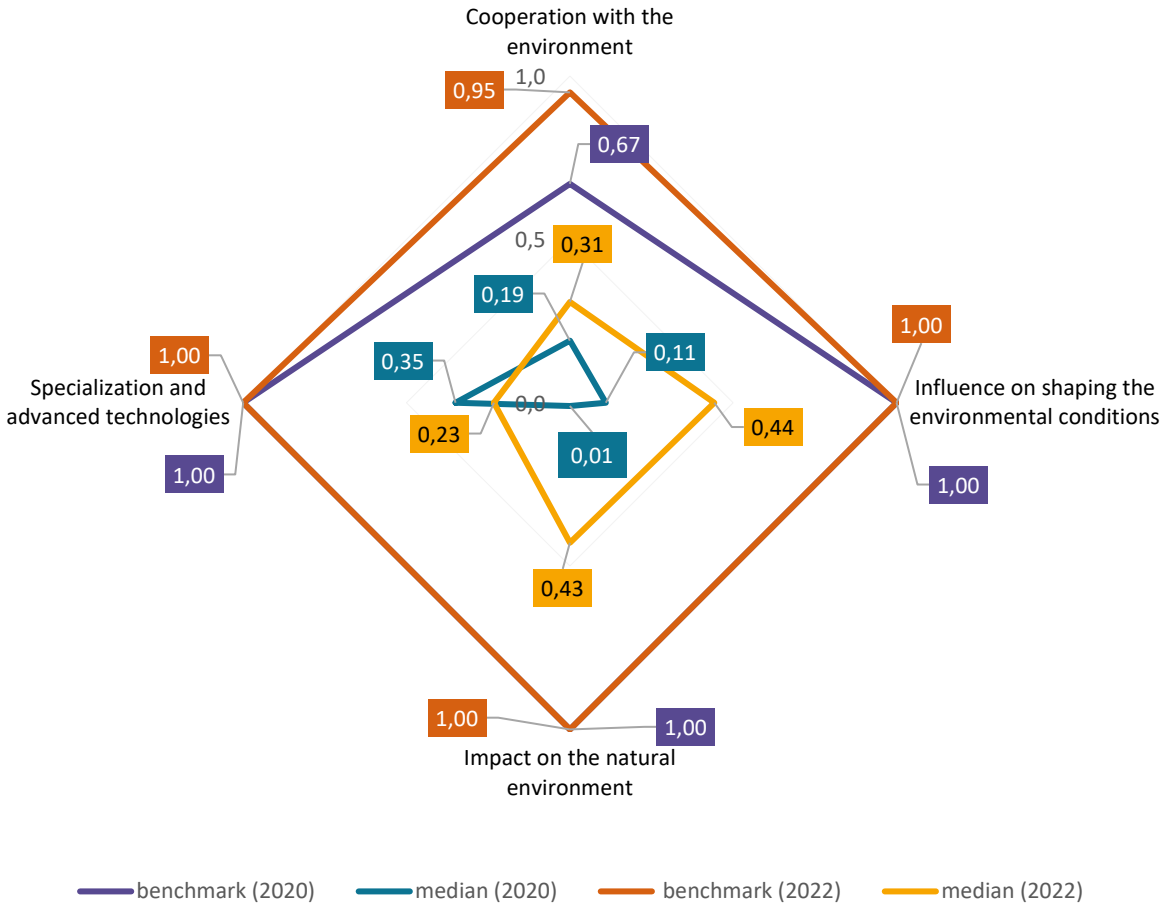
5.4. Impact on the environment

The assessment in the examined area focused on several sub-areas:

- **Cooperation with the environment** – cooperation of the cluster with external entities such as public authorities, business support institutions, the R&D and education sectors, and other associations of enterprises, including other clusters.
- **Influence on shaping the environment conditions** – participation in consultative bodies at the national and regional levels, activities that influence society, and lobbying efforts.
- **Impact on the natural environment** – number of initiatives focused on enhancing the condition of the natural environment.
- **Specialization and advanced technologies** – the number of enterprises engaged in business activities related to the National Smart Specialization and the dominant Regional Smart Specialization for the cluster, as well as the number of enterprises working in the area of technologies that are essential for the future economic development of the EU (so-called KET – key technologies).

In the previous and current editions of the study, three out of the four sub-areas exhibit very high benchmark values, indicating the presence of clusters achieving exceptional scores in these areas. In the previous edition, there was a significant number of clusters with poor results regarding their impact on the environment (median 0.11) and their impact on the natural environment (median 0.01). However, in the current edition, the results have significantly improved, with median values rising to 0.44 and 0.43 for these sub-areas, respectively. Conversely, there has been a slight decrease in the median value for specialization and advanced technologies. This may suggest a greater sectoral diversification among cluster members, shifting away from narrow specialization towards interdisciplinary activities, possibly driven by an increasing number of cluster members.

Graph 61. Values of subsynthetic indicators related to environmental impact for the 2020 and 2022 editions of the study

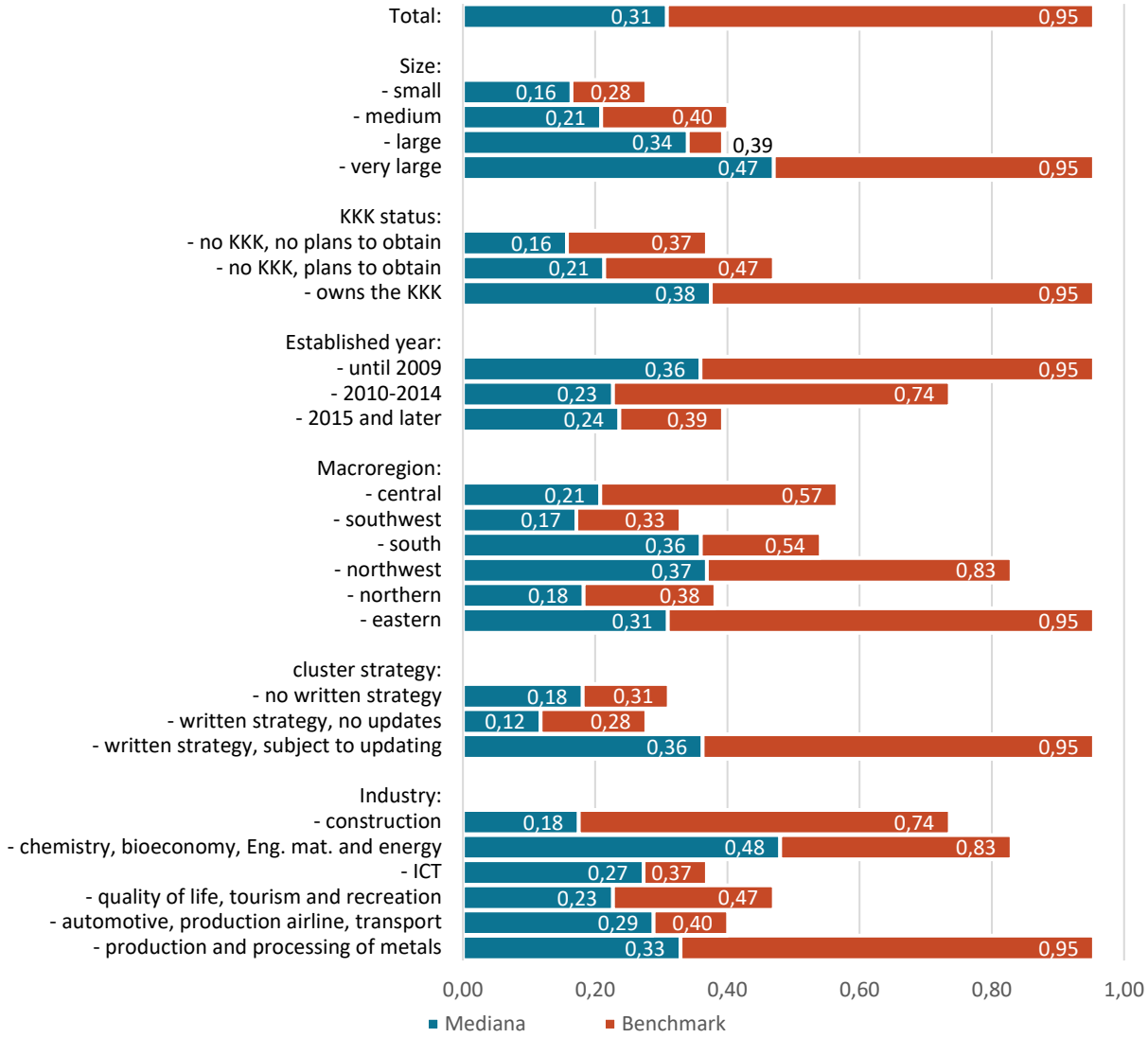


Source: own elaboration based on research involving cluster coordinators (N=41).

5.4.1. Cooperation with the environment

The assessment of cooperation with the environment reveals a notable difference between the median value (0.29) and the benchmark value (0.95), indicating significant diversity among the studied clusters in this sub-area. Once again, clusters with KKK status demonstrate a significant advantage in terms of the median value (0.41) compared to other clusters (0.21 and 0.26). The benchmark value, set at a very high level, indicates the presence of a leading cluster among the examined clusters. This leading cluster is characterized as a very large cluster established before 2010, holding KKK status and having a written strategy subject to updating.

Graph 62. Median and benchmark for the sub-area cooperation with the environment



Source: own elaboration based on research involving cluster coordinators (N=41).

Analysis of partial indicators for sub-areas

Table 15. Analysis of partial indicators regarding sub-area cooperation with the environment

Indicator	All clusters
Number of active cooperation agreements with public authorities (local and central government)	Average: 2.4, median: 2.0, benchmark: 20.0. Over one-third of clusters (15) lack any active cooperation agreement with public authorities. This reflects the relatively low involvement of public authorities in cluster activities in a more advanced model, where only 16 clusters have local government units (LGU) as partners. However, this does not necessarily indicate the LGU's membership in the cluster; there may be cooperation agreements in place.
Forms of cluster support from public authorities	Average: 1.85, median: 2.0, benchmark: 7.0. From the list of five forms of support, the following were most frequently indicated: promotional support (51%), financial support (46%), and training and education support (39%). Organizational support (27%) and legal support (10%) were of much lesser importance. Clusters could indicate additional forms outside the cafeteria (hence the benchmark is higher than the list of forms of support). The clusters also indicated, among others, the CORNET initiative at the National Center for Research and Development, competitions of the Marshal's Offices, and economic missions.
Number of active cluster cooperation agreements with business support institutions	Average: 3.3, median: 2.0, benchmark: 16.0. Over three-quarters of clusters (32) maintain active cooperation with BEI. The frequent presence of business support institutions in cluster activities stems from several reasons. Often, BEI serves as the cluster coordinator. Additionally, business support institutions are typically interested in joining the cluster, for instance, to expand the potential pool of contractors. At the same time, BEI can offer a range of valuable services to the cluster coordinator and its members. One of the most significant business support institutions in clusters regarding KKK status is, for example, innovation centers certified by the Ministry of Development and Technology. Clusters vying for KKK status must include such a center among their members.

Indicator	All clusters
Intensity of cooperation with the R&D and education sectors	Average: 2.6, median: 3.0, benchmark: 6.0. From the list of four possible areas of cooperation, the following were most frequently indicated: collaboration with selected scientists (73%), cooperation in teaching (66%), and joint implementation of projects (61%). Clusters may suggest additional areas of collaboration beyond the cafeteria. Among other initiatives, those in the field of creating demonstration laboratories or organising trips to fairs were mentioned.
Number of active cooperation agreements in clusters with institutions in R&D and education sectors	Average: 3.9, median: 3.0, benchmark: 16.0. Only 10 clusters lack an active cooperation agreement with R&D sector institutions. It's worth noting that in only 3 clusters is one agreement concluded. Other clusters approach the issue of cooperation with this category of units more broadly.
Number of fields of study in which the cluster was involved in launching and implementing	Average: 3.9, median: 2.0, benchmark: 24.0. Twenty-nine clusters contributed to the development of new fields of study. The majority of clusters participated at the higher education level (24 clusters, 60 launched majors) and in postgraduate studies (17 clusters, 29 majors). Conversely, several clusters (14) were involved in creating courses for vocational education.
Number of completed apprenticeships, internships, or implementation doctorates	Average: 61.1, median: 6.0, benchmark: 1,882.0. The leader of the list has completed nearly 2,000 practices, internships, or implementation doctorates, which significantly overstates the value of the average. If this cluster were excluded from the list, the average number of apprenticeships/internships would be 15.6. At the same time, 15 clusters are not involved in this area of activity. In total, the study showed 1,310 internships, 1,092 internships, and 104 implementation doctorates.
Number of active cooperation agreements with national clusters	Average: 1.9, median: 1.0, benchmark: 22.0. Twenty-two clusters have an active cooperation agreement with another national cluster. Only in two cases was this number higher than five, amounting to eight and twenty-two, respectively (benchmark).
Number of active cooperation agreements with foreign clusters	Average: 3.7, median: 2.0, benchmark: 20.0. An interesting situation concerns the number of active cooperation agreements with foreign clusters. In this case, the situation is more favorable than that of domestic cooperation, as evidenced by the nearly twice as high average number of contracts. Additionally, more clusters (24) have at least one active contract with a foreign cluster, and for 7 clusters, the number of contracts exceeds 5.

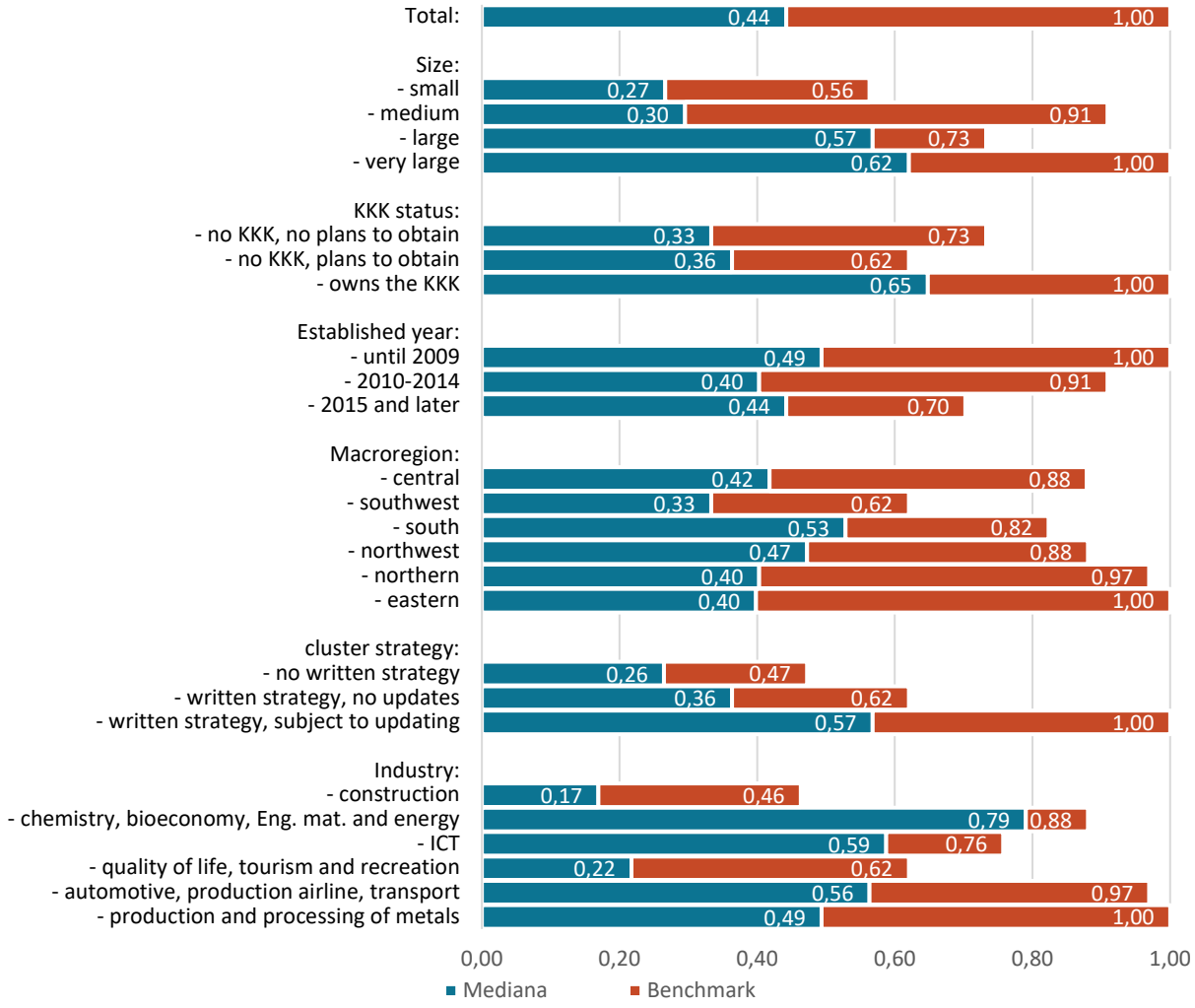
Indicator	All clusters
Number of active cooperation agreements in clusters with other associations of enterprises	Average: 1.8, median: 1.0, benchmark: 19.0. Twenty-three clusters are active in this area, as indicated by the relatively low value of the median. Only two clusters have ten or more signed agreements.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.4.2. Influence on shaping the environmental conditions

The median value for the impact on environmental conditions sub-area reached a relatively high level of 0.44. Interestingly, the year of the cluster's establishment and its location did not significantly affect the results in this sub-area. Instead, clusters operating in industries such as chemistry, bioeconomy, materials, and energy engineering achieved higher median scores of 0.79. Additionally, clusters with KKK status (0.65), a written strategy subject to updating (0.57), and at least 121 members (0.62) also demonstrated advantages in this sub-area. The benchmark value of 1.00 indicates the existence of at least one cluster in the ranking that obtained maximum scores in each of the partial indicators. This leading cluster possesses KKK status, was established before 2010, has at least 121 members, and maintains a written strategy subject to updating.

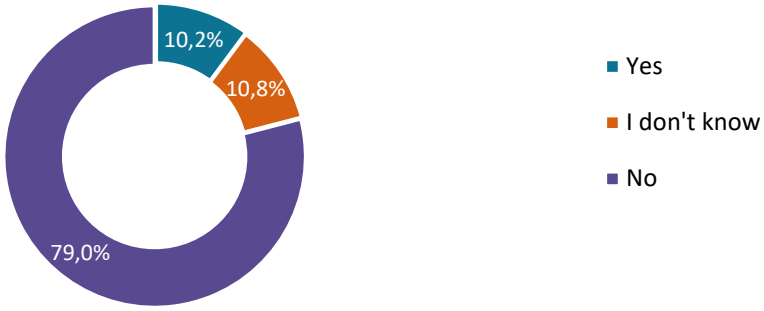
Graph 63. Median and benchmark for the sub-area impact on shaping the environmental conditions



Source: own elaboration based on research involving cluster coordinators (N=41).

The benchmark value indicates that clusters lacking a written strategy and operating in the construction industry performed relatively poorly regarding their impact on the environment. This suggests that these clusters may have lower scores compared to others in the sub-area of environmental impact. The representation of cluster structures in various consultative bodies is an important aspect of cluster activity that influences the external environment. However, the survey results show that cluster members' participation in such bodies is moderately active, with only 10% of members reporting their involvement.

Graph 64. Representation in economic, social and scientific consultative bodies (e.g. NCBR[76], NCN[77])



Source: own elaboration based on a survey of cluster members (N=642).

Clusters, from an institutional perspective, have the potential to shape the external environment in a diverse and comprehensive manner. They can engage in various activities that range from soft initiatives such as training and information sharing to investment activities aimed at enhancing the external environment of the clusters. Some of these activities may also fall under corporate social responsibility. Here are examples of interesting activities that clusters have indicated:

- Providing funding prizes for high school students participating in competitions and Olympiads allows them to visit plants associated with the cluster. This promotes innovation and nurtures the talents of young individuals.
- Co-organizing sports, medical, or cultural events and actively participating in them under the cluster's brand enhances visibility and fosters community engagement.
- CSV (Creating Shared Value) activities. Examples of activities in this area are described in the section on good practices in Chapter 7 (Promotion of Łódź as a way to attract employees from the IT industry - ICT Central Poland Cluster or Social Responsibility of the Cluster - IT for Ukraine - ICT Cluster West Pomerania).

[76] National Centre for Research and Development Poland.
[77] National Science Center Poland.

- Conducting educational, training, and informational activities, particularly in areas such as sustainable economy or Industry 4.0:
    - A series of free webinars in the area of sustainable economy "We close the circuits"
    - Workshop on Recycling Composite Materials / New Energy Sources (Hydrogen)
    - Support for vocational education
    - Cluster Scholarships
    - SysteMA project aimed at improving competences in the medtech industry.
- Offering free programming workshops for teenagers to foster their interest in technology and innovation.
- Offering free consulting services to enterprises in the ICT sector, including non-members of the cluster.
- Extending financial or in-kind donations, including the dedicated production of materials and articles, to healthcare facilities during the COVID-19 pandemic.
- Collaborating on initiatives to assist refugees from Ukraine.
- Undertaking promotional activities to advance low-emission drives in coastal shipping, with the aim of enhancing the quality of life for the inhabitants of the Hel Peninsula.
- Providing infrastructure, including machines, tools, and materials, for university projects such as the PWR RACING TEAM at Wrocław University of Science and Technology, to support their development of a university F1 car.
- Conducting innovation audits, organizing cooperation forums, and facilitating B2B exchanges to enhance collaboration and innovation within the cluster.
- Participating in global initiatives like the World Cleaning Operation.
- Establishing digital innovation hubs, such as the Pomeranian Digital Innovation Hub.

Analysis of partial indicators for sub-areas

Table 16. Analysis of the values of partial indicators influencing environmental conditions development in the sub-area

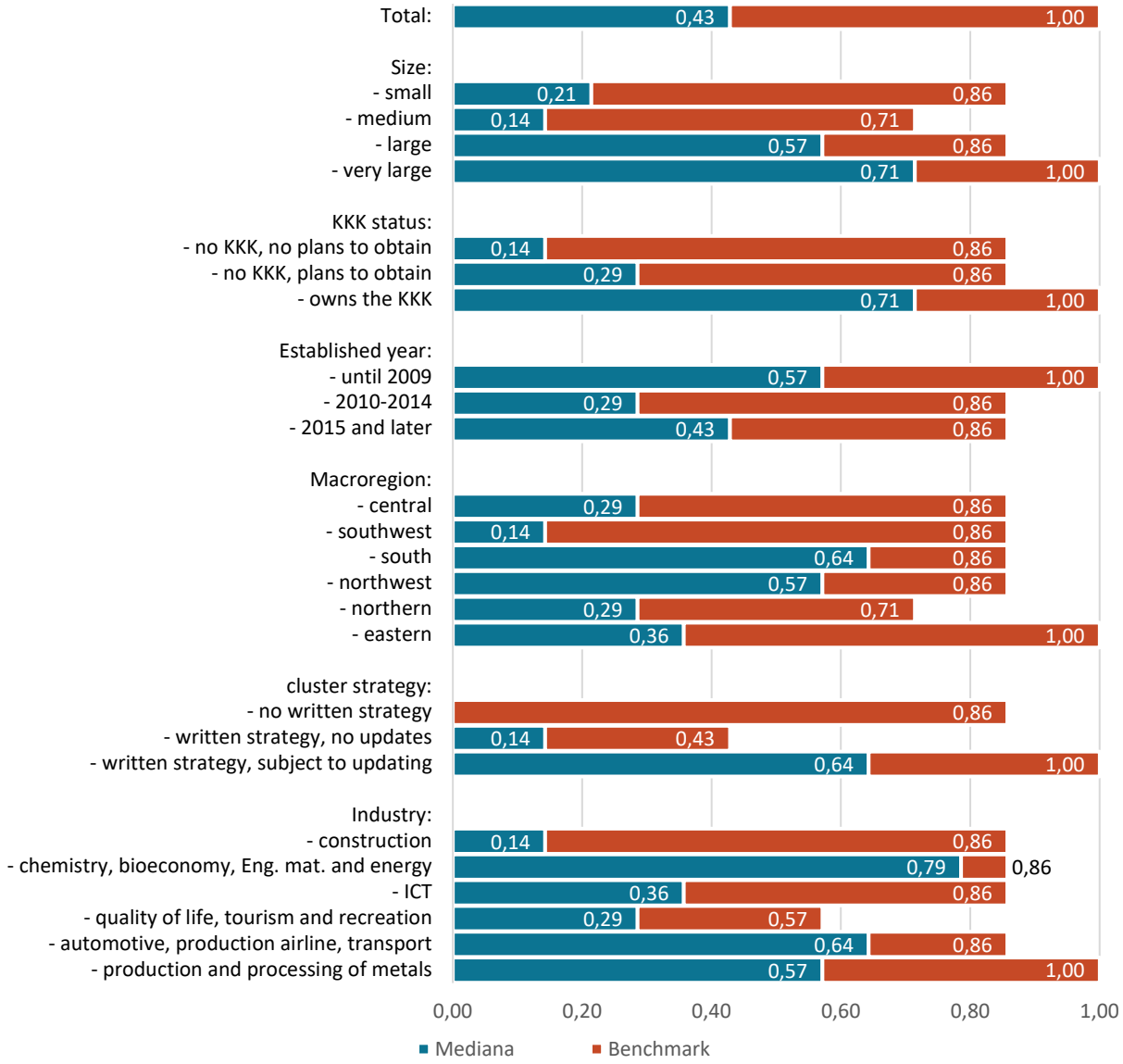
Indicator	All clusters
Number of consultative bodies (economic, social, scientific) at the national and regional level with representatives of the cluster coordinator (representing the cluster, not the parent organisations)	Average: 3.8, median: 3.0, benchmark: 20.0. Representatives of cluster coordinators often participate in various consultative bodies. This activity was reported by thirty-four clusters. In the case of three clusters, there were 10 or more bodies involved.
Taking actions by the cluster that positively impact society (e.g. in accordance with environmental, social and corporate governance criteria (Environmental, Social and Governance - ESG), the concept of creating shared value (Creating Shared Value - CSV), corporate social responsibility (Corporate Social Responsibility - CSR), etc.)	Sixty-eight per cent of clusters reported taking actions with a positive impact on society. More information about the types of actions taken has been included earlier in the text.
Number of initiatives designed to enhance the external conditions for cluster members' business operations	Average: 4.6, median: 2.0, benchmark: 55.0. Thirty-two clusters were declared to run lobbying initiatives. In only five clusters was the number of initiatives greater than or equal to ten. The total number of initiatives across all examined clusters was 187.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.4.3. Impact on the natural environment

The sub-area of impact on the natural environment shows a positive trend, with the median indicator reaching a relatively high level of 0.43. This suggests that the majority of clusters have undertaken activities aimed at improving the natural environment. This marks an improvement compared to the previous edition of the study, where at least half of the clusters were less active in this area. The report includes essential information on how clusters are affecting the environment, including political initiatives under the European Green Deal. It highlights the market activities that clusters engage in to address environmental concerns and promote sustainability.

Graph 65. Median and benchmark for the sub-area of impact on the natural environment



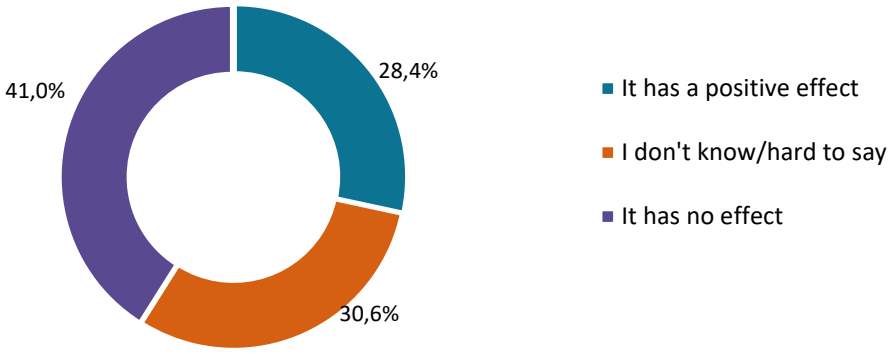
Source: own elaboration based on research involving cluster coordinators (N=41).

The analysis indicates that KKK clusters, particularly those established before 2010 and with a written strategy subject to updating, as well as very large clusters, have been more advantageous regarding their impact on the natural environment compared to other clusters. Clusters operating in the chemical, bioeconomy, materials, and energy engineering industries also achieved higher median levels in this area. Interestingly, clusters in the southern and northwestern macroregions had a slight advantage.

The benchmark value of 1.00 suggests that at least one cluster achieved maximum scores in each partial indicator, demonstrating exemplary performance in its impact on the natural environment. These clusters typically have a large membership, KKK status, a long history of establishment, and an updating writing strategy.

On the other hand, the survey revealed that only 28% of cluster members assessed the impact of their participation in the cluster as having a positive effect on taking actions to improve the natural environment. This represents a decrease of 10 percentage points compared to the previous edition of the survey. This suggests that there is room for improvement in engaging cluster members and raising awareness about the importance of environmental initiatives within clusters.

Graph 66. Assessment of the impact of involvement in the cluster on activities related to green transformation



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 17. Analysis of the values of partial indicators for the sub-area of impact on the natural environment

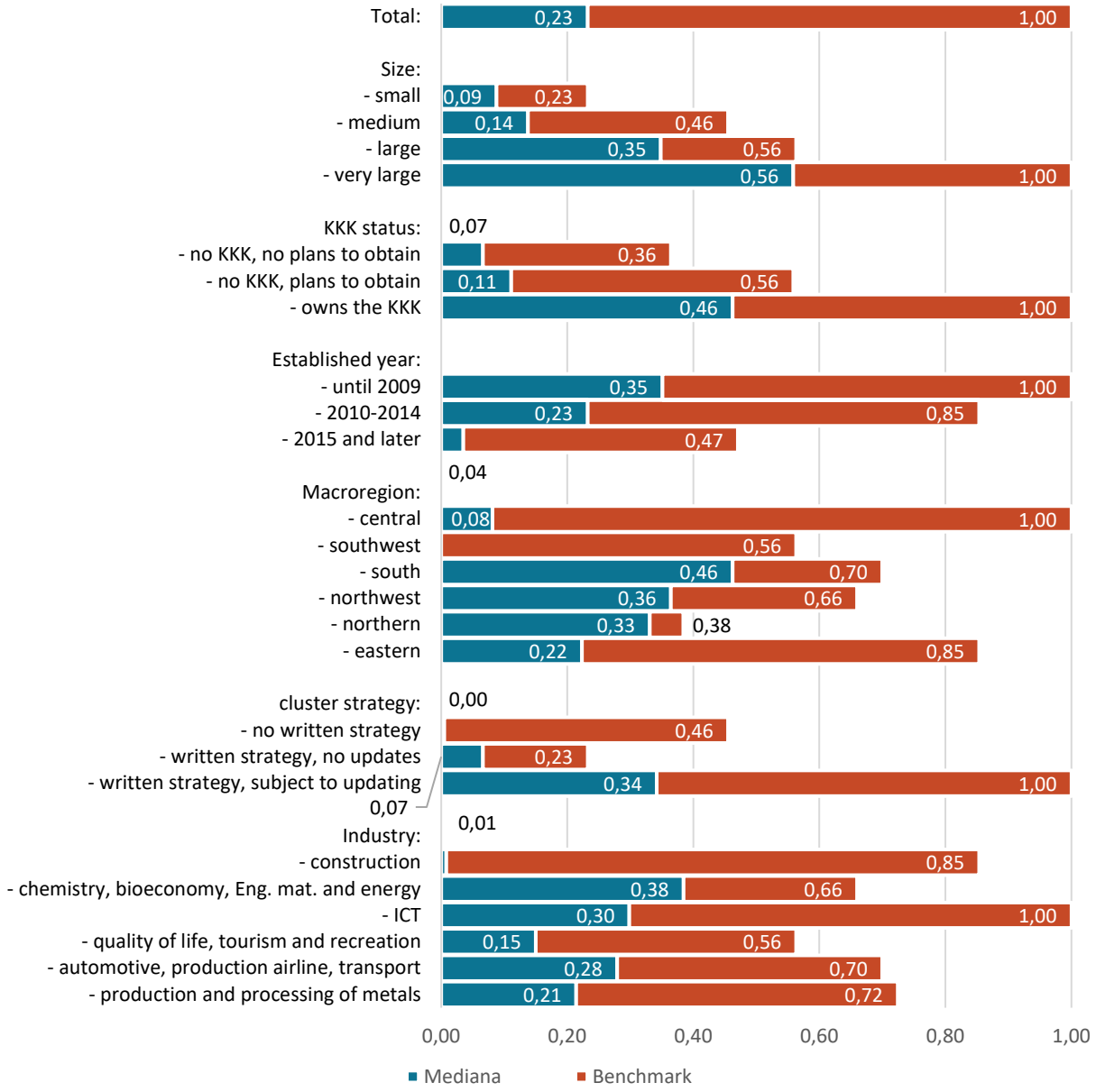
Indicator	All clusters
Number and types of cluster activities aimed at improving the condition of the natural environment	Average: 3.1, median: 3.0, benchmark: 7.0. From the list of six types of activities, the following were most frequently indicated: the use of the circular economy concept (59%), implementation of solutions arising from the energy audit (59%), R&D work in the area of low-emission technologies (54%), and production and distribution of energy from renewable energy sources (54%). To a lesser extent, measures such as the implementation of low-emission economy projects (49%) and the possession and implementation of environmental certificates for technology (ETV) or products (Ecolabel) or equivalent (34%) were noted. Clusters had the option to indicate other activities not included in the list. In this instance, it is worth mentioning conducting training sessions, which are intended to help reduce the negative impact on the environment (e.g., by improving the efficiency of production processes).

Source: own elaboration based on research involving cluster coordinators (N=41).

5.4.4. Specialization and advanced technologies

The analysis indicates that the median for the sub-area of specialization and advanced technologies was 0.23, suggesting a relatively balanced involvement of clusters in this area. However, certain clusters stood out in terms of their performance. Clusters established before 2010, which had the status of KKK, a written strategy subject to updating, and included at least 121 members, obtained higher median values (0.35, 0.46, 0.34, and 0.56, respectively). Furthermore, clusters located in the southern macroregion and operating in the chemical, bioeconomy, materials, and energy engineering industries achieved a median value of 0.38.

Graph 67. Median and benchmark for the sub-area of specialization and advanced technologies



Source: own elaboration based on research involving cluster coordinators (N=41).

The benchmark value of 1.00 indicates that at least one cluster achieved maximum scores in each of the partial indicators within the sub-area of specialization and advanced technologies. This cluster demonstrated exceptional performance in specialization and advanced technologies.

The cluster that received the highest ratings and met the benchmark criteria was described as a very large cluster with the status of KKK, founded before 2010, and with a written strategy subject to updating.

Analysis of partial indicators for sub-areas

Table 18. Analysis of the values of partial indicators for the sub-area of specialization and advanced technologies

Indicator	All clusters
Number of cluster enterprises conducting economic activity in the area of the National Smart Specialization (KIS) that is dominant for the cluster	Average: 64.8, median: 49.0, benchmark: 250.0. This indicator and the next three count the number of companies operating in a given area. Benchmarks are therefore the share of very large clusters. On the other hand, to add value, the average percentage of enterprises included in a given activity was calculated (i.e. a measure taking into account the size of clusters). On average, 67% of cluster enterprises engage in activities in the field of KIS, which is dominant for the cluster. Only three clusters indicated 100%.
The number of cluster enterprises conducting economic activities within the framework of the Regional Smart Specialization dominant for the cluster.	Average: 54.4, median: 32.0, benchmark: 250.0. On average, 62% of cluster enterprises engage in RIS activities, which are predominant for the cluster. For five clusters, this percentage is 100%.
Number of cluster enterprises engaged in business activities within the dominant industry for the cluster (by NACE divisions)	Average: 49.6, median: 35.0, benchmark: 250.0. On average, 60% of cluster enterprises engage in activities aligned with the cluster's dominant industry. Only in the case of three clusters is this figure 100%.
The number of cluster enterprises conducting business activities with technologies that shape the future economic development of the EU (KET key technologies: micro- and nanoelectronics, photonics, biotechnology, advanced materials, advanced manufacturing, artificial intelligence, security, and connectivity)	Average: 34.8, median: 30.0, benchmark: 175.0. On average, 41% of cluster enterprises engage in activities aligned with the technologies that will shape the future economic development of the EU. In only one cluster does this reach 100%.

Source: own elaboration based on research involving cluster coordinators (N=41).

Area summary

- In the area of "Impact on the environment," several sub-areas were analyzed: cooperation with the environment, influence on shaping environmental conditions, impact on the natural environment, and the level of specialization and advancement of technology among cluster members. Cooperation with the environment, influence on shaping environmental conditions, and impact on the natural environment showed improvement compared to the previous edition of the study. This indicates that clusters are becoming more active in these areas and taking initiatives to contribute positively to the environment. However, in terms of specialization and advancement of technology, there was a decrease in the median. This suggests that clusters are moving away from narrow industry specialization and adopting a more interdisciplinary approach. This shift may reflect a broader focus on incorporating various technologies and expertise to drive innovation.
- The impact on the natural environment, which was introduced as a new sub-area in the current edition, demonstrated an overall improvement compared to the previous study. However, there is still room to increase cluster activity in this area, as some indicators showed deterioration.
- Only 41% of cluster enterprises operate in the field of key Key Enabling Technologies (KET), which are crucial for the future economic development of the EU. These technologies, including advanced manufacturing, artificial intelligence, and connectivity, hold significant potential for various industries.
- Information and communication technologies (ICT) and geoinformation continued to dominate the cluster landscape, with no major changes from the previous edition of the survey. On average, 67% of cluster enterprises operate within the scope of Knowledge-Intensive Services (KIS).
- More than half (60%) of cluster enterprises align with at least one of the Regional Smart Specializations (RIS). Compliance with RIS is often a necessary or rewarding condition for applying for project co-financing from regional funds, which highlights the importance of regional alignment in accessing funding opportunities.

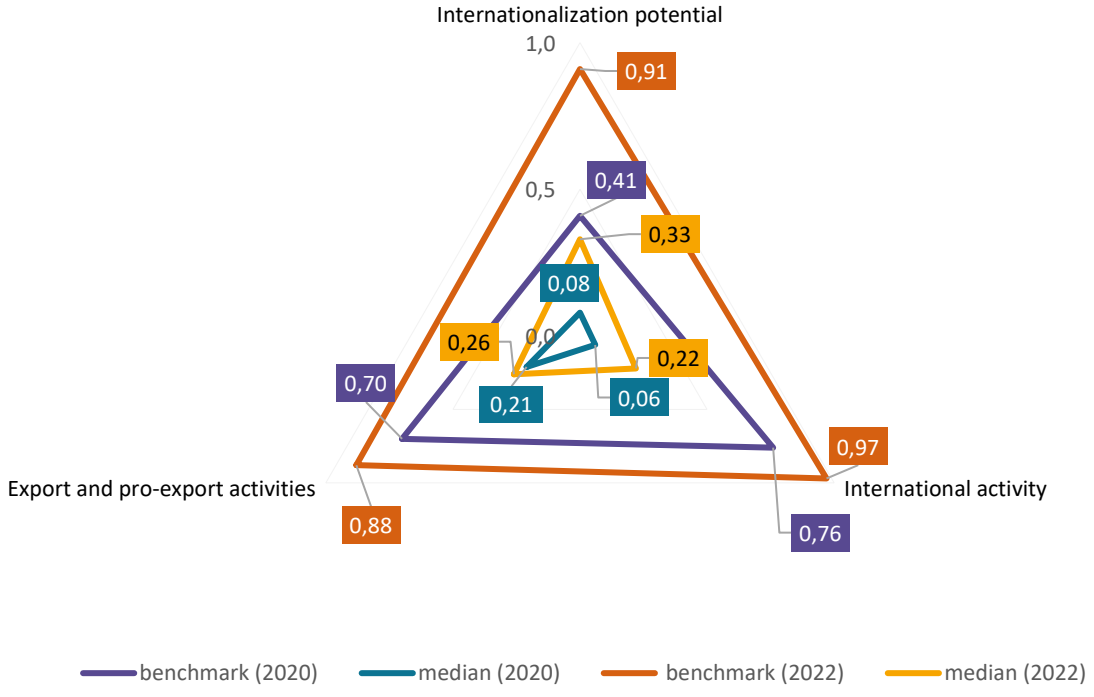
5.5. Cluster internationalization

In the area of cluster internationalization that was examined, the following sub-areas were assessed:

- **Internationalization potential** – services for the internationalization of clusters and their usage among members, multilingual website.
- **International activity** – strategic cooperation with international entities, global projects and events, as well as direct foreign investments.
- **Export and pro-export activities** – the results of export activities, the activities of clusters at foreign fairs, foreign trips, and received visits from foreign clusters.

The internationalization aspect of clusters had relatively low benchmark and median scores in the previous benchmarking edition, indicating limited performance, particularly in terms of internationalization potential and activity. However, the current edition shows a positive trend with increased median and benchmark scores in all sub-areas. This progress is notable considering the challenges posed by the COVID-19 pandemic, which significantly hindered international activities, especially in 2020. Compared to the previous edition, clear leaders have emerged in the ranking, demonstrating high performance across most indicators as evidenced by their elevated benchmark levels.

Graph 68. Values of subsynthetic indicators regarding cluster internationalization from the 2020 and 2022 editions of the study



Source: own elaboration based on research involving cluster coordinators (N=41).

The increasing focus on analytical and implementation activities in the internationalization of clusters signifies a new phase in clustering development. The 2014 report on the "Internationalization of Clusters" recognized the significant role of clusters in international markets, providing various benefits for both the coordinator and cluster members, particularly micro, small, and medium-sized enterprises. These benefits include access to knowledge for new products and services, entry into new markets, access to essential infrastructure, collaboration with new partners, enhanced enterprise reputation, and the attraction of direct foreign investments:

- access to knowledge that can be used in new products and services;
- access to new markets;
- access to key infrastructure elements;
- access to new partners for cooperation;
- raising the rank of the enterprise;
- attracting direct foreign investments.

Recent sources at the EU level, including the recommendation report of the European Group of Cluster Experts, highlight the significant role of clusters in internationalization. Over the past decade, clusters have demonstrated their importance in this regard. The European Commission has provided support through the "Clusters Go International" instrument, aimed at assisting cluster enterprises in developing and implementing internationalization strategies. However, the limited budget allocated to this activity has led to moderate effects. The COVID-19 pandemic has significantly impacted internationalization strategies over the past 2-3 years, affecting global markets and value networks. Consequently, clusters are expected to play a crucial role in rebuilding the position of cluster enterprises in international markets by adapting to new realities and adopting a strategic, long-term approach.

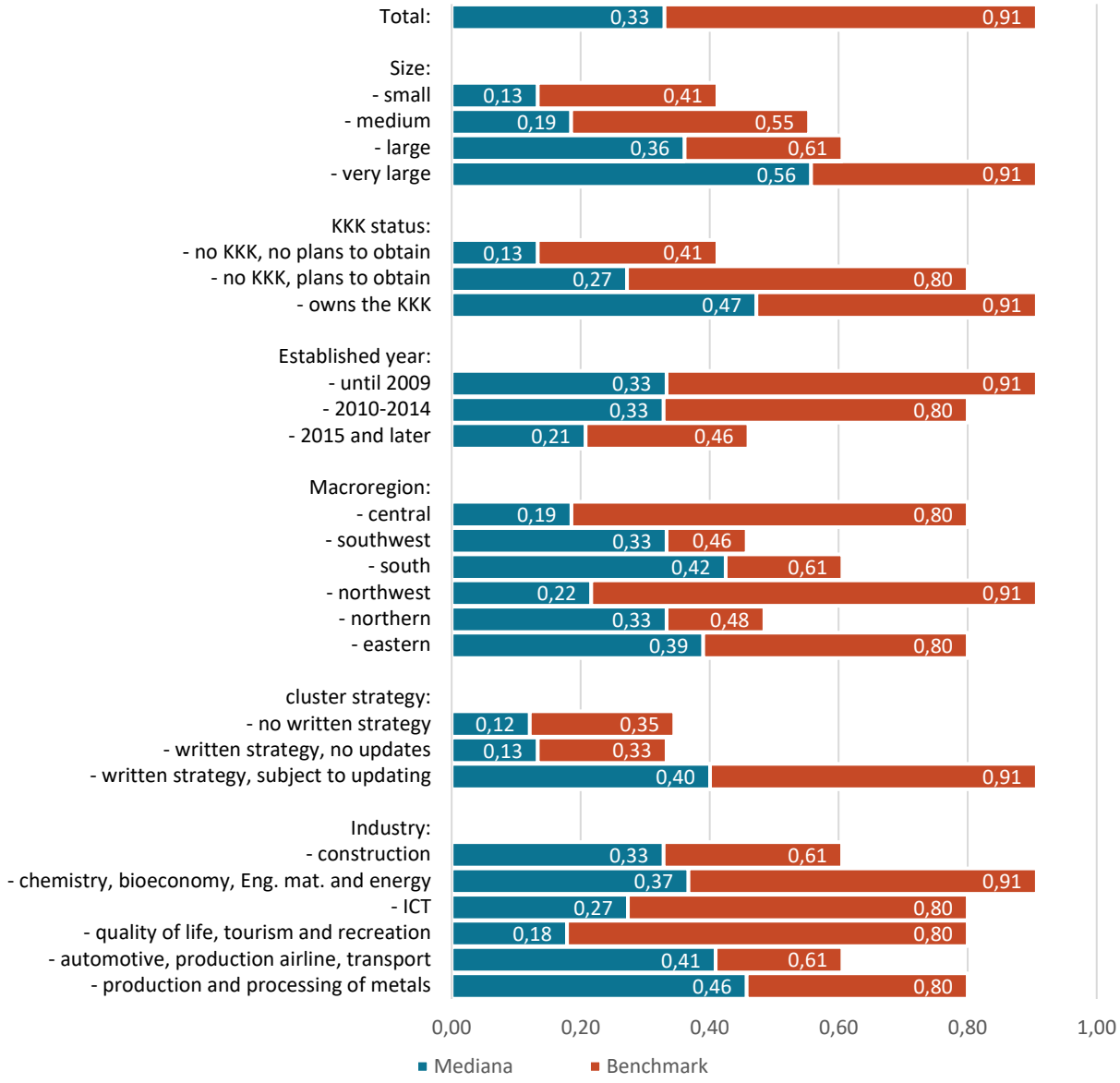
The role of clusters in supporting their members' activities in international markets has been recognized by public authorities. Documents such as "Directions and assumptions of the cluster policy until 2020" and "Directions of cluster policy development in Poland after 2020" emphasize the importance of clusters in this regard. As a result, an instrument was implemented to strengthen cluster internationalization and export activities, specifically targeting leading clusters (with KKK status) in international markets under the "Internationalization of National Key Clusters" measure in the expiring financing perspective of the Smart Growth Operational Programme (sub-measure 2.3.3). Support for internationalization, including KKK and supra-regional growth clusters, is also planned in the next financial perspective under FENG 2.17[78].

[78] Funds for Modern Economy.

5.5.1. Internationalization potential

The overall median for the sub-area of internationalization potential was high. However, certain variations were observed among different cluster categories. Nevertheless, clusters with at least 121 members (median 0.56), KKK status (0.47), and a regularly updated written strategy (0.40) remained the most advantageous. A benchmark of 0.91 was achieved by a cluster registered before 2010, with KKK status, over 121 members, and a regularly updated written strategy.

Graph 69. Median and benchmark for the sub-area of internationalization potential



Source: own elaboration based on research involving cluster coordinators (N=41).

It is notable that a substantial number of clusters (32) provided internationalization services to their members. Among the surveyed cluster members, 34% utilised these services either directly or through the cluster, while 27% had the opportunity to access such services but opted not to. These figures indicate a decrease of 3 and 10 percentage points, respectively, compared to the previous survey edition.

Graph 70. Internationalization services

Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 19. Analysis of partial indicators for the sub-area of internationalization potential

Indicator	All clusters
Number of services offered by and/or through the internationalisation cluster	Average: 6.4, median: 3.0, benchmark: 60.0. Thirty-two clusters reported having an offer of services for internationalization. In the case of six clusters, there were ten or more services. The most frequently mentioned services include organising trips to trade fairs and economic missions. Participation in trade fairs could take various forms (e.g., a joint exhibition of cluster entities at fairs relevant to the cluster's industry or the individual organization of a trip to a fair for a specific entity or group of entities). Additionally, the promotion of brands and products abroad, along with supportive areas (including consulting and training), were also noted. It is worth mentioning that in the previous financial period, such services could be co-financed under the Instrument of Internationalization of National Key Clusters (sub-measure 2.3.3 SG OP)[79].

[79] Under this instrument, projects involving the internationalization of the cluster's offer were supported, e.g. related to the introduction of the offer/products of the cluster and/or its members to foreign markets (with

Indicator	All clusters
The number of cluster members who have benefited from internationalization services offered by or through the cluster	Average: 23.0, median: 5.0, benchmark: 227.0. In the case of fifteen clusters, the number of cluster members using the services was equal to or exceeded 20. Only in one cluster did it surpass 100 members. It is worth noting that due to interest in this type of service, 9 clusters that do not yet offer such services should consider implementing them in their activities. In total, 941 entities utilised this type of service, which accounts for about 22% of all members of the surveyed clusters.
Number of language versions of the cluster's website, excluding the Polish version	Average: 1.7, median: 1.0, benchmark: 14. The research team verified the number of language versions of the website. Notably, 11 clusters lack a foreign language version of the site. In this edition, the list leader with 14 foreign language versions of the website has appeared once again. In this instance, Google's automatic translation tools for website content were utilised. Given the continuously improving translation algorithms, this solution may be appealing for clusters without any foreign language version of the site.

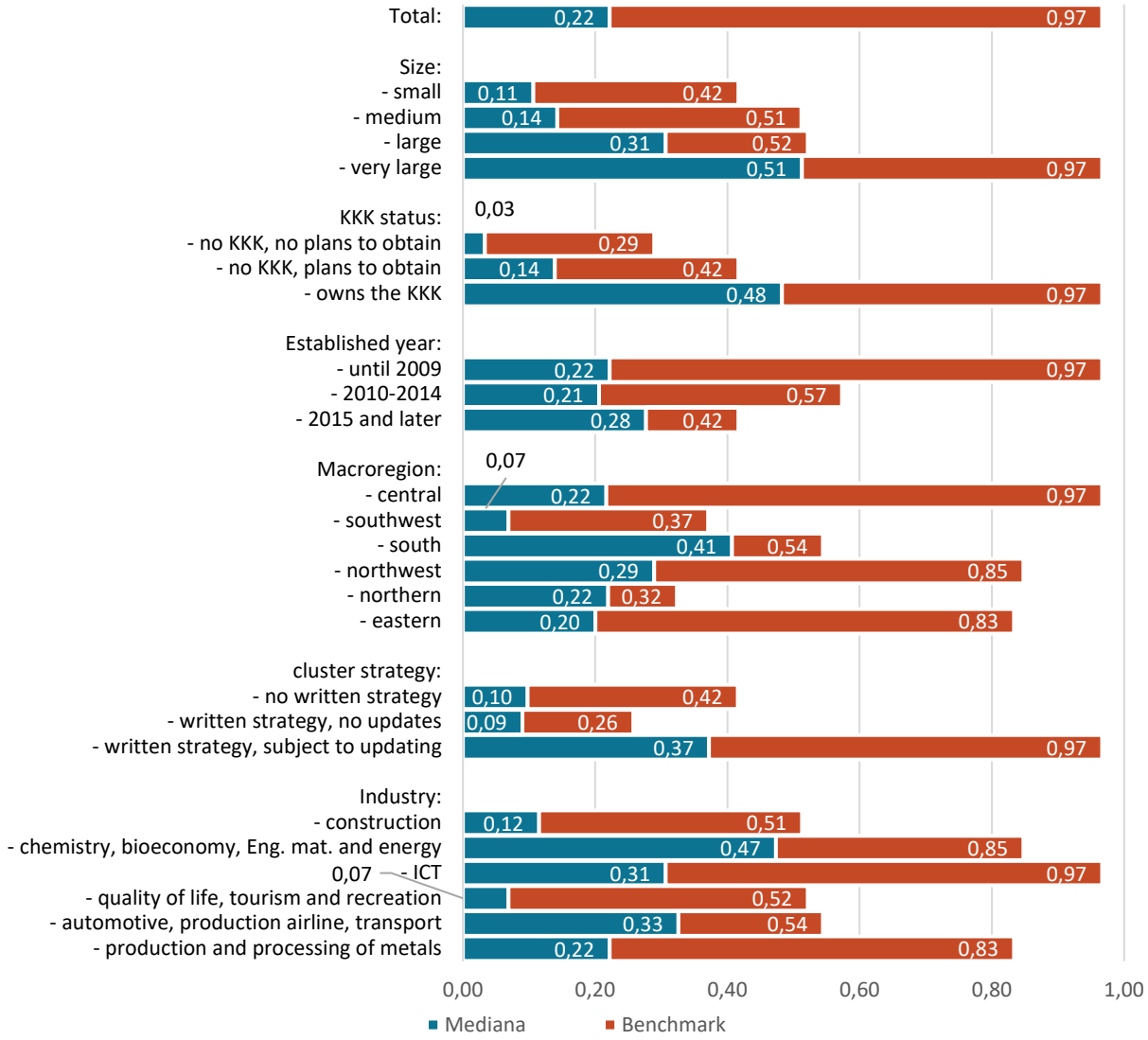
Source: own elaboration based on research involving cluster coordinators (N=41).

particular emphasis on technologically advanced products). The objectives of the sub-measure include, among others: activation of cluster members in the area of internationalization, creation of cooperation networks, exchange of knowledge with foreign partners or increasing the cluster's visibility on international markets.

5.5.2. International activity

In the sub-area of international activity, the median score was 0.22, indicating a relatively equal level of involvement among clusters. However, certain clusters had advantages in this area, particularly very large clusters (0.51), those with KKK status (0.48), and a written strategy subject to updating (0.37), as well as clusters established after 2015. On the other hand, small clusters (0.11) without KKK status (0.05) performed less favorably. The benchmark score of 0.97 indicates that at least one cluster achieved high scores across most criteria. Specifically, it refers to a cluster founded before 2010, with KKK status, and over 121 members.

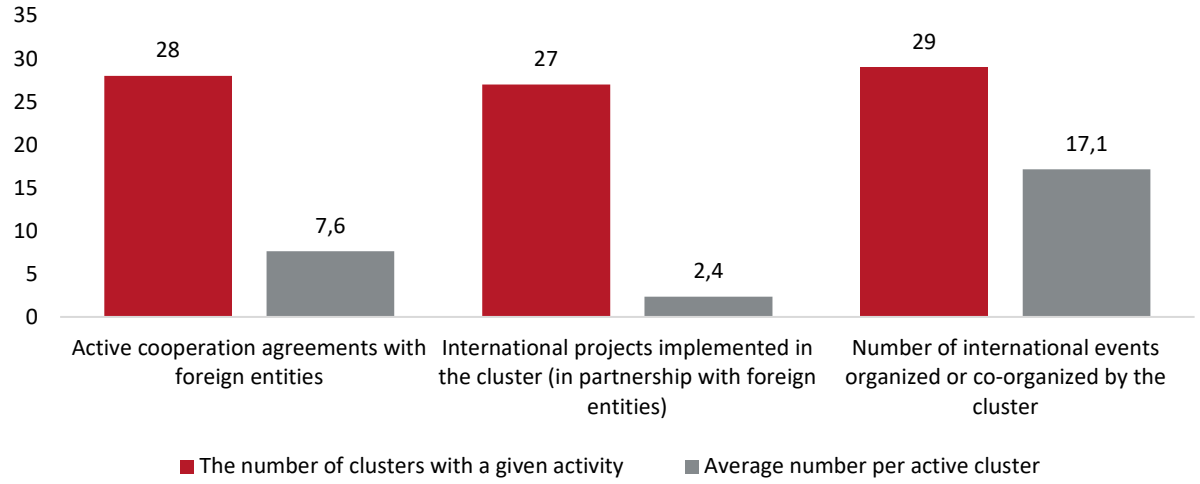
Graph 71. Median and benchmark for the international activity sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

The international activity of clusters was assessed using indicators such as established foreign cooperation (active contracts), the number of implemented international projects with foreign partners, and the organization or co-organization of international events. International projects, often carried out in consortia, were considered valuable for establishing foreign cooperation and facilitating knowledge exchange. Among the surveyed clusters, 27 implemented a total of 64 projects (an average of 2.4 per active cluster), while 29 clusters were involved in organizing international events, averaging 17.1 events per cluster. The total number of organized events was 497, representing a significant increase compared to the previous survey. Additionally, 28 clusters had active cooperation agreements with foreign entities.

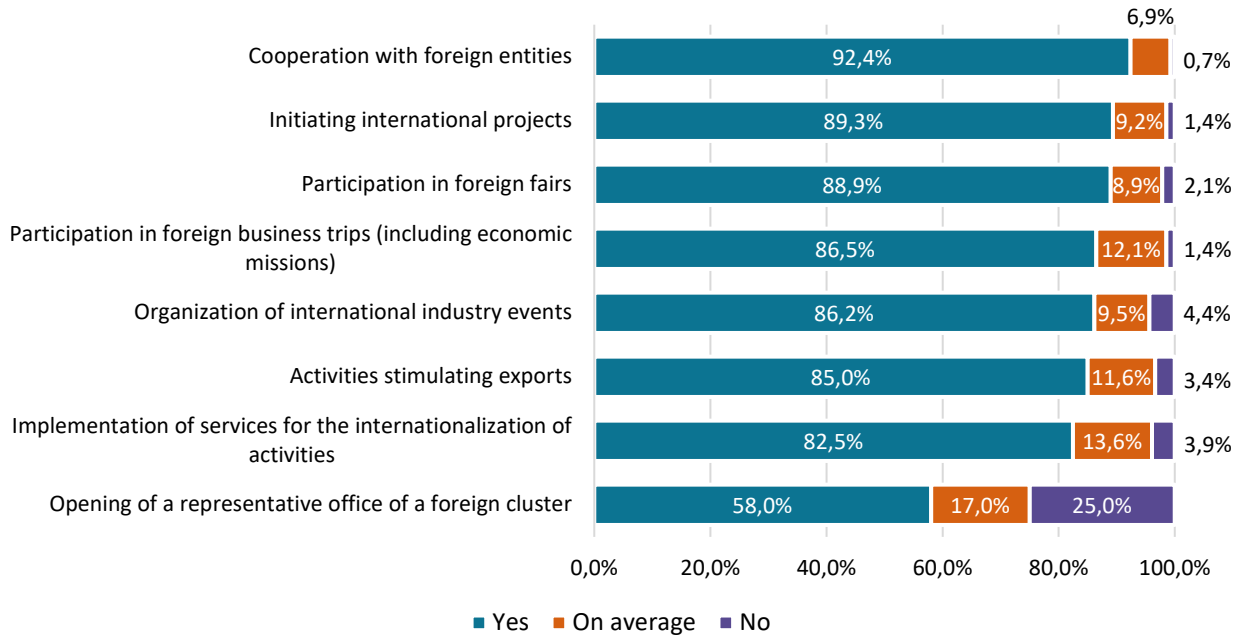
Graph 72. International activity in clusters



Source: own elaboration based on research involving cluster coordinators (N=41).

Cluster members were surveyed to evaluate the international activities of clusters. The most frequently mentioned activities for the internationalization of cluster members included cooperation with foreign entities (92.4% of responses), initiating international projects (89.3%), and participation in foreign fairs (88.9%). Establishing a representative office for a foreign cluster was the least popular option. Compared to the previous survey, there was an increase in interest of approximately 3-10 percentage points for almost every type of activity.

Graph 73. Interest in the activities of the cluster coordinator for the internationalization of cluster members



Source: own elaboration based on a survey of cluster members (N=642).

Analysis of partial indicators for sub-areas

Table 20. Analysis of the values of partial indicators for the sub-area of international activity

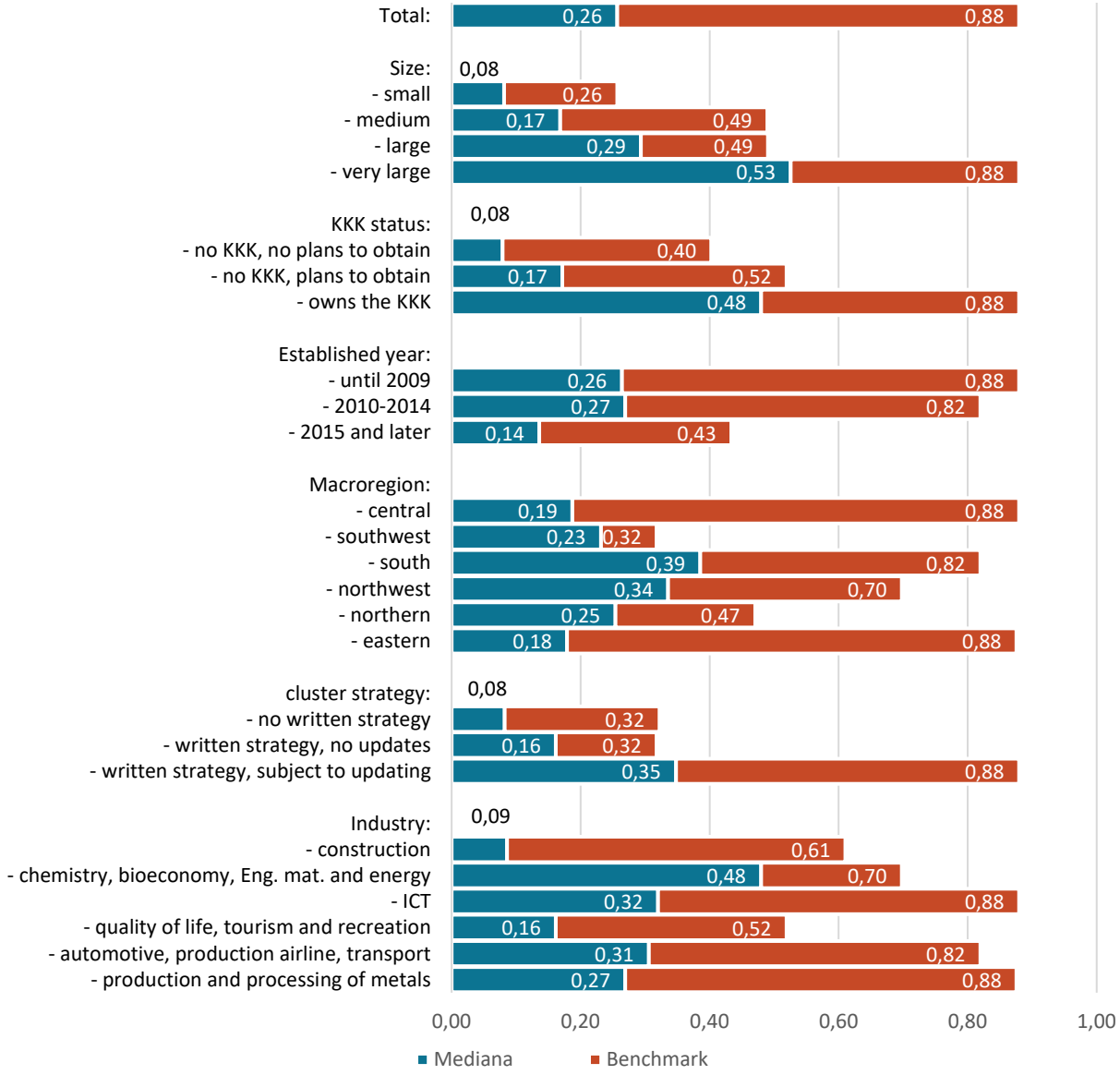
Indicator	All clusters
Number of active cooperation agreements with foreign entities	Average: 5.2, median: 2.0, benchmark: 52.0. More than two-thirds of the clusters (28) have signed cooperation agreements with foreign entities. In the case of four clusters, there are 10 or more contracts.
Number of international projects implemented in the cluster in partnership with foreign entities	Average: 1.6, median: 1.0, benchmark: 7.0. A similar number of clusters, as in the case of the previous indicator (27), implemented international projects in partnership with foreign entities. It can be assumed that some of the signed contracts are closely related to these projects (e.g., forming a consortium requiring a written contract).
Value of international projects conducted in the cluster (in partnership with foreign entities)	Average: 10.6 million PLN, median: 0.3 million PLN, benchmark: 245.0 million PLN. Twenty-six clusters indicated the value of international projects. Notably, these types of projects do not necessarily need to have budgets in the millions, which could be reflected in the average value. At least a few clusters can be identified in the list where the value of projects was less than or equal to 200,000 PLN.
Number of international events organized or co-organized by the cluster	Average: 12.1, median: 2.0, benchmark: 270.0. Twenty-nine clusters organized or co-organized international events. The leader of the ranking significantly inflates the average by declaring the organization of 270 events. For most clusters, this number did not exceed 10.
The number of cluster entities involving foreign units, such as shares, branches, or other forms of foreign direct investment in the cluster (inward)	Average: 8.4, median: 0.0, benchmark: 87.0. Twenty clusters reported that their members include entities representing direct foreign investments. The average number of entities with foreign involvement in this group was 17.2. Among them were primarily clusters from the fields of ICT and the automotive industry.
Number of cluster entities involved with foreign entities through shares, branches, or other forms (foreign direct investment undertaken by cluster enterprises abroad (outward))	Average: 4.5, median: 0.0, benchmark: 42.0. Implementation of direct foreign investments undertaken by cluster enterprises was declared by 18 clusters. The average number of entities exposed to foreign entities in this group was 10.3.

Source: own elaboration based on research involving cluster coordinators (N=41).

5.5.3. Export and pro-export activities

In the sub-area of export and pro-export activities, very large clusters (median 0.53), with KKK status (0.48), and a written strategy subject to updating (0.35) achieved higher values for both the median and benchmarking. In terms of geography, clusters from the southern (0.39) and north-western (0.34) macroregions performed relatively well. The chemistry, bioeconomy, materials engineering, and energy industries yielded the best results (0.48) in this area.

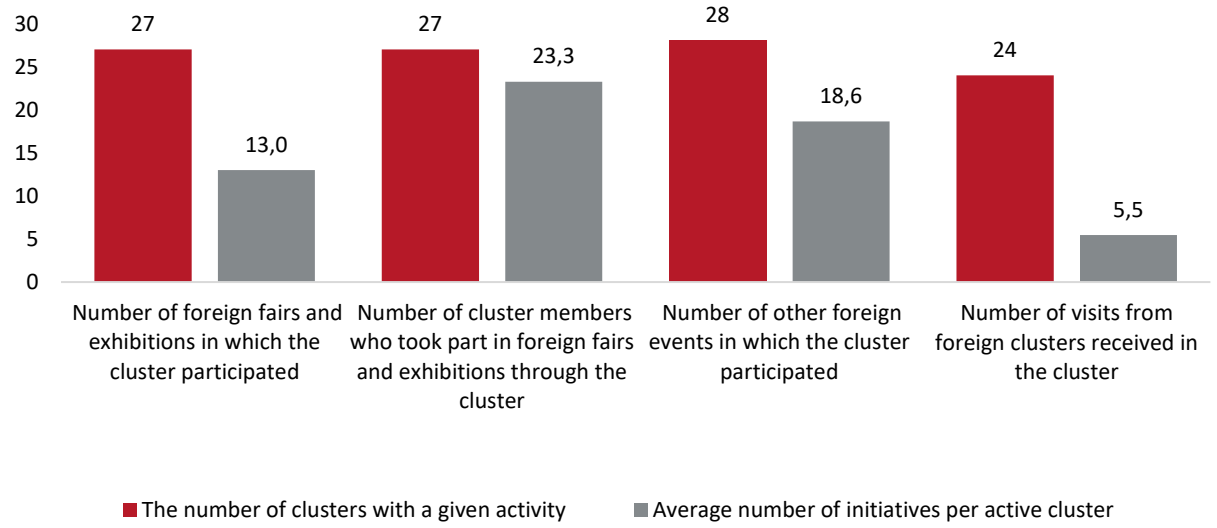
Graph 74. Median and benchmark for the export and pro-export activities sub-area



Source: own elaboration based on research involving cluster coordinators (N=41).

In the sub-area of exports and pro-export activities, the measurement included factors such as the number of foreign events attended and the number of foreign fairs and exhibitions participated in by the cluster. The reported figures indicate that there were 351 trips made to foreign fairs and exhibitions, with 628 cluster members participating. Additionally, there were 522 trips to other foreign events and 131 visits from foreign clusters.

Graph 75. Number of events, fairs, exhibitions and other foreign events with the participation of the cluster



Source: own elaboration based on research involving cluster coordinators (N=41).

Approximately 25.1% of cluster members reported an improvement in their export performance, while 47.7% indicated a negative response, suggesting a decline in exports.

Analysis of partial indicators for sub-areas

Table 21. Analysis of the values of partial indicators for the export sub-area and pro-export activities

Indicator	All clusters
Number of cluster enterprises that conducted export activities (i.e. obtained revenues from sales abroad)	Average: 36.8, median: 30.0, benchmark: 161.0. Most of the coordinators (35) declared that cluster enterprises obtain revenues from foreign sales. The average number of enterprises earning revenues from foreign sales for this group of clusters was 43.1. In total, it was indicated that nearly one and a half thousand cluster enterprises (1,471) obtained revenues from foreign sales. This constitutes approx. 41.6% of all enterprises in clusters.

Indicator	All clusters
Share of export revenues from enterprises within the cluster compared to the total sales revenues of enterprises earning export revenues in 2021, including the share of electronic commerce (e-commerce)	Average: 29.2%, median: 26.8%, benchmark: 80.0%. Twenty-nine clusters were able to indicate or estimate the share of export revenues of cluster enterprises in total sales. The average share of export revenues for this group of clusters was 41.3%. Clusters in the field of ICT stand out in this respect, as do larger clusters in the area of industrial processing.
Number of foreign markets (countries) where cluster enterprises exist	Average: 31.2, median: 19.0, benchmark: 120.0. The most popular foreign markets for clusters, defined as having 10 or more indications by coordinators, were Germany (17 clusters), the USA (16), France (15), Canada (14), Ukraine (12), Belgium (11), as well as Denmark, Italy, China, Sweden, Lithuania, Spain, and the Czech Republic (10 clusters each). Among the more exotic markets accessed by cluster enterprises, the following can be highlighted: Kyrgyzstan, Yemen, Uzbekistan, Cameroon, Tajikistan, Turkmenistan, Paraguay, Venezuela, and Iran (single indications).
Number of foreign fairs and exhibitions in which the cluster participated	Average: 8.6, median: 2.0, benchmark: 107.0. Twenty-seven clusters declared participation in foreign fairs and exhibitions. Five clusters declared participation in 20 or more events.
Number of cluster members who participated in foreign fairs and exhibitions through the cluster	Average: 15.3, median: 6.0, benchmark: 127.0. A total of 628 cluster members (15% of all studied cluster members) participated in the events covered by the previous indicator. Over 20 members who participated in trips declared 6 clusters.
Number of other foreign events in which the cluster participated	Average: 12.7, median: 3.0, benchmark: 251.0. Twenty-eight clusters indicated participation in other events abroad, and in most cases, it represented a maximum of 10 events.
Number of visits received from foreign clusters in the cluster	Average: 3.2, median: 1.0, benchmark: 50.0. Just over half of the clusters (24) received visits from foreign clusters. Only in three instances was this number greater than or equal to 10. In this area, a cluster emerged that clearly leads the ranking, having received 50 visits from foreign clusters.

Source: own elaboration based on research involving cluster coordinators (N=41).

Area summary

- Within the area of “Internationalization of the cluster," the following sub-areas were analyzed: internationalization potential, international activity, as well as export and pro-export activities. The actual internationalization potential was rated the highest, with a median of 0.33. There was an increase in both the median value and benchmarks for each sub-area compared to the previous edition of the study.
- The number of international projects increased by approximately 10%, with two-thirds of clusters involved in these projects, representing a 35% increase compared to before.
- There was a noted increase in interest (around 3-10 percentage points) among cluster members in internationalization services, with the highest interest in developing collaboration with foreign entities, initiating international projects, and participating in foreign fairs.
- Support for internationalisation provided by cluster coordinators was well-received by members, with more than one-third of entities in the cluster using these services, especially for preparatory activities, consulting, training, and organizing missions and fair trips.
- Large clusters with KKK status and at least 10 years of market presence have gained a clear advantage in this area, likely due to the project implementation under sub-measure 2.3.3 SG OP.

6. Good practices of cluster operation

6.1. Introduction

One of the components of the cluster benchmarking study was identifying best practices – exemplary solutions that demonstrate exceptional effectiveness and efficiency in achieving the development goals of the cluster. These practices needed to be replicable and applicable to other clusters, highlighting their potential for imitation and learning. Therefore, the identification and selection of these practices aimed to facilitate their implementation in other cluster structures.

The key criteria for selecting the best solutions in this study were as follows:

- innovation and novelty of the applied solution;
- efficiency and effectiveness of the solution;
- systematic nature and sustainability of the solutions implemented in the cluster;
- flexibility and adaptability to change;
- universality, allowing application by other clusters, even from different industries;
- optimal utilization of available cluster resources;
- potential to withstand rapid changes, such as the impact of the COVID-19 pandemic.

Special attention was given to identifying good practices implemented in seven specific sub-areas that significantly influence the development of cluster structures. These sub-areas encompass various aspects related to cluster organizational maturity, cooperation and innovation, and internationalization. The selected sub-areas are as follows:


Market activity


Cluster digitization


Innovative activity


Development of cooperation in the cluster


Cooperation with the environment


Impact on the natural environment


Influence on shaping the environmental conditions


Export and pro-export activities

6.2. Good practices of national clusters

6.2.1. A comprehensive offer of the Radom Metal Cluster for vocational education

Cluster name	Radom Metal Cluster
Key area of good practice	Cooperation with the environment
Other areas of good practice	▪ Development of cooperation in the cluster ▪ Influence on shaping the environmental conditions
Purpose and circumstances for introducing good practice	In various industries, including the metal sector, there is a shortage of employees with the necessary competencies and skills for the rapidly changing industrial landscape. This shortage impacts the industry's ability to fully realise its potential. The cluster has recognised this challenge and implemented effective practices to address it. Enterprises within the metal sector have reported gaps in employee qualifications, including a lack of professional experience, low levels of industry knowledge, and inadequate technical skills. In response to these challenges, the cluster actively promotes technical professions among young people and collaborates with trade schools in this initiative.
Description of the good practice	The Radom Metal Cluster is actively engaged in various initiatives to enhance vocational education in alignment with the needs of its members. The cluster coordinator carries out grassroots activities to raise awareness among young individuals and their parents about the benefits of choosing technical education and pursuing professions desired by cluster companies. Cluster members actively participate in meetings with parents of final-year primary school students, presenting the educational offerings of vocational schools, highlighting professional development opportunities, and showcasing the employment conditions provided by Radom companies operating in the metal industry. Furthermore, a group of entrepreneurs from the cluster supports first-year students of the Complex of Technical Schools and the Complex of Vocational Schools (specializing in machine tool operation and mechanical technical training) through a layette program. This program is

	financed by metal industry companies and covers the purchase of work attire and books for vocational training. Additionally, they develop educational materials, organize study visits to industry companies, and arrange trips to trade fairs. The cluster's next natural step is to work on the implementation of the dual education system. An exemplary achievement of the cluster is the creation and execution of a pilot dual vocational training course for the profession of "CNC numerically controlled machine tool operator," which takes place in a first-level trade school. Students receive practical training in a modern technological environment directly at employers in companies located in Radom and the surrounding area, including cluster companies. This approach improves the quality and practicality of education, thereby enhancing the competences and skills of school graduates entering the labor market. The coordinator actively promotes activities related to dual education at various educational levels among cluster entrepreneurs to encourage their increased involvement. This promotion occurs during local conferences, workshops, meetings at the City Hall, or in the context of jointly implemented projects. Cluster members who are active in this area receive extensive promotion for their companies on the cluster's website and through its social media channels.
Impact of implementing good practice	The collaboration between the cluster, schools, and universities plays a crucial role in promoting vocational education and highlighting the production and engineering sectors as valuable sources of long-term employment in the region. As a result of these efforts, over 500 students have been recruited to participate in supported programs over five years. The activities conducted by the cluster coordinator and its members enhance the efficiency of the education process and help develop the competencies and skills of individuals entering the job market. This, in turn, improves the chances for cluster members to find the specialized workforce they require. By providing students with opportunities to apply their knowledge in real production settings and engage in the creation of actual products for specific clients, their understanding of related concepts expands, and they gain awareness

	of the broader functioning of the business environment within the supply chain context. Dual education offers an avenue to elevate the technical proficiency of the local community and prevent educated young individuals from migrating to other industrial centers. This not only increases the economic value of the social environment but also improves the overall quality of life. Furthermore, these initiatives enhance the market position of companies within the cluster, expanding the scope of the cluster's activities. The cluster aims to obtain KKK (National Key Cluster) status in the future, and these actions increase its prospects of achieving this designation.
Possibility to use good practice	The coordinators' efforts should primarily focus on consistently fostering a sense of shared responsibility among cluster members to establish mutually beneficial collaborations with schools, particularly in areas experiencing a noticeable shortage of skilled employees. This collaboration should be ongoing and can take various forms. By continuously promoting technical education at different levels and engaging in related activities, the cluster not only contributes to the availability of well-prepared human resources in the job market, including for cluster members, but also enhances its reputation. By implementing educational programs in partnership with employers, prospective future employees experience a smoother transition into the professional world and work environment. These initiatives, like providing students with practical work experiences in their chosen profession, also enhance the perception of the industry and technical education, making them more appealing options.
Przemysław Radomski, plenipotentiary of IPZHR for RKM	*Revitalizing vocational technical education in a new, employer-driven format undoubtedly fostered a platform for understanding and collaboration among metalworking companies in the region. It created an atmosphere of trust and established a strong foundation for continued cluster cooperation. As a result, companies no longer viewed each other solely as competitors. Their involvement in this innovative, customized teaching model aligned curriculum*

	requirements with the practical challenges faced in real production settings. *The primary beneficiaries of this project are the students who acquire skills more efficiently and adapt better to the future work environment. This significantly enhances their competitiveness in the labor market.*

6.2.2. Industry Competence Center for MEDTECH

Cluster name	MedSilesia Silesian Network of Medical Devices
Key area of good practice	 Development of cooperation in the cluster
Other areas of good practice	▪ Innovative activity ▪ Cooperation with the environment ▪ Cluster digitization
Purpose and circumstances for introducing good practice	To tackle the challenges posed by the constantly evolving legislative landscape in the field of medical devices, the cluster's coordinator took a proactive step by establishing the Industry Competence Center. As part of this initiative, the MedSilesia Competence Academy was created to offer cluster members specialized training programs tailored to their needs. The main objective of the academy is to enhance the knowledge and skills of employees in the medical device sector. By providing targeted training programs, the academy aims to facilitate access to relevant information and expertise, ultimately supporting the development and certification of medical technologies. Through the Industry Competence Center and the MedSilesia Competence Academy, the cluster demonstrates its commitment to assisting its members in navigating complex regulatory frameworks and keeping up with industry advancements.
Description of the good practice	As part of the cluster's recent activities aimed at knowledge exchange and information sharing, the Industry Competence Center was established. This center aims to enhance the competencies of entities within the industry, including both cluster members and external

	parties. Within the center, the MedSilesia Competence Academy was formed, offering tailored training programs for medical device manufacturers and technology companies in the medical field. Two specific training programs have been implemented as part of the Competence Academy. The first is the PRRC MASTER Program[80], designed for individuals responsible for regulatory compliance or those seeking to expand their knowledge in this area. The program encompasses various aspects, including medical device conformity verification, device release processes, technical documentation creation and maintenance, and post-marketing surveillance. Participants also acquire practical insights into designing, obtaining approval for, registering, conducting, and reporting clinical investigations of medical devices as part of the required clinical evaluation for device conformity assessment. The second training program, known as the Quality Expert Academy, focuses on equipping auditors and quality representatives with the essential knowledge and practical tips. Participants learn how to effectively fulfill the role of the Quality Management System Representative in accordance with ISO 13485 requirements. The program covers audit principles, internal auditor responsibilities, quality methods and tools throughout the medical device lifecycle, and risk management based on the EN-ISO 14971:2019 standard. Through the Industry Competence Center, cluster members access valuable information about potential international partnerships. The center organizes webinars focused on legal updates and current trends in the medtech field. Additionally, it provides services such as support for internationalization and commercialization, along with business model consulting. The Industry Competence Center operates through the COIN platform (Collaborative Innovation Network), a proprietary tool developed by the cluster coordinator. In addition to providing access to studies and training materials, the platform also offers information on the current offerings of regional R&D units and universities serving the medical device industry.

[80] PRRC: Person Responsible for Regulatory Compliance, i.e. persons responsible for regulatory compliance.

Impact of implementing good practice	The Industry Competence Center plays a vital role in supporting the medical industry by fostering the development of necessary skills and providing access to current knowledge, including comprehensive databases. The introduction of the COIN platform as a tool, along with the industry-specific training program, facilitates the formation of stronger teams and enhances the competitive position of cluster members through effective human resource management. Moreover, this creates a conducive environment for implementing innovative projects. The utilization of resources within the COIN platform has enabled the cluster's partners to identify potential collaborators for joint ventures. For instance, they have successfully connected through competitions organized by the Medical Research Agency or the National Center for Research and Development. This platform serves as an opportunity for research and development institutions to effectively commercialize their knowledge. Additionally, the COIN platform showcases a dedicated section focused on internationalization, which proves particularly valuable for the numerous cluster members involved in joint MedSilesia Go Global projects.
Possibility to use good practice	Knowledge is a valuable asset that significantly contributes to gaining a competitive edge in the market. To address the challenges faced by cluster members and the industry as a whole, it is crucial to gather, create, transfer, and promote a culture of sharing information and knowledge. The Industry Competence Center and the Academy of Competences serve as organized initiatives to respond to the competency needs of cluster members and facilitate the utilization of experts' potential within the cluster. These platforms enable the sharing of practical knowledge, identification of development directions, and promotion of commercialization and technology transfer to the economy. Such activities are essential and can yield positive outcomes for any cluster. To effectively meet these objectives, it is vital to accurately identify gaps, map the needs of cluster members and the industry, and subsequently develop and implement robust training programs. This service generates significant interest from members and others, making it a valuable offering from the cluster coordinator.

MedSilesia Cluster - Silesian Network of Medical Devices	*By leveraging efficient IT tools like the COIN platform, cluster coordinators can enhance their ability to align offerings with the specific needs and expectations of cluster members. The establishment of the Industry Competence Center highlights the necessity of IT tools, as digitalization becomes an imperative that cluster coordinators must embrace. In situations where there are limited human resources and growing demands for professionalized services, adopting such technology presents a viable solution to meet expectations and uphold recognized standards. The utilization of IT tools ensures greater efficiency, effectiveness, and the ability to provide high-quality services in line with industry norms.*

6.2.3. Promotion of Lodz as a way to attract employees from the IT industry

Cluster name	ICT Central Poland Cluster
Key area of good practice	 Cooperation with the environment
Other areas of good practice	▪ Development of cluster cooperation ▪ Influence on shaping the environmental conditions
Purpose and circumstances for introducing good practice	The IT industry is experiencing rapid growth nationwide, including in Łódź, and it is becoming a significant driver of the economy. Consequently, there is a high demand for programmers and other IT specialists. Cluster members, along with other companies in the industry, face the challenge of a shortage of skilled professionals in the labor market, making it difficult to find suitable employees. The persistent shortage of IT specialists has emerged as a major obstacle to further growth. Recognizing the need to sustain its development momentum, the city of Łódź is actively and effectively taking measures to attract new residents, particularly talented individuals, by competing at both national and international levels. It is also in the city's interest to have a strong presence of reputable employers within its area. The stability of the labor market and opportunities for career advancement play a crucial role in attracting new, highly skilled residents to the city.
Description of the good practice	The cluster actively promotes Łódź as an attractive city for the IT industry. One of its initiatives is the Join IT in Łódź campaign, which has had three editions. The campaign aims to showcase Łódź as an ideal destination for learning, studying, and working in the ICT sector. The campaign website, www.joinitinlodz.pl, serves as a platform for this promotion. The first edition of the campaign, called "Re-industry," in 2020, featured clips showcasing employees from cluster companies who made a career change to the IT industry, despite lacking a background in IT. The stories focused on their successful adaptation to this new professional reality. The second edition, "Yesterday a student, today an employee" in 2021, targeted secondary school students from the Łódź

	Voivodeship, encouraging them to pursue their professional careers in Łódź. It featured five stories of young individuals who came to Łódź for their studies and are now working in the IT industry. In the third edition in 2022, the cluster highlighted the experiences of individuals from various countries who connected their personal and professional lives to Łódź's IT industry. Heroes from Ukraine, Azerbaijan, Canada, Lithuania, and Tunisia shared their stories, detailing how they arrived in Łódź, what attracted them, and why they decided to stay. Additionally, the cluster actively participates in the "Recommendations of subjects" program, which fosters cooperation between companies and universities associated with the ICT Central Poland Cluster. Through this program, cluster members inform universities about labor market demands and their expectations from future graduates. After consultation and approval from the university, they can officially recommend specific subjects, such as programming in Python, which can then be incorporated into the curriculum at institutions like the Lodz University of Technology, the University of Lodz, or the Academy of Social Sciences. This pioneering initiative in Poland promotes subject recommendations from the business sector, emphasizing their relevance for future career opportunities.
Impact of implementing good practice	The efforts to promote Łódź as a city with abundant opportunities in the IT industry yield benefits on multiple fronts, involving collaboration between the cluster, the public sector, and universities. This broad promotion aims to attract potential IT employees, entice new residents to the city, and create new jobs and business opportunities, particularly for cluster companies. By encouraging individuals to connect their future with Łódź, the cluster not only provides its members with skilled personnel but also offers students practical knowledge and grants companies access to potential future employees who are already well-trained. The cluster's activities, such as subject recommendations, enhance the image and visibility of the companies. Moreover, through collaboration between Łódź universities and the cluster and its members, graduating IT students are immediately presented with employment opportunities, having gained practical knowledge

	during their studies. By recommending specific subjects in the study programs, companies can attract students interested in pursuing a career in their particular field. The three editions of the Join IT in Łódź campaign, carried out in collaboration with the city authorities, have successfully drawn attention to the challenges faced by the IT industry in finding highly qualified employees. Additionally, these campaigns have demonstrated the cluster's value as a reliable partner for cooperation. As a result, discussions have been initiated with the city office regarding the joint participation of companies, universities, and local government in labor market-related events, primarily in selected regions. The Join IT in Łódź initiative has also fostered greater integration within the Łódź IT industry, facilitating regular meetings among cluster members as well as with representatives of City Hall, thus strengthening collaboration and synergy among all interested IT companies in Łódź.
Possibility to use good practice	Clusters significantly impact their local ecosystems by actively promoting and encouraging individuals to pursue employment or higher education opportunities. These efforts benefit not only the clusters themselves but also urban centers and universities. Therefore, establishing partnerships between clusters, local government authorities, and universities is crucial to collaborate on initiatives that attract future residents, employees, and students. Initiating relationships with local government authorities should start by gathering comprehensive information about the potential of the industry within a specific region. Often, local governments may not fully understand the scope and impact of projects implemented within their jurisdiction, including both local and global initiatives, as well as the number of employees involved in these projects. By sharing this information, clusters can help local governments grasp the significance of the industry and the opportunities it presents for their region. This collaboration and exchange of knowledge among clusters, local government authorities, and universities can drive regional development and growth by attracting talent, fostering innovation, and creating a favorable environment for economic prosperity. By

	working together, these stakeholders can leverage their unique resources and expertise to support the advancement of their communities.
Adam Owczarek, Manager of the Lodz ICT Cluster	*Implementing similar projects in collaboration with local governments offers the potential for greater reach and the ability to connect with a larger audience. The Join IT in Łódź campaign serves as an example, with a total of approximately 150,000 views over three years and a promotional reach exceeding 1,000,000.* *One of the main challenges encountered during the campaign was convincing cluster participants that their professional stories were compelling and worth showcasing to inspire others. However, the increasing number of campaign heroes each year demonstrates that it was indeed the right decision.* *By highlighting the experiences and achievements of employees within the cluster, these campaigns not only promote the IT industry in Łódź but also provide valuable inspiration and motivation for others. Sharing personal stories can create a sense of connection and demonstrate the potential career paths within the industry, fostering a stronger talent pool and encouraging individuals to consider opportunities in the IT sector.*

6.2.4. Cluster social responsibility - IT for Ukraine

Cluster name	West Pomeranian ICT Cluster
Key area of good practice	 Influence on shaping the environmental conditions
Other areas of good practice	▪ Cooperation with the environment ▪ Development of cooperation in the cluster
Purpose and circumstances for introducing good practice	The Russian attack on Ukraine has resulted in a humanitarian crisis, creating a need for support and solidarity with the Ukrainian people. Polish clusters, including the West Pomeranian ICT Cluster, along with Polish society, have actively engaged in various initiatives to aid both refugees and Ukrainian citizens who have remained in the country. Through strong relationships within the cluster and with external partners, members of the ICT West Pomerania cluster have played an active role in organizing and providing assistance to those affected. The cluster has leveraged its resources and network to support the impacted individuals on multiple levels, offering various forms of aid and assistance during this challenging time.
Description of the good practice	Since the beginning of the war, the ICT Western Pomerania cluster has been actively involved in numerous initiatives aimed at assisting Ukrainian citizens and soldiers. The cluster coordinator organized a teleconference with member companies to collectively discuss potential avenues of assistance. Based on the information gathered about Ukrainian needs and an assessment of the cluster's resources and capabilities, the coordinator and members decided to engage in various projects, including the "Polish IT for Ukraine" initiative. The primary objective of "Polish IT for Ukraine" is to harness the collective human resources, knowledge, and equipment of the IT industry to provide effective support. Fundraising activities, such as "Polish TECH and business for fighting Ukraine #CyberBridge," were conducted to collect funds for purchasing equipment for the soldiers. The cluster established cooperation with the Ukraine

	Foundation to identify current needs and ensure coordinated and purposeful actions. In addition to fundraising efforts, the cluster actively combats disinformation and identifies fake news through its news platform. Cluster members provide technical support in the form of products and services that enhance the work of volunteers in Poland. They also assist in organising transportation for Ukrainian citizens and animals across the eastern border. To assist refugees from Ukraine, the cluster initiated an information campaign and provides support for education and pursuing or continuing careers in the IT industry. Together with the City of Szczecin, they maintain an industry website called "Work Visit Szczecin" featuring job offers and content available in Ukrainian. They have also created a section on the website that provides instructions on how to submit CVs, which are then forwarded to cluster companies. Legal support related to employment and the legalization of stay in Poland is also prioritized. The cluster promotes its companies that offer support for Ukraine through its social media channels. Furthermore, the ICT Western Pomerania Cluster, in collaboration with the ITCorner cluster and the SoDA organization, has communicated with relevant ministries, advocating for a special act to assist Ukrainian citizens and proposing specific regulatory changes. They have expressed their willingness to participate in a working group to implement the suggested provisions, many of which have been addressed.
Impact of implementing good practice	The war and its aftermath have demonstrated the willingness and ability of clusters, coordinators, and cluster members to contribute to organized and purposeful assistance. Through collaboration in resource identification and needs assessment, the cluster has effectively utilized its available resources to provide multidimensional support that extends beyond material or monetary donations. The aid activities undertaken by the clusters for Ukraine have yielded valuable outcomes, including increased commitment and strengthened bonds between the cluster and its members. These initiatives have fostered a sense of belonging within the

	organization, emphasizing the importance of humanitarian values and promoting corporate social responsibility. Moreover, the cluster's expanded cooperation with external stakeholders has enhanced its visibility and that of its members in the broader community.
Possibility to use good practice	The importance of Corporate Social Responsibility (CSR) in clusters is increasing, as it enables them to build a credible image as socially responsible institutions that actively contribute to solving ecosystem problems. This aspect is particularly relevant for clusters aiming to obtain or maintain the status of a National Key Cluster, as their involvement in pro-social activities is evaluated in competitions and assessments. When considering CSR activities, it is crucial to recognize that there are various forms of social engagement and assistance that can be offered. CSR encompasses a wide range of initiatives and practices. In the context of clusters, corporate social responsibility involves not only caring for the interests of their members but also for the surrounding environment. When planning social activities, each cluster should thoroughly assess its environment's specific needs and align them with its own potential and capabilities. From the outset, the cluster coordinator should strive to involve its members and establish a system that inspires and encourages their active participation by setting an example. Through effective coordination of activities, targeted assistance can be provided to the right places and individuals in need. This tangible impact allows cluster members to witness the concrete dimensions of their contributions, fostering a sense of commitment and further motivating their engagement in CSR initiatives.
Dr Magdalena Ławicka, Operations Director, IT Cluster (full name: ICT West Pomeranian Cluster Association)	*It is commendable that, as one of the largest technology clusters in Poland, we have successfully undertaken several initiatives to support individuals from Ukraine. By actively encouraging member companies and collaborating with other organizations across the country, we have expanded the reach and impact of our activities. One notable contribution has been the provision of computer equipment, which is sent to Ukraine through our cluster. To date, we*

	have managed to send several dozen items, including laptops, monitors, UPS devices, VOIP phones, servers, and more.

6.2.5. Together for Industry 4.0 in Lubuskie Province

Cluster name	Lubuski Metal Cluster
Key area of good practice	 Cooperation with the environment
Other areas of good practice	▪ Innovative activity ▪ Cluster digitization ▪ Development of cluster cooperation
Purpose and circumstances for introducing good practice	In 2021, several projects were initiated in the Lubuskie Voivodeship to stimulate the regional innovation ecosystem. The Marshal's Office of the Lubuskie Voivodeship led a two-stage competition aimed at identifying smart specializations with high research and development potential and fostering collaboration among diverse entities. These efforts were closely linked to the preparation of the Innovation Development Program 2030 (PRI), which was crucial for leveraging funds from the new EU financial perspective for 2021-2027. The Lubuski Metal Cluster actively seized opportunities to enhance its members' innovativeness through the development of smart specializations in the region. Since 2014, the cluster has been involved in all initiatives initiated by the UMWL (Marshal's Office of the Lubuskie Voivodeship) related to the selection, monitoring, and updating of smart specializations. The cluster's proposal to include the metal industry within the scope of Lubuskie Smart Specializations was approved by the regional authorities. As a result, the cluster has established itself as a credible and progressive partner in the region, and its member entities anticipate increased support from the regional authorities for their ongoing initiatives. The competition for selecting key areas of Lubuskie Smart Specializations presents an opportunity for the cluster to secure additional funding for implementing cluster projects.

Description of the good practice	The Lubuski Metal Cluster, in collaboration with various partners from the region, including entrepreneurs, universities, institutions that support entrepreneurs, and the City Hall of Gorzów Wielkopolski, has established a partnership called SMART FACTORY 4.0. This partnership participated in a competition to select key areas within the Lubuskie Smart Specializations framework. The competition was part of the entrepreneurial discovery process, aimed at identifying new technological and business trends, understanding entrepreneurs' expectations, and verifying policies and instruments to support innovation. The proposal put forward by the SMART FACTORY 4.0 Partnership encompasses activities aligned with two Lubuskie Smart Specializations: Innovative Industry and Green Economy. The Partnership has received a positive recommendation from the Competition Commission and is awaiting the signing of an agreement with the UMWL (Marshal's Office of the Lubuskie Voivodeship). The primary objective of the Partnership is to transform Lubuskie enterprises toward Industry 4.0, focusing on supporting entrepreneurs in creating new products and services through research, development, and implementation efforts. The activities also consider the digital maturity model in Industry 4.0 and aim to reduce negative environmental impacts. The main research areas addressed by the Partnership fall into two dimensions: ▪ The technological dimension encompasses areas such as automation and digitization of production, advanced materials, additive technologies, and eco-technologies in industry. ▪ The process dimension emphasises production management, the integration of business systems, intelligent processes, and production equipment. Additionally, the cluster, in cooperation with the Gorzów Technological Center GOT PNP Sp. z o. o. and the Academy of Jakub from Paradyż in Gorzów Wielkopolski, will establish the Sustainable Development Accelerator 3E - Earth, Energy & Environment. This accelerator aims to support the development of innovations that

	contribute to the green transformation in the region and build future competencies. By combining the expertise of the participating entities, the accelerator will provide high-quality services in the field of the green economy and support the implementation of R&D projects by entities in the region. Establishing such a diverse partnership also facilitates cooperation in preparing innovative projects and initiatives to be financed under the new EU financial perspective for 2021-2027. Membership in this partnership allows members to apply for innovation vouchers, and they receive additional points in the merit-based evaluation. Furthermore, an extra 20 points can be obtained in the criterion for operating in a partnership established as part of the Regional Smart Specializations during the Lubuskie Innovation Forum.
Impact of implementing good practice	The cluster's initiative has led to the establishment of multi-level cooperation among active and innovative entities in the region, aimed at creating specific projects and innovative ventures. These initiatives, outlined in the Entrepreneurship Development Program (EDP), will have the opportunity to receive financing at the national level and will be promoted by the Lubuskie Voivodeship Self-government through territorial contracts and other means of aligning regional priorities at the central level. The self-government of the Lubuskie Voivodeship will also support these projects for financing at the international level through programs such as Horizon and COSME. As a result of these actions, the cluster has solidified its position as a strong partner willing to collaborate with regional authorities. It has demonstrated its capacity as an entity with ideas, initiative, and the necessary resources to implement activities that support innovation and entrepreneurship in the Lubuskie region. The cluster's proactive stance has attracted new members and increased its recognition within the region. By implementing these activities, including the establishment of the Sustainable Development Accelerator 3E, the cluster's activities will expand to a national level. Additionally, these initiatives will

	contribute to the cluster's pursuit of obtaining the status of the Key National Cluster (KKK).
Possibility to use good practice	The transformation of the economy to Industry 4.0 requires a holistic approach and collaboration at various levels. The comprehensive activities carried out by the Lubuski Metal Cluster, along with their ability to initiate and engage diverse partners, serve as a valuable example of regional cooperation between science and business. This model can be considered a successful approach for other clusters to emulate. Effective transformation strategies often involve collaboration among cluster members and external entities. By establishing partnerships, clusters can implement joint projects with clients, suppliers, partners, universities, research centers, and even industry competitors in some cases. The goal is to involve a wide range of partners to deliver maximum added value to the value chain.
Dr. hab. Katarzyna Cheba, prof. ZUT, *member of the board, Lubuski Metal Cluster*	*Indeed, integrating representatives from various environments and aligning them toward a common goal can be challenging. It requires effective communication, a shared understanding, and a willingness to collaborate on joint projects. In the case of the Partnership, where diverse entities are involved, such integration becomes crucial for the successful implementation of the tasks at hand.* *To address this challenge, regular and transparent communication channels should be established within the Partnership. Joint meetings, workshops, and forums provide opportunities for all stakeholders to share their ideas, concerns, and perspectives.*

6.2.6. Innovative activity in the area of digitization of the construction process in Poland

Cluster name	Cluster of Information Technologies in Construction (BIM Klaster)
Key area of good practice	 Innovative activity
Other areas of good practice	▪ Cooperation with the environment ▪ Development of cluster cooperation
Purpose and circumstances for introducing good practice	Cutting-edge technologies and the digitisation of specific procedures are increasingly making their presence felt in the building industry; however, the potential they offer remains largely untapped. It has been observed that construction projects are generating an ever-growing amount of unorganised data. The transition from paper to digital records facilitates superior management of information – a crucial competitive edge in today's digital world – and enables a more structured approach than what is achievable through conventional methods. Effective data management and its subsequent utilisation for refining processes and decision-making stand as pivotal elements in the successful evolution of the construction sector. Through the implementation of digital information modelling methods, it is possible to enhance the cost-efficiency of investments throughout the lifespan of a structure while simultaneously ensuring the quality and punctuality of deliveries. Given this backdrop and aware of the necessary digitisation and strengthening of investment and building procedures, BIM Klaster has accepted an invitation from PwC to participate in a project titled "Digitisation of the Construction Process in Poland. " This project, endorsed by the European Commission (DG Reform), and initiated by the Ministry of Development and Technology, has commenced the development of a strategy for incorporating BIM methodology into public procurement in the construction industry.
Description of the good practice	The essence of Building Information Modelling (BIM) technology lies in digitally capturing comprehensive knowledge and data about a building project, intending to employ this information in the design, construction, and subsequent utilisation of the facility.

	Within the scope of the project, an evaluation of experiences related to the application of BIM methodology and the digitisation of construction in select European Union nations was conducted, including an analysis of the domestic market. Procedures where BIM technology could be utilised for public projects were identified, and strategic BIM document templates were developed, such as a roadmap for integrating BIM methodology into public procurement, BIM document templates, and a concept for an IT BIM Digital Platform. The development of the roadmap involved extensive consultations and discussions with stakeholders in the construction industry, including cluster members, investors, public entities, designers, and principal contractors. Due to the PUSH-PULL strategy, the roadmap addresses not only the public procurement sector but also the necessary measures taken in the private sector. The developing BIM Platform is envisioned as a hub presenting the latest information on top-down initiatives for BIM promotion in Poland and their outcomes. Furthermore, the functionalities of the BIM Platform are expected to incorporate interactive tools designed to directly aid activities and processes related to BIM that project stakeholders undertake during the execution of investment projects. Utilising this "tool" will facilitate the better preparation of suitable project documentation for public procurement building. The deployment of digital tools during the investment planning phase will enable the optimisation of ongoing projects and the generation of savings. This presents a significant opportunity for enhancing efficiency, encompassing the investor's decision to initiate the investment, cost estimation, scheduling, risk identification, design, implementation with supply logistics, and ultimately, the operation of the facility. Significantly, the project's results can also be utilised by the private sector. All resources developed as part of the project are available on the Ministry of Development and Technology's website and the cluster's website, free of charge for use.

Impact of implementing good practice	The systematic and effective solutions outlined in the roadmap and project materials have been adopted as the foundational building blocks and starting point for the formal BIM Working Group (GRdsBIM). This group was established in 2022, at the directive of the Minister of Development and Technology, with the mission of devising a cohesive strategy for BIM deployment in Poland. Among the group's members are representatives from the Cluster. A primary function of this group is to provide advisory support to the Minister regarding BIM implementation. Furthermore, the Group drafts proposals for legislative measures related to the execution of investment projects in the construction sector, in line with BIM methodology, including public procurement. The positive effects of implementing best practices are also expected to appear in the following ways: ▪ The advocacy for BIM technology elements in investment and building procedures. ▪ The provision of BIM document templates, accompanied by a summary, to the market will assist stakeholders in the investment and building process with planning the execution of investments that meet BIM requirements. ▪ The active participation of industry representatives in formulating both BIM Templates and the Roadmap for BIM implementation in public procurement enhances their practical utility.
Possibility to use good practice	The primary beneficiaries of the best practices cultivated through the project include representatives of the construction sector (investors, designers, contractors), along with other clusters and organisations comprising micro, small, medium, and large enterprises from the investment and construction industry, both in Poland and globally. Within the framework of the "Digitalisation of the Construction Process in Poland" project, many BIM documents and templates were created, and processes were outlined where BIM technology could be employed for both public and private projects. These resources can also be utilised by other clusters, including international ones, for pilot projects. The documents produced through the project serve as a substantial reservoir of

	knowledge and a robust foundational resource for crafting BIM templates or devising BIM implementation roadmaps in other EU member states that are nascent in this realm (documents in English are also available on the MriT website). From the perspective of best practices, the cluster's willingness to share highly specialised knowledge and experience is also noteworthy. For years, the companies and experts within the cluster have engaged in informational and educational initiatives. Their participation in the "Digitalisation of the Construction Process in Poland" project, which also extended invitations to foreign experts who had previously collaborated with the cluster, is a testament to the effectiveness of this work method. It has a practical bearing not only on the development of the cluster itself and its members but also on the industry that this cluster represents.
Katarzyna Orlińska-Dejer, President of the Management Board of the Information Technology in Construction Cluster (BIM Klaster)	*Since the outset, our Cluster has championed the principles of openness, collective effort, and sharing knowledge, both internally and externally. By leveraging our most crucial resource – expertise, we have consistently engaged in information and educational projects over the years. These initiatives aim to enhance industry representatives' understanding of the application of innovative technologies in construction. The project, "Digitalisation of the Construction Process in Poland," aligns seamlessly with these endeavours. The project's execution methodology, its transparency, and open approach (involving surveys and extensive consultations with the market) have facilitated the creation of outcomes that accurately mirror the needs of the industry.*

6.2.7. Integration of cluster members around issues related to the USV industry, including the development of a common product - the prototype of the USV "Hornet" unmanned boat

Cluster name	Interizon – Pomeranian ICT Cluster
Key area of good practice	 Innovative activity
Other areas of good practice	▪ Development of cluster cooperation ▪ Cooperation with the environment
Purpose and circumstances for introducing good practice	Unmanned vehicle technology is globally recognised as a major trend and is projected to be among the most significant and appealing areas of advancement within the broader field of transportation, both in Europe and worldwide. Members of the Interizon - Pomeranian ICT Cluster are companies involved in global value chains, and their business partners seek reliable solutions to enhance the security of cyber-physical systems at the lowest possible costs. This has provided additional motivation to participate in the development of a prototype unmanned boat. Simultaneously, the Pomeranian Voivodeship, the country's premier maritime economy hub, has the potential to emerge as one of the key centres supplying products and services to the Unmanned Surface Vehicle (USV) market in the near future. Concurrently, the cluster conducts a variety of initiatives aimed at fostering cohesion among its members, such as through the joint efforts of the Task Force Autonomous Vehicles (GZPA) of Interizon Cluster[81]. In light of this, during the Group's proceedings, a necessity arose to undertake research and implement a novel, innovative product of the cluster. The coordinator compiled a report outlining the characteristics of USV vessels within the region and Poland. This

[81] The initiators of the creation of the Autonomous Vehicles Task Group are the Interizon Cluster and the Digital Technology Center of the Gdańsk University of Technology. Its goal is to build and strengthen international competitiveness and accelerate the growth rate of enterprises in the ICT sector of the Pomeranian Voivodeship, through the implementation of research and development works and building intellectual potential for creating innovative products and services in the field of interactive technologies in an information-saturated environment. The members of the group are entities interested in the subject matter in question, including mainly: manufacturers of autonomous vehicles and devices, machines, installations and other accessories, technology suppliers, as well as entities interested in using this type of vehicles in current operations.

	report is advantageous for entities and institutions within the maritime and ICT industries that either create or may in the future establish a value chain related to the market of unmanned surface vehicles, including autonomous vehicles. The cluster coordinator also participated, through the Group, in efforts to develop a prototype of the USV "Hornet" unmanned boat.
Description of the good practice	The cluster coordinator embarks on various initiatives to consolidate members around significant themes and concerns. One such endeavour involves integrating members into Task Forces, including the GZPA. The following are some of the most intriguing undertakings of this group. The USV report, compiled by the cluster coordinator, the Interizon Foundation, encapsulates existing knowledge about types of unmanned surface vehicles, illustrates potential applications for such vessels, and offers insights into the market structure. This is pivotal for the continued operations of the Autonomous Vehicles Task Force and serves as a knowledge resource for national and regional decision-makers, as well as businesses and institutions that can contribute to creating complete value chains delivering innovative, competitive products for global markets. The USV Hornet, a prototype of the first Polish unmanned boat designed to meet maritime industry requirements, emerged from group discussions. "Hornet" will be the inaugural vessel of its kind in Poland, with potential for semi-autonomous and autonomous operation. The substantive work of the Task Force on Autonomous Vehicles was initiated by the Digital Technology Center of the Gdańsk University of Technology, which also secured an international project under the Horizon 2020 program. The prototype was developed within the research and development project "TRANSACT - Transform safety-critical cyber-physical work distributed solutions for end-users and partners. " The basic, equipment-loaded boat is now ready, with scientists currently working on edge and cloud technology solutions utilising artificial intelligence and machine learning. The Hornet boat will be capable

	of functioning autonomously, which implies it will have the ability to "learn. " There is already interest in the Polish port and offshore industry for utilising such boats. The unmanned boat "Hornet" may be deployed, for instance, to inspect shipping channels and patrol offshore wind farms (e.g., to identify objects that should not be present in a given area). The boat will be a collaborative product of the cluster, with members contributing components and technologies. The coordinator oversees the integration process and encourages cooperation. In tandem with the implementation of the European project, local collaboration was initiated under the Smart Specialisations of Pomerania. This initiative, launched by the Marshal's Office of the Pomeranian Voivodeship, aimed to strengthen the relationship between the maritime and ICT sectors in Pomerania, animated by the Interizon Cluster and the Gdańsk Incubator Starter, respectively. As a result of this collaboration, a task group of the Pomeranian ICT Interizon Cluster was formed, bringing together entities interested in the joint development of products related to unmanned and autonomous boats.
Impact of implementing good practice	Within the context of the project and its identified requirements, there is increasing recognition that access to specialised, educated personnel and appropriate technological infrastructure are essential factors for the maritime industry's evolution toward the design, production, maintenance, and implementation of products and services based on USV technology. As part of the endeavour to create an innovative product, Gdańsk University of Technology's collaborative approach enabled the establishment of a value chain involving the Interizon ICT Cluster. This facilitated the cluster members' creation of components, including advanced algorithms and systems that will form part of the future autonomous boat's solutions. Meanwhile, the cluster coordinator initiated numerous initiatives aimed at integrating its members around issues relevant to the USV unit industry, resulting in both intra-cluster and external cooperation being enhanced.

	The initiation of collaboration on a shared product that is still in its development phase has proven invigorating and has encouraged both the coordinator and cluster members to explore additional areas of cooperation.
Possibility to use good practice	The identified best practices could serve as inspiration for other clusters, showcasing their potential to offer unique and innovative problem-solving methods for their members and their surrounding environments, thereby facilitating market-driven solutions. Studying a specific industry and its related sectors enables clusters to uncover new collaborative opportunities, connect with potential contractors, and distinguish themselves from competitors. Simultaneously, this process accumulates knowledge within the cluster and promotes innovative solutions across the economy and society. As such, one of the key responsibilities of cluster coordinators is to maintain transparent communication about the significance of these initiatives and their advantages for economic and societal development. Furthermore, they should strive to identify innovations that could benefit the ecosystems in which the clusters operate while encouraging member engagement in their execution.
Jarosław Parzuchowski, President of the Board of the Interizon Foundation, coordinator of the Pomeranian ICT Interizon Cluster	*The collaborative approach of Gdańsk University of Technology enables firms in the ICT sector, associated with the Interizon Cluster, to create components, including sophisticated algorithms and systems, that will contribute to the solutions for the forthcoming autonomous boat. We expect to establish a value chain involving numerous Polish companies, thereby creating an innovative product.*

6.2.8. International cooperation with other clusters as a tool for generating green innovations

Name of good practice and cluster	Silesia Automotive & Advanced Manufacturing
Key area of good practice	 Cooperation with the environment
Other areas of good practice	▪ Innovative activity ▪ Cluster digitization ▪ Development of cluster cooperation ▪ Impact on the natural environment
Purpose and circumstances for introducing good practice	Members of the Silesia Automotive & Advanced Manufacturing cluster are primarily large businesses and subsidiaries of international corporations. Thus, when it comes to internationalising operations, the cluster coordinator emphasises different facets compared to clusters with a significant proportion of SMEs. One key aspect of international cooperation here is knowledge sharing, mutual learning, and collaborative projects focused on deploying modern digital and green technologies to optimise processes and shift businesses towards carbon neutrality. It is crucial for the cluster's development to foster an environment where knowledge and best practices can be disseminated among cluster participants and foreign counterparts, including businesses in other countries, European clusters, and European institutions that support digital and green transformation, among others. The manufacturing industry's commitment to digital and green transformation is crucial for maintaining business competitiveness and achieving the objectives of the Green Deal.
Description of the good practice	As part of the COSME program from 2018 to 2021, the Silesia Automotive & Advanced Manufacturing cluster, in a consortium with six automotive clusters, implemented the project "EACN for Joint Industrial Modernisation" Investments"[82]. This project aimed to aid the automotive industry in its digital transformation. Given the high

[82] Other Polish automotive clusters were also involved in the project, including the Polish Automotive Group, the Lower Silesian Automotive Cluster and the Eastern Automotive Alliance.

	demand for knowledge about effectively deploying and utilising new technologies in production processes, along with the substantial value derived from sharing experiences among European partners in this area, the project resulted in the formation of an ongoing partnership involving over 25 European automotive clusters. One outcome of this collaboration within the European Network of Automotive Clusters is a new joint project aimed at advancing the digital and green transformation of the automotive industry. An example of such a project is GreenSME, in which the Silesia Automotive & Advanced Manufacturing cluster participates. This project's objective is to assist SMEs in their green transition towards a more sustainable, adaptable, and resilient EU manufacturing industry, capable of addressing current and future challenges in the industrial sector. GreenSME strengthens the capacity of SMEs to adopt advanced technologies, making them more competitive, carbon-neutral, and maximising benefits for all societal groups, aligning with a sustainable European manufacturing industry. This vision posits that SMEs should adopt a strategic approach to sustainable development. In line with the project's vision, this goal will be achieved by creating a Greensme HUB and developing a sustainable SME transformation path. This path will encompass the entire process of support offered to manufacturing SMEs to enhance their ability to implement advanced technologies for sustainable development. SMEs that participate in the Sustainability Assessment will have the opportunity to apply for a subsequent advisory service that provides an Advanced Sustainability Action Plan tailored to each SME's needs. After the project is prioritised (and approved by the project consortium), SMEs will receive financial support of up to EUR 40,000 to implement the developed action plan. Thanks to cooperation within the framework of an international partnership, initially aimed at project implementation, the cluster strengthens its position and enhances its reputation on the international stage. The exchange of experiences and knowledge between entities with complementary expertise in transforming SMEs toward a digital and green industry in Europe, along with access to know-how beyond local cluster resources, enhances the competencies of the cluster coordinator and its members. The

	GreenSME HUB facilitates the creation of a community of innovative SMEs engaged in sustainable production. The HUB serves as a platform for knowledge exchange, bringing together resources, activities, and stakeholders to enable the adoption of advanced technologies by SMEs for sustainable development.
Impact of implementing good practice	Through international partnerships originally formed for project implementation, the cluster strengthens its position and expands its international recognition. Sharing experiences and knowledge among entities, each possessing unique expertise in transforming SMEs towards a digital and green industry in Europe, enhances the capabilities of both the cluster coordinator and its members. Additionally, access to know-how from beyond the local cluster further bolsters these capabilities. The GreenSME HUB plays a crucial role by creating a community of innovative SMEs engaged in sustainable production. This hub serves as a space for knowledge exchange and brings together essential resources, activities, and stakeholders. Its purpose is to encourage the adoption of advanced technologies by SMEs, propelling them towards sustainable development. This cooperative platform enriches the cluster's knowledge base, sparks innovative ideas, and fosters a sustainable, future-ready mindset among its members.
Possibility to use good practice	Building international inter-cluster networks facilitates the globalization of Polish cluster activities while simultaneously encouraging the acquisition of new knowledge. By collaborating with other organizations, the cluster also broadens the scale of its operations. This results in valuable learning experiences for both the cluster coordinator and its members. These collaborations lead to new projects that allow cluster members to further develop their potential. Entering into international partnerships enhances the capacity of SMEs to adopt advanced technologies. These partnerships provide exposure to various international practices and methodologies, thus widening the scope of technological understanding. As a result,

	SMEs become more adaptable and versatile, effectively boosting their competitive advantage in the global marketplace.
Łukasz Górecki, Director of the SA&AM Cluster	The SA&AM Cluster, while rooted in local initiatives, operates on an international scale, particularly in projects that align with the interests of its members and provide tangible benefits. Given the unique nature of the Cluster and our region, topics related to digital and green transformation are especially important for entrepreneurs today. This is why the SA&AM Cluster has participated in such projects for several years, often as part of international consortia. A recent example of this involvement is the GreenSME project. The target group for this project is SMEs, which we aim to support in testing and implementing new technologies and climate-neutral solutions. Our goal is to ensure that businesses in our region are modern, environmentally friendly, and equally effective and competitive on both the national and international stages. Collaboration is a key aspect of growth, and partnering with more experienced and developed entities is particularly valuable. This is why we carry out our activities not only locally, but also with European partners who are often more experienced. We have gradually been developing this approach over many years. Initiating project collaboration at the European level is certainly facilitated by our participation in the European Network of Automotive Clusters, under which we previously implemented a project in the field of digital transformation.

6.2.9. Cooperation of entrepreneurs during the crisis (COVID-19 pandemic)

Cluster name	Bydgoszcz Industrial Cluster Tool Valley
Key area of good practice	 Market activity
Other areas of good practice	▪ Influence on shaping the environmental conditions ▪ Development of cluster cooperation ▪ Cooperation with the environment
Purpose and circumstances for introducing good practice	The challenging period of the COVID-19 pandemic indeed promoted collaboration, encouraging clusters and their members to engage in extensive projects aimed at combating the coronavirus. Clusters became pivotal platforms for cooperation in addressing the crisis, which caused significant disruptions in the economy and business operations. To mitigate revenue declines and enhance business resilience, cluster coordinators adjusted their activities across various aspects of the organization's functioning and value creation areas. They employed strategies such as fostering shared resources, promoting knowledge transfer, and encouraging collaborative innovation to navigate these difficult times. These measures helped manage not only the immediate effects of the crisis but also prepare for a post-COVID-19 world, with an emphasis on digital transformation, sustainability, and resilience.
Description of the good practice	The response of the Bydgoszcz Industrial Cluster of the Tool Valley to the COVID-19 pandemic underscores the vital role that such a cluster can play during a crisis. The cluster office staff collaborated closely with the Marshal of the Kuyavian-Pomeranian Voivodeship to secure essential protective materials, including masks, aprons, and gloves, for healthcare facilities. Not only that, but the cluster coordinator also managed and coordinated collaboration activities among businesses, universities, and health centers to produce protective visors and masks. These collaborative efforts resulted in the manufacture of visors from

	proprietary materials using 3D printing technology, which were subsequently distributed to companies for use. In the face of the crisis, the cluster also established a cooperation exchange platform. This platform facilitated the exchange of offers and demands among members and served as a focal point for collaborative efforts aimed at supporting the healthcare industry and hospitals, which were experiencing shortages of protective products. Furthermore, in collaboration with the Association of Entrepreneurs of Kujawy and Pomerania and the ADEP Tax Office, the cluster coordinator organized webinars on human resources and accounting. These were designed to provide businesses with crucial information during the crisis, covering topics such as "Employer's subsidy under the anti-crisis shield," "Restructuring and transformation in my company," and "Remote work, how to win this crisis?" Additionally, the coordinator promoted the Solidarity Radio Action of WNET Radio among cluster members. This initiative offered companies impacted by the crisis the chance to receive free radio advertisements. At the national level, the cluster coordinator initiated cooperation with other clusters and participated in consultations regarding the Anti-crisis shield and Anti-crisis shield 2. The coordinator also prepared and submitted comments to the Marshal of the Kujawsko-Pomorskie Voivodship, outlining ways to support entrepreneurs during this challenging period. These combined efforts exemplify how a cluster can provide essential support during a crisis by utilising its network, capabilities, and resources to assist its members and the wider community.
Impact of implementing good practice	The COVID-19 pandemic has undeniably had a profound impact on the dynamics of collaboration within clusters and among their members. The crisis, due to its widespread and intense repercussions, has stimulated a surge in cooperation among cluster participants. In response to the pandemic, various entities within the

	cluster came together to devise and implement strategies to mitigate its effects. Interestingly, the pandemic also led to connections with new partners from various fields. While collaborations with other R&D companies and institutions within the same industry were strengthened, partnerships were formed with a broader range of stakeholders, including healthcare and caregiving facilities. This period of adversity served as a litmus test for the quality of partnerships among entities within and outside the cluster. As a result, a heightened level of active involvement, readiness to reconcile conflicts of interest, and willingness to share resources was observed. This shift in behavior underlines the power of collective action in the face of crisis and illustrates how the spirit of cooperation can be strengthened even in challenging circumstances.
Possibility to use good practice	Indeed, the state of the epidemic has highlighted the power of a common objective in mobilizing diverse entities to collaborate, even those that may have had no previous experience with cluster cooperation. The cluster coordinator can play a pivotal role in these efforts, using their experience to foster collaboration for a shared goal among not only cluster members but also a broader range of stakeholders. During these challenging times, the coordinator's scope of operation can expand dramatically and rapidly. In this context, the human resources of coordinators are extremely valuable, as they are responsible for managing various aspects of the crisis response. The use of electronic tools can greatly facilitate their activities, assisting in coordination and communication. Faced with a crisis, companies may feel compelled to reassess the current applications of their components or final products and explore new avenues for development. This mindset enables the coordinator to initiate specific forms of collaboration more easily. Importantly, the benefits of collaborating within the cluster extend beyond individual economic goals. These collaborative efforts can also target important social objectives. This highlights the relevance and timeliness of the concept of creating shared value – the idea that organizations can generate economic value in a way that also produces value for society by addressing its needs and challenges.

	The pandemic has underscored the capacity of clusters and their members to uphold this principle through cooperative actions.
Piotr Wojciechowski – Managing Director – Bydgoszcz Industrial Cluster Tool Valley	*Indeed, the pandemic period posed significant challenges not only for companies within clusters but also for their coordinators. Within a very short time frame, they needed to adapt to a changing landscape, suspending some activities while addressing new needs and challenges. This necessitated rapid shifts and adjustments to the prevailing conditions. Despite these daunting circumstances and multifaceted challenges, clusters demonstrated remarkable flexibility. Their members displayed a willingness to cooperate and support various initiatives at regional or national levels. This resilience and adaptability can be viewed as a positive outcome emerging from the crisis.* *Furthermore, the experiences gained during the pandemic have been invaluable. They have equipped clusters with the capacity to respond better to subsequent crises, such as the war in Ukraine. Once again, member companies within the clusters have demonstrated great solidarity and support during these challenging times, reinforcing the strength and importance of these collaborative networks in times of adversity.*

6.2.10. Integration of the Polish drone industry around the Silesian Drone Valley

Name of good practice and cluster	Silesian Aviation Cluster
Key area of good practice	Development of cooperation in the cluster
Other areas of good practice	▪ Innovative activity ▪ Cooperation with the environment ▪ Influence on shaping the environmental conditions
Purpose and circumstances for introducing good practice	The Silesian Aviation Cluster plays a crucial role by bringing together a variety of companies and institutions, many of which are deeply involved in the burgeoning drone market. Over 100 companies and institutions are associated with this cluster, more than 20 of which actively participate in the drone sector. Given the evolving nature of the drone market and the anticipated demand for services offered by unmanned aerial vehicles, such collaborative platforms can be instrumental in shaping the growth trajectory of this young market, particularly in fostering domestic capabilities. Most companies in the drone industry are small, and to a lesser extent, medium or large-sized. Given the dispersed nature of this market, there is a lack of sufficient knowledge among entities about the broader ecosystem. This includes research institutions, potential users of drone systems such as administrative bodies (e.g., Górnośląsko-Zagłębiowska Metropolis), and large companies. This knowledge gap could potentially hinder the pace of development of new drone products and services. As such, the establishment of the Silesian Drone Valley serves as a response to consolidate the drone industry in Poland, addressing a need identified by the cluster coordinator. As the industry gravitates towards increased automation, more opportunities emerge for hardware and software manufacturers. As an established platform for integrating market participants, the Silesian Aviation Cluster influences regulations that are vital for those involved in the market. Its role entails coordinating cooperation and integrating various entities in the realm of

	unmanned and autonomous technologies, spanning from suppliers and integrators to customers, scientific institutions, local governments, public administration, financial institutions, and investors. This collaborative effort not only aids in scaling the industry but also maximizes its potential impact.
Description of the good practice	**CEDD** The Central European Drone Demonstrator (CEDD) was established as a first step towards integrating and leveraging modern drone technology. Initiated by the Silesian Aviation Cluster, the Upper Silesian - Zagłębie Metropolis (GZM), the Institute of Aviation in Warsaw, and the Silesian Marshal's Office, in conjunction with the Civil Aviation Office and the Polish Air Navigation Services Agency, the CEDD serves as a testing ground for technical drone solutions in an urban environment. It evaluates potential drone services according to current and future legal regulations. **Drone Valley** In a move towards broader integration of the drone sector, the Silesian Aviation Cluster initiated the establishment of the Silesian Drone Valley in November 2019. This initiative extends beyond the cluster, engaging entities from outside it and aiming to consolidate the entire drone sector in Poland, connecting it with partners across the European Union and beyond. Within the framework of the Drone Valley, the Silesian Aviation Cluster is open to collaboration with entities from other clusters, such as the Aviation Valley. This openness creates the conditions for future cooperation and practical applications within the rapidly emerging drone market, testing drone systems under both controlled laboratory conditions and real urban scenarios. **Additional activities for the Drone Valley** In addition to these initiatives, the cluster co-founded and actively participates in the "European Drone Cooperation," a collective of drone clusters from over a dozen European Union countries. The cluster is involved in organizing drone conferences, such as the CURPAS conference near Berlin and the national Silesian Aviation and Drone Days.

	Moreover, the cluster is developing an online transaction platform for the drone market, complete with a database and an information portal. This platform will be open to all entities willing to share their knowledge and experience, ranging from service providers using Unmanned Aerial Vehicles (UAVs) to constructors, scientific institutions, and local government institutions. The cluster's coordinator also contributes to shaping the regulatory framework for the drone economy, including participation in consultations announced by the European Commission regarding the "Strategy for Drones 2.0." These efforts highlight the cluster's proactive role in driving and shaping the future of the drone industry in Poland.
Impact of implementing good practice	The establishment of the Silesian Drone Valley has led to significant advancements in the UAV industry, including the operational CEDD test area within the GZM region. This test area provides a controlled environment for testing drone solutions and services, with a verified procedure to assess their maturity. Additionally, the publication of recommendations on smog monitoring using UAVs and a model ToR (Terms of Reference) for ordering smog monitoring services has been an important outcome. The integration of various stakeholders within the Drone Valley initiative has allowed the cluster to promote its activities more effectively. Stakeholder meetings and drone tests for monitoring landfills have been organized, along with webinars addressing operators conducting UAV flights in special categories and entrepreneurs interested in implementing UAV services. These initiatives have gained increasing recognition and response from the industry. The cluster has also strengthened its cooperation with local governments and provided documentation on how to utilize drones in local government tasks related to environmental protection. Numerous industry meetings and conferences have been organized, offering a platform for Polish UAV industry representatives to engage in discussions on legal regulations and showcase their solutions and services.

	Overall, the Silesian Drone Valley has become a catalyst for deeper integration within the Polish drone ecosystem, actively supporting and promoting the industry both domestically and internationally.
Possibility to use good practice	The aforementioned good practice demonstrates that clusters have the potential to expand their traditional area of operation, which has primarily focused on supporting the innovation of their members and integrating the economy with science in a regional context. Clusters can extend their influence to a national level, coordinating large-scale projects and representing the industry before public administration and regulators. By strengthening industry integration, cluster enterprises gain the ability to impact the entire ecosystem surrounding the cluster, including authorities regarding legislation and support initiatives. This can lead to an increase in the number of cluster members, as well as the implementation of new projects, services, and initiatives. This good practice can serve as a model for other clusters operating in different market sectors to integrate participants from the entire sector, not just cluster members. The potential sequence of cluster activities for industry integration, involving entities outside the cluster, may include: 1. Identifying and establishing relationships with public entities that influence regulations in the specific sector. 2. Identifying and establishing relationships with potential customers, including institutional clients, within the sector. 3. Identifying and establishing relationships with entrepreneurs who represent the sector at the national level. 4. Organizing meetings and conferences, including international ones, to facilitate relationship-building among the aforementioned entities. 5. Developing an online platform or knowledge base that promotes information sharing, contacts, and collaboration among entities in the sector. 6. Undertaking, initiating, or supporting specific projects that enhance business activities within the sector (e.g., CEDD). 7. Representing the interests of the sector in interactions with administrative and regulatory bodies.

Krzysztof Krystowski, President of the Management Board of the Silesian Aviation Cluster	*The development of the drone industry within the Silesian Aviation Cluster represents a natural progression of the cluster's activities and serves as a testament to its effectiveness in building partnerships and credibility. By uniting drone entities from across Poland and fostering collaborations with regional and national organisations, the cluster has become a central hub for the drone market in the country.* *To achieve such success, clusters must undertake various initiatives and establish relationships beyond their immediate environment. This involves building robust financial and organizational foundations to ensure credibility and the capacity to pursue ambitious tasks.* *For other clusters aiming to implement industry-wide initiatives, it is crucial to prioritize establishing a strong financial and organizational position. This will empower them to effectively support the entire industry and position themselves as credible partners in collaboration with external entities. By doing so, clusters can play a significant role in driving industry development and achieving mutual benefits for all stakeholders involved.*

6.2.11. Support in the field of circular and innovative transformation. The first national recycling certificate KRN Green

Cluster name	Waste Management and Recycling Cluster
Key area of good practice	 Market activity
Other areas of good practice	▪ Innovative activity ▪ Development of cluster cooperation ▪ Cooperation with the environment ▪ Influence on shaping the environmental conditions ▪ Impact on the natural environment
Purpose and circumstances for introducing good practice	The rapid advancement of technology and evolving customer needs present a challenging task for enterprises, including cluster members, who must keep pace with trends and respond promptly to changes. Companies that resist these changes often fail to fully harness their potential. Good practices address the following challenges: ▪ Adopting new technologies and solutions to reduce raw material usage and promote their reuse. ▪ Developing expertise in design and production technology to effectively recover raw materials for future use. ▪ Establishing standardized recycling processes. ▪ Fostering cross-sectoral innovation to create new value chains and business models in line with the principles of the circular economy. ▪ Initiating and supporting the development and dissemination of innovative solutions in the circular economy that benefit both cluster members and the overall circular economy. ▪ Providing support for investment implementation. ▪ Building competencies in implementing innovations or Industry 4.0 solutions. ▪ Additionally, good practice addresses the barriers of limited knowledge, employee resistance to organizational changes, and high implementation costs that many enterprises face and struggle to overcome without external support.

	This good practice aligns with the objectives of the Circular Economy (CE) plans, which play a crucial role in achieving climate goals. Such goals, set at national, EU, and global levels, necessitate significant changes in resource and product production and consumption. Closing the loop is a pivotal element of the European Green Deal, which shapes the regulatory and business environment in which companies operate.
Description of the good practice	Since it began operations, the Waste Management and Recycling Cluster has actively responded to market demand for circular economy transformation and innovation, including digitization towards Industry 4.0. The cluster coordinator provides various services to enhance the development and competitiveness of both cluster members and external clients. These services focus on the digital and circular transformation of enterprises, developing new business models, supporting innovation implementation, and certifying waste recycling companies, with a particular emphasis on post-consumer waste. The cluster offers several key services. **ProGoz** This comprehensive support service assists companies in building and enhancing products, services, and business models aimed at the Circular Economy. It is accessible to companies of all sizes and industries, as well as public administration. ProGoz is a modular service that employs methodologies such as Human-Centered Design, Lean, Lean Startup, and Jobs-to-be-done. It includes original tools like workshop scenarios, boards, and playing cards. The service culminates in a report and action plan based on global standards and prepares companies for certification, such as the KNR Green standard. The service features collaborative design with the client's company, developing solutions in partnership with their internal team. **ProInno** This service supports enterprise development through two paths: ▪ Innovation support. ▪ Industry 4.0 support. It facilitates innovative transformation and digital transformation, including the creation of digital roadmaps. The service formulates a

	customised development plan with specific actions and offers guidance from dedicated experts throughout the implementation process. Additionally, it helps identify potential financing sources for specified projects. **KNR Green** KNR Green is the first Polish recycling certification standard aimed at recyclers in seven industries: textile, metallurgy, paper, wood, glass, chemical, and plastic. This certification confirms compliance with legal and quality requirements in the European Union market. It serves as an official certification for the content of post-consumer waste in final products, supporting the circular economy concept. The certification enables companies to meet the increasing demands of major retail chains for sustainable development labeling and to comply with national and European Union legislation on waste recycling. **ClusterBox** KlasterBox is a new platform designed for members of the Waste Management and Recycling Cluster. It provides a space for communication and membership status management, and it supports cluster processes. Additionally, KlasterBox serves as an enhanced sales platform where cluster members can offer and purchase products and services from one another. These services reflect the comprehensive approach of the cluster coordinator in addressing industry needs and solving various challenges faced by cluster members and clients.
Impact of implementing good practice	The implementation of good practice in the Waste Management and Recycling Cluster has resulted in several significant effects. These include: ▪ Introducing Innovations: The cluster has facilitated the introduction of innovative solutions in enterprises, enabling them to stay ahead of market trends and meet evolving customer needs. ▪ Circular Innovation Ecosystem: The cluster has created an ecosystem that promotes circular economy practices and encourages the development and adoption of sustainable business models and practices.

	▪ Building Competitiveness: Through services like ProGoz, ProInno, KNR Green, and KlasterBox, cluster members and external entities have enhanced their competitiveness. They receive knowledge, inspiration, and tools for innovation management, circular economy strategies, customer acquisition, and adapting to new regulations and business expectations. ▪ Improving Competences: The cluster supports the development of competences among its members, equipping them with the necessary skills and knowledge to excel in their respective fields. ▪ Strengthening Relationships and Value Chains: The cluster has fostered connections and collaborations among its members, enhancing the development of value chains and strengthening relationships within the industry. ▪ Access to Financing: The cluster actively assists companies in seeking and obtaining external financing, helping them fund their innovative projects and initiatives. ▪ Digitization of Processes: By embracing digitization, the cluster has improved its internal and external processes, leading to enhanced efficiency, knowledge management, and service delivery to its members. Overall, these effects have enhanced the cluster's image as a comprehensive support entity for entrepreneurs, recognised for its responsiveness to their needs and its commitment to promoting sustainable practices and innovation.
Possibility to use good practice	The circular economy holds significant potential for innovation by promoting a holistic approach to product life cycles and encouraging the creation of new services and business models. To effectively transition towards a circular economy, clusters and their members must engage in various activities across all stages of the product life cycle, including product design, raw material sourcing, processing, production, consumption, waste collection, and management. Adopting a comprehensive approach and planning a logical sequence of activities is essential for success, although cluster services can be developed gradually over time.

	For clusters that may lack the necessary resources to independently drive circular economy initiatives, collaborating with the Waste Management and Recycling Cluster can be advantageous. The Waste Management and Recycling Cluster can function as a platform for information, communication, and cooperation, offering valuable insights, expertise, and support in the field of circular economy. By leveraging the resources and expertise of the Waste Management and Recycling Cluster, clusters and their members can access knowledge, exchange ideas, and foster collaboration to accelerate their transition toward a circular economy. This collaborative approach enables clusters to tap into the full potential of the circular economy and unlock new opportunities for their business activities.
Katarzyna Błachowicz, Vice-President of the Management Board, Waste Management and Recycling Cluster	*Clusters play a crucial role in fostering competitiveness in today's economy, increasingly driven by research, development, and innovation. By facilitating collaboration among businesses, research institutions, support organizations, NGOs, and local authorities, clusters act as catalysts for innovative processes.* *Projects that support the innovativeness of companies significantly drive innovation. Within the cluster, the "ClusterLab" project has led to the development of services focused on digital transformation and the circular economy. Additionally, the cluster offers the KNR Green certification, the only certification in the field with a specific focus on the circular economy. Through our ideas and innovations, we aim to stay one step ahead of established laws and initiatives, such as the European Green Deal. While this approach carries risks and requires investment preparation, our primary focus is on the environment and the tangible impact we can have on greening the economy and protecting the environment.*

6.2.12. Building a culture of openness, cooperation and partnership with local government authorities

Name of good practice and cluster	North-South Logistics and Transport Cluster
Key area of good practice	 Cooperation with the environment
Other areas of good practice	▪ Innovative activity ▪ Development of cluster cooperation ▪ Influence on shaping the environmental conditions
Purpose and circumstances for introducing good practice	Support for smart specializations (IS) involves the targeted allocation of public funds within the European Union to activate and leverage the potential of specific areas or sectors of the economy that demonstrate a high capacity for dynamic development and expansion into foreign markets. The support provided to entities operating within selected IS primarily focuses on implementing innovative projects and research and development activities, aimed at strengthening the potential of these specializations. In line with this approach, the Coordinator of the North-South Logistics and Transport Cluster has recognized the innovative and competitive potential of its members. Considering the dynamics of the national environment and global conditions, the cluster coordinator has actively engaged in identifying and monitoring smart specializations within the Pomeranian Voivodeship.
Description of the good practice	In the Pomorskie region, a bottom-up approach is used to define smart specializations (IS). Interested economic and scientific circles submit their proposals through a competitive procedure, and the regional authorities select those with the greatest potential for development from the submissions. As the coordinator of the North-South Logistics and Transport Cluster, the Management Board of Baltic Sea Cluster Initiatives Sp. z o. o. is dedicated to enhancing the competitive advantage of its members. Acknowledging that inclusion in the IS area is a formal and mandatory criterion for accessing public funds, the cluster actively engages in

	efforts to identify offshore, port, and logistics technologies as one of the smart specializations of the Pomeranian Voivodeship. This involvement includes active participation in formulating the voivodeship strategy and assumptions for this IS area. The cluster representatives contribute to defining the development directions of this specialization. It is important to note that the IS selection process is conducted periodically by the Pomeranian Voivodeship Board to update knowledge and plans. This requires the verification of IS areas by the cluster coordinator and confirmation of their relevance in consultation with cluster members. Simultaneously, the cluster undertakes various activities to foster intensified cooperation for the development of the IS, particularly between entrepreneurs and entities representing the science sector. The aim is to collaboratively develop unique technologies, products, and services. Similar efforts are made to strengthen cooperation between cluster members and local government units.
Impact of implementing good practice	The success in selecting offshore, port, and logistics technologies as one of the smart specializations (ISP 1) was achieved through the establishment of an open and cooperative culture that fosters partnerships with local government authorities and other entities interested in the development of smart specialization. As the cluster coordinator, we are proud to be one of the signatories of the Agreement for the Smart Specialization of Pomerania in the area of offshore and port logistics technologies. This agreement aims to align the goals of ISP development, define the scope and priority research directions, and address key research problems that are crucial for the specialization's development. It also establishes the principles and forms of support for projects that contribute to the development of ISP, particularly through research and development initiatives. The focus on offshore, port, and logistics technologies aims to enhance international competitiveness and accelerate the growth of enterprises in the maritime economy sector within the Pomeranian Voivodeship. This will be achieved through the implementation of research and development initiatives and the creation of innovative

	products, services, and technologies that ensure the environmentally safe exploration and exploitation of marine resources. In line with the development of smart specialization and the promotion of cross-sectoral connections, our cluster actively collaborates with other voivodeships. Together, we strive to unlock the full potential of offshore, port, and logistics technologies, drive innovation, and foster sustainable growth in the maritime economy sector, contributing to the economic advancement of the Pomeranian Voivodeship and beyond.
Possibility to use good practice	There is a need to further develop the role of coordinators in influencing public institutions. The concept of smart specializations provides a framework for comprehensive support to cluster members, fostering their growth and enhancing regional competitiveness. Clusters themselves can serve as effective tools for implementing smart specializations. Through active engagement in the process of defining these specializations, clusters can facilitate a more efficient implementation of technological solutions in the market, leading to a higher likelihood of achieving faster returns on investments in research, development, and innovation (R&D&I). Cluster members can enhance their innovativeness by participating in and leveraging projects focused on smart specialization development. By aligning their activities with the defined specializations, clusters can capitalize on the available resources, expertise, and collaboration opportunities within the cluster ecosystem. This collaborative approach promotes knowledge exchange, facilitates joint R&D projects, and supports the transfer of innovative solutions to the market. By harnessing the collective strengths and capabilities of cluster members, smart specialization projects can generate significant impact and deliver tangible benefits to both the cluster and the region. In conclusion, fostering the active involvement of clusters in developing and implementing smart specializations enhances their potential for innovation, drives regional economic growth, and contributes to overall competitiveness. Through strategic alignment and collaborative approaches, clusters can fully leverage the opportunities presented by smart specialization initiatives.

Jerzy Uziębło, Vice-President of the North-South Logistics and Transport Cluster	*The strength of our cluster lies in the diverse range of members who actively participate in various initiatives, including meetings organized by us. These gatherings provide valuable opportunities for networking and establishing relationships among participants, ultimately leading to effective collaborations for industry development and the advancement of smart specializations. This strong collaborative culture within the cluster results from our excellent internal communication, which fosters a sense of commitment, openness, and willingness to cooperate among our members. Furthermore, we recognize the importance of learning from other, more experienced clusters, both domestically and internationally.*

6.2.13. Comprehensiveness of activities in the field of internationalization

Name of good practice and cluster	Cluster Polish Automotive Group
Key area of good practice	 Export and pro-export activities
Other areas covered by good practice	▪ Market activity ▪ Development of cluster cooperation ▪ Cooperation with the environment
Purpose and circumstances for introducing good practice	The COVID-19 pandemic underscored the importance of building robust value chains within clusters, as evidenced by the challenges encountered during that time. The cluster acknowledged the risk of disruptions in the supply chain from production plants in Asia, which highlighted the limitations of globalization and the associated difficulties with supply and logistics. This socio-economic situation, triggered by the pandemic, inspired the Polish Automotive Group Association (PGM) to initiate the Polish Automotive Production Hub (PAPH) project. In anticipation of the pandemic, a group of cluster members established an export consortium called "PGM AUTOMOTIVE" to facilitate the entry of Polish suppliers of automotive spare parts into distant and challenging markets. This initiative, along with other activities, enhanced the internationalization offerings of the PGM cluster, providing a comprehensive approach to supporting member companies in expanding their market presence. It is worth noting that the development of this offering was made possible through the dedication and private funding of the cluster members. By proactively addressing the challenges posed by the pandemic and leveraging the collective resources and expertise within the cluster, the PGM cluster demonstrated its commitment to fostering resilience, adaptability, and international competitiveness in the automotive industry.

Description of the good practice	**Polish Automotive Production Hub (PAPH)** As part of its activities, PGM aims to foster the internationalization of businesses, including attracting foreign capital and encouraging foreign companies to invest in Poland through the cluster. The Polish Automotive Production Hub (PAPH) is a project targeting companies, particularly in the automotive industry, that are interested in relocating their industrial production to Poland. PAPH provides technological and production support for new investments in Poland. Its objectives include promoting the Polish automotive industry, enhancing the competitiveness of Polish manufacturers of automotive parts and components, integrating Polish manufacturers into new supply chains, and facilitating cooperation between foreign investors and Polish automotive manufacturers through joint ventures or other collaboration models. The support offered by the cluster is flexible and tailored to investors' needs. It includes assistance with supply chain development, collaborations in research and development, knowledge exchange, investment support, and legal guidance. The coordinator actively promotes the cluster and directs interested parties to the relevant cluster members. Cluster members, in turn, are prepared to cooperate with investors by, for example, accommodating investors' production lines in their own facilities and utilizing their technologies as well as those of their business partners. The existing factories in Poland, along with their production capacity, provide favorable conditions for foreign investors considering the possibility of transferring production without the need to build new plants from scratch. **PGM AUTOMOTIVE** To provide a comprehensive and effective service to potential customers and investors, an export consortium named "PGM AUTOMOTIVE" was established. This unified offering attracts contractors and increases interest from entities outside the cluster. The commercial company, representing multiple cluster entities, distributes automotive parts from domestic factories to distant and challenging markets, such as Africa and the Middle East. The synergies created through cooperation have yielded positive results, including attracting customers for a diverse product range offered by various

	cluster members in countries such as Algeria, Saudi Arabia, Morocco, and Guinea. **Other Activities** The Polish Automotive Group also organizes inbound missions for customers and outbound missions for its members, such as participating in the COSME project, where four PGM members engage in missions to Japan, Singapore, and the USA. Additionally, the group collaborates with automotive giants like HYUNDAI Motor Manufacturing Czech and KIA Motors Slovakia to help identify new suppliers in Poland.
Impact of implementing good practice	PGM's initiatives demonstrate effective action in supporting its members' internationalization efforts and promoting their products in global markets. Through these efforts, several PGM members have been successfully recommended as potential suppliers to Hyundai Motor Manufacturing Czech, Toyota Tsusho Company, and Norauto France. Polish companies are recognised for their modernity, strong investments, and openness to collaboration with foreign partners. They offer not only production outsourcing and access to research centers but also the potential to provide new technologies. The establishment of the export consortium has significantly facilitated the organization of B2B talks and streamlined their progress, leading to more effective business interactions.
Possibility to use good practice	A key challenge for companies operating within clusters is reorganising their knowledge flow channels, shifting from an internal focus to embracing external collaborations and opportunities. Building a comprehensive internationalization offer, even without public funds, is highly beneficial as it fosters cooperation within the cluster, builds trust among members, and increases their overall turnover. A joint offer also enhances the cluster's market value. It is crucial for the coordinator to play an active role in driving these activities and effectively integrating the cluster members. The coordinator should have a profound understanding of the capabilities and potential for international cooperation among the members,

	enabling them to align their activities within the cluster and effectively attract potential clients. Such proactive measures contribute to the development of global production networks, with cluster members playing a pivotal role within them.
Bartosz Mielecki, cluster manager of PGM	*The success of a cluster heavily relies on the commitment and active participation of its members. Encouraging members to share their best practices, experiences, and collaboratively address common problems can be a challenging task. However, at PGM, we have successfully fostered a community of automotive industry entrepreneurs who are not only friendly but also open to cooperation. A prime example of this is the establishment of the PGM AUTOMOTIVE export consortium.*

6.3. Good practices of foreign clusters

6.3.1. Development of cooperation and chain building in the vegetable protein sector

Cluster name	Protein Industries Canada
Key area of good practice	Development of cluster cooperation
Other areas covered by good practice	▪ Cooperation with the environment ▪ Innovation activity ▪ Impact on the natural environment
Purpose and circumstances for introducing good practice	Protein Industries Canada (PIC) is one of Canada's five innovation clusters chosen to strengthen the country's economy and serve as an engine of growth. These clusters were selected through a competitive process and receive public funding, which must be matched by industry, to promote collaborative projects and ecosystem initiatives. While aligned with government priorities, the clusters operate independently as not-for-profit entities, directed by their respective Boards of Directors. Global demand for plant-based proteins is growing, and Canada, as one of the world's leading producers of protein-rich crops, is well-positioned to meet its goal of being a world leader in this field. To fully capitalise on this opportunity, the cluster acts as a catalyst to stimulate cooperation, identify shared priorities, recruit new members, and foster collaboration with entities outside the cluster. Cluster members work closely together, share risks, and leverage their strengths to accelerate innovation. The cluster also collaborates with partners and members to co-invest in R&D projects carried out through partnerships.
Description good practices	The cluster is focused on building capacity in the Canadian plant-based protein sector in a way that benefits both its members and the entire value chain. The cluster has approximately 250 members, while over 4,000 entities belong to all clusters in total. Protein Industries Canada provides an effective framework for selecting and co-investing in collaborative R&D projects. This structure reduces the risks associated with conducting R&D efforts,

	encourages bold initiatives, enables the creation of new ingredients and food products, facilitates the establishment of industry partnerships, and opens doors to promising new investments. With a current portfolio of nearly half a billion dollars in innovative research and development projects, Protein Industries Canada collaborates with companies to create solutions to the global food challenge. Government funding for implementing these projects by small and large companies comes through a competitive process. This means that access to funds requires the presentation of an effective industry cooperation plan, including the execution of R&D activities. The goal is to effectively transform agriculture and the food processing industry. A necessary condition is to submit projects in partnerships (e.g., involving an SME enterprise and a scientific unit). This positively impacts cooperation processes within the cluster, which can be substantial considering the number of members. Notably, most of the implemented projects (72%) reduce impacts on the natural environment. The cluster recognises an opportunity to leverage the strengths of the entire value chain to develop new ingredients and products. This necessitates a robust plant-protein ecosystem that encompasses the agri-food value chain and includes members not just from Canada but also from countries around the world. It also demands an ecosystem that values innovation and collaboration, integrates research with practical experience, and minimises environmental impacts.
Impact of implementing good practice	PIC serves as a catalyst for innovation, driving business-to-business collaboration to harness Canada's agri-food potential. PIC encourages private sector partners to co-invest in projects and strengthen Canada's plant-based protein industry. Members of Protein Industries Canada collaboratively introduce new protein ingredients for plant-based food and feed to the market and create new technologies and crop varieties for farmers, thus opening new market opportunities for exporters. Over the past four years, Protein Industries Canada and its industry partners have invested over $477 million in Canada's plant-based

	food, feed, and ingredient ecosystem through 55 innovative projects. A total of 445 partners have participated in these projects. The results of these investments are becoming increasingly tangible, with new ingredients and food products appearing on retail shelves and restaurant menus in Canada and beyond. It is noteworthy that nearly ¾ of all projects simultaneously decrease impacts on the natural environment.
Possibility use good practices	The practice serves as a Canadian example of how to support selected sectors of the economy—specifically, the agri-food sector in the field of plant proteins—by focusing on clusters and paying particular attention to values, such as reducing the environmental impacts of agriculture and the food industry. It demonstrates effective collaboration within the cluster to implement innovative projects by leveraging public funding and industry co-investment. This cooperation connects cluster members with each other and with new clients, facilitating participation in global value chains. The coordinator enhances the potential of members and the industry through mentoring. The applied solution can exemplify how to support cooperation within large clusters with multiple members, but it can also serve as a model for smaller clusters. It underscores the importance of building a value chain to propel the entire industry forward. The increasing importance of enhancing the global competitiveness of cluster members through partnerships within the cluster is also evident. These partnerships leverage strengths to foster innovations, overcome barriers, and uncover new opportunities. Access to public and private funding plays a crucial role in the development of the cluster and its members.
Barbara Gibbon, Director General - Innovation, Science and Economic Development Canada (ISED), Government of Canada	*Protein Industries Canada, one of Canada's five Global Innovation Clusters, fosters collaboration and innovative projects with the participation of the Government of Canada. Since being announced, the cluster has helped Canada become a leader in the plant-based food sector and has demonstrated that innovation through collaboration is the key to success.*

6.3.2. Stimulating project activity, in particular in the area of R&D among members of the XYLOFUTUR cluster

Cluster name	XYLOFUTUR
Key area of good practice	 Innovative activity
Other areas of good practice	▪ Development of cooperation in the cluster ▪ Cooperation with the environment
Purpose and circumstances for introducing good practice	Good practice addresses the issue of insufficient collaboration in implementing joint research and development (R&D) projects within clusters. The XYLOFUTUR cluster in France stands out as a European leader in building trust and promoting R&D cooperation. Over its 15 years of operation, the cluster has initiated or supported nearly 300 projects, primarily focused on R&D in the forestry, wood, and paper sectors. Notably, the areas of activity, research, and innovation of the cluster members span the entire value chain.
Description of the good practice	The primary objective of the Xylofutur cluster is to enhance the competitiveness of the domestic forestry, wood, and paper sector through innovation and research and development (R&D) activities. The cluster coordinator plays a crucial role in unlocking the innovative potential of its members, particularly small and medium-sized enterprises (SMEs). The coordinator provides support in creating projects, facilitating partnerships between SMEs and key stakeholders, and identifying sources of public and private funding. Cooperation within the cluster takes both formalized and informal forms[83], involving the establishment of contracts, agreements, and mutual understanding of objectives through joint working groups. The cluster undertakes various actions to promote innovation, including evaluating innovative projects from a market perspective by industry experts. Additionally, Xylofutur actively shares innovative solutions and techniques within the sector to foster knowledge sharing and advancement.

[83] A Memorandum of Understanding (MOU) is a non-binding agreement that sets out each party's intentions to take action, conduct a business transaction, or form a new partnership.

	In addition to its core activities, Xylofutur has established the initiative "La Wood Tech," which serves as a dedicated center for start-ups in the forestry and wood sector in France. This initiative provides a platform for nurturing and supporting innovative ventures in the industry. Every two years, Xylofutur organizes the "Canopée Challenge," a competition that fosters innovation and showcases cutting-edge ideas within the sector. As an open innovation cluster, Xylofutur does not impose specific guidelines or recommendations regarding the areas of research and innovation that its members should pursue. Instead, it encourages a bottom-up approach where projects submitted to Xylofutur are primarily driven by the members themselves. These projects align with national strategies and funding schemes that influence their subject matter and focus. Recognizing the challenges faced by small and medium-sized enterprises (SMEs) in the sector, Xylofutur has taken collective actions using a top-down approach to support and structure the industry. Many companies in the sector lack the necessary resources to undertake innovative projects effectively. Xylofutur plays a vital role in assisting these companies by providing them with the skills, knowledge, and guidance needed to optimize their resources and advance innovative initiatives. Additionally, Xylofutur helps SMEs identify potential funding opportunities and prepares them for the labeling process, which further enhances their chances of success. To support project implementation within the Xylofutur cluster, a dedicated team is appointed to guide projects from their inception to commercialization. For French competitiveness clusters like Xylofutur, a specific process known as "labelling" is followed to recognize projects of excellence. This process involves evaluating projects by a committee made up of industry professionals from both academia and the private sector. These committee members are selected from the Xylofutur cluster and assessed based on specific criteria, including their national or regional recognition and sector-specific expertise. Achieving the "Status of Excellence" through the labelling process confirms that a project is innovative, collaborative, and technically and economically feasible. It is expected to have a significant impact

on the sector and the relevant area at the local, regional, and/or national level. Projects awarded this status are also required to include a dissemination strategy that can be supported by Xylofutur.

The "Status of Excellence" provides assurance to public sponsors who may have difficulty assessing the technical feasibility or innovative value of a project during the funding evaluation process. This recognition serves as a guarantee that the project is well-prepared, financially viable, and aligned with the goals of the ecosystem. Consequently, projects with the "Status of Excellence" are more likely to gain public funding support.

The Xylofutur cluster is actively involved in developing both the cluster and its members at the European level. A key objective is to offer guidance and assistance to cluster members in securing funding for their projects. Furthermore, the cluster promotes the formation and integration of consortia made up of various entities to enhance collaboration in implementing joint European projects.

To facilitate participation in European initiatives, Xylofutur engages in activities such as monitoring European "calls for proposals." This involves tracking funding opportunities and competitions announced by European institutions or programs. By doing so, Xylofutur aims to promote the involvement of its cluster members in these competitions and enhance their chances of success. Furthermore, the cluster actively seeks to connect with European research networks, enabling its members to participate in collaborative research and innovation efforts at the European level.

Xylofutur identifies two main goals for the future regarding R&D projects and initiatives:

- Initiating or carrying out more activities or projects with a high impact across the sector and/or industrial regions could generate additional synergies among different stakeholders in the forest and timber value chain.
- Coordination of cascading funding projects[84] as this would help Xylofutur to gain greater visibility among SMEs that are

[84] Cascade grants also known as Financial support to Third Parties (FSTP). It is the European Commission's mechanism for distributing public funds to help beneficiaries such as start- ups, scale-ups, SMEs, sometimes in

	not yet members of the cluster and offer new ways of networking.
Impact of implementing good practice	Thanks to its well-established organizational structure and effective procedures for idea identification, selection, and implementation, the cluster coordinator has successfully supported its members in undertaking activities in the forestry, wood, and paper sector. This has resulted in the execution of 272 joint projects, with 192 of them receiving external support financing[85]. These projects have enhanced the competitiveness of companies in the sector through innovation and research and development efforts. The cluster takes pride in fostering strong and lasting relationships among various entities, including companies, universities, research organizations, communities, institutions, and investors. These partnerships enable the implementation of innovative projects and the creation of added value. Joining Xylofutur provides companies and research organizations access to a sectoral and innovation network. This offers opportunities to connect with partners who have complementary knowledge or are part of the supply chain, accelerating project development. Membership in Xylofutur also enhances market visibility. The cluster actively participates in regional, national, and European innovation events and ensures that its members' voices are heard in these forums. Xylofutur supports its members in disseminating project results both within and beyond the sector, promoting cross-sectoral collaboration as well.
Possibility to use good practice	To achieve excellence in research, development, and innovation, it is crucial for all stakeholders to collaborate and coordinate their efforts. The cluster coordinator plays a key role in establishing specialized structures and implementing effective procedures in R&D activities. These initiatives can enhance activity efficiency, streamline idea

partnership with universities or public bodies, to implement, develop or test innovative solutions. This method of financing is aimed at simplifying administrative procedures, creating an SME-friendly scheme for submitting applications, by allowing some projects financed by the European Commission (under the H2020 Program and currently Horizon Europe) to announce open calls.

[85] Detailed list of projects implemented by the cluster: www. xylofutur.fr/wp-content/uploads/2022/11/Liste-Projets-labellises-Xylofutur-catalogue-MAJ-au-09112022.pdf (accessed April 19, 2023).

	generation processes, and ultimately yield tangible benefits for clusters. Furthermore, it is worth noting that Xylofutur aims to expand its involvement in programs such as Euroclusters or European Innovation Ecosystems (EIE). By doing so, the cluster seeks to further develop its capabilities and provide its members with activities that support innovation and facilitate access to cascading finance. This indicates potential funding opportunities for Polish clusters to explore and pursue.
Information from the cluster's website	*For 16 years, the Xylofutur Competitiveness Cluster has been developing its professions, research topics, and spheres of influence to align closely with the economic and operational realities of its members. As of January 2023, it has 275 members and 273 marked projects with a budget of EUR 461.3 million, including 197 projects financed with EUR 290.5 million, amounting to EUR 104 million in state aid.*

6.3.3. Forming alliances, opening markets

Cluster name	Cluster Czech purchase
Key area of good practice	 Export and pro-export activities
Other areas of good practice	▪ Cooperation with the environment ▪ Development of cooperation in the cluster
Purpose and circumstances for introducing good practice	In the European Union, the furniture manufacturing sector includes a substantial number of small and medium-sized enterprises (SMEs), accounting for about 70% of the roughly 130,000 companies in this sector. These companies collectively employ over one million people. In the Czech Republic, the furniture industry provides jobs for over 100,000 individuals, whereas in Poland, around 200,000 people are employed in this sector, as reported by the Czech Ministry of Industry and Trade and the Polish Chamber of Commerce of Furniture Manufacturers, respectively. Furniture clusters operating internationally have identified several challenges faced by their SME members regarding internationalization. The main challenges include a lack of knowledge about entering and developing activities in international markets, instability in legal frameworks, volatility in the logistics market, difficulties in accessing public funds, and the adverse effects of the COVID-19 pandemic. Recognizing the economic impact of the pandemic on sectors that rely on products and services from the furniture and wood industries, such as tourism and retail, the European Commission has decided to fund an international furniture cluster partnership project. The Czech furniture manufacturers' cluster actively participates in the international arena, establishing partnerships and engaging in the implementation of international projects. Additionally, the cluster supports its members in the application process and facilitates access to national and international funding opportunities. These initiatives aim to enable cluster members to develop and access new

	international value chains, fostering their growth and competitiveness in the global market.
Description good practices	An example of a project that the cluster is involved in to stimulate the export of its member companies is "FURNITURE GO INTERNATIONAL: FORMING ALLIANCES, OPENING MARKETS." This project is managed by eight European clusters from six countries, representing over 500 SMEs and the complete value chain of the furniture industry. It is funded by the European Commission. The main objective of the project is to assist SMEs in entering new markets through cooperation and innovation. It aims to create a new European Strategic Cluster Partnership to strengthen collaboration in the furniture industry and related sectors within the European Union, as well as with selected third countries, including the USA, Canada, Egypt, and South Africa. The clusters involved in the project include TFC - Transylvanian Furniture Cluster (Romania), HABIC - Association Cluster of Habitat, Wood, Office, and Contract Sector (Spain), WIC - Timber Industry Cluster (Slovenia), KCN - Cluster Czech fýbětář, družstvo (Czech Republic), ICS - Interior Cluster Sweden (Sweden), PWC - PRO WOOD Regional Cluster (Romania), BFC - Bulgarian Furniture Cluster (Bulgaria), and HCB - Habitat Cluster Barcelona (Spain). The cluster actively identifies and establishes new strategic partnerships across Europe and organizes exploratory visits for cluster representatives to selected third countries. It manages the project package focused on the long-term sustainability of established partnerships, aiming to conclude cooperation agreements between the Project Partnership and international business organizations or research and development institutions. The cluster coordinator supports its members in seizing business opportunities and becoming competitive in the global market. This includes helping members adapt their product portfolios to the needs of target markets, collect and process relevant market information and experiences, and facilitate entry into new markets. Companies' involvement in the project is based on their interests and goals related to internationalization.

	The cluster coordinator aims to enhance the position of its members in the market, improve the quality of products, and increase the competitiveness of the Czech furniture industry.
Effect introduction good practices	As a result of their participation in the project activities, cluster members have gained valuable benefits. They now have access to a comprehensive study on the furniture industry in the target third countries: USA, Egypt, Canada, and South Africa. This study provides them with essential insights and market information necessary for expanding their operations in these markets. Furthermore, cluster members benefit from a matchmaking platform, which serves as a closed community for promoting, matching partners, and facilitating cooperation. This platform helps them connect with potential partners and establish fruitful collaborations. The cluster and its project partners are actively exploring the possibility and feasibility of extending partnerships in the target third countries. The aim is to establish first-contact relationships with key stakeholders in these markets, paving the way for future collaborations and business opportunities. Additionally, the cluster is currently engaged in negotiations with project partners regarding the opening of a joint showroom or representative office in Cairo, Egypt. This initiative aims to create a physical presence for the cluster and its members in the Egyptian market, further strengthening their market position and facilitating business interactions.
Possibility use good practices	The Cluster Czech nábytkářů (Czech Furniture Cluster) provides comprehensive support to its members in various aspects to foster their growth and competitiveness within the cluster and on the international stage. The cluster coordinator has identified key areas and actions that enable members to create a competitive export offer and stimulate their development. ▪ In terms of business cooperation, the cluster organizes events such as business meetings, seminars, and conferences, providing a platform for members to exchange knowledge, share experiences, and establish valuable business contacts.

	This fosters networking opportunities and encourages collaboration among cluster members. ▪ The cluster also emphasises research and development cooperation, aiming to drive innovation and the creation of new technologies and solutions in the furniture industry. Members have access to research findings and can actively engage in research projects, fostering their involvement in cutting-edge advancements within the sector. ▪ Promotion is another crucial aspect of the cluster's activities. The cluster organizes promotional campaigns, exhibitions, and furniture fairs where furniture produced by cluster members is showcased, enhancing visibility and exposure for their products and brands. ▪ To strengthen the voice and representation of its members, the cluster establishes partnerships with public institutions and industry organizations. By collaborating with these entities, the cluster can advocate for the interests of its members before authorities and regulations, ensuring that their needs and concerns are acknowledged. ▪ Training and support services are provided to assist members in their business development. The cluster organizes training programs covering various areas such as management, marketing, sales, and more. These initiatives aim to enhance members' skills and capabilities, equipping them with the necessary tools to succeed in the competitive market. By offering support in these key areas, the cluster coordinator enables its members to create a competitive export offer, stimulate their growth within the cluster, engage in international projects, and explore new markets through foreign partnerships. This comprehensive approach promotes the development and success of cluster members in the European cluster environment.
Information from the cluster's website on internationalization	*The global goal of the cluster is to enhance the international competitiveness and economic development of its member companies by concentrating on research, development, and innovation, continuously improving connections between scientific units and the business sector in the furniture industry, and reinforcing internationalization.*

	An example of this activity was organising an international conference of furniture and carpentry clusters in Brno in 2019. The program of the event focused on establishing new business contacts, exchanging good practices and experiences, and creating a new international partnership among the participating clusters. As a result, furniture clusters from the Czech Republic, Slovenia, Spain, and Sweden signed a Memorandum of Understanding on cooperation in the furniture and wood industries, which established the international platform called the Partnership of Furniture and Wood Processing Clusters. The main motivation for creating the platform was to foster international cooperation in scientific research, technology transfer, and sharing know-how, as well as preparing joint international projects that would lead to the formation of the European Strategic Partnership of Clusters in the furniture and wood sector.

7. Cross-industry analyses

This section outlines the methodology used to categorize the clusters participating in the study based on their industry structure. The clusters were divided into six distinct groups:

1. Quality of life, tourism and recreation (11 clusters).
2. Automotive, aviation production, transport (8).
3. ICT (8).
4. Production and processing of metals (5).
5. Construction (5).
6. Chemistry, bioeconomy, materials engineering and energy (4).

Many clusters function at the intersection of various aforementioned areas, highlighting the synergies and collaborations among different industries. Here are some examples:

1. Cluster of Information Technology in Construction: This cluster focuses on the construction industry and includes a significant representation of members from the information technology sector. The cluster aims to leverage IT solutions to enhance construction processes, project management, and digital transformation within the construction industry.
2. Sustainable Infrastructure Cluster: This cluster operates at the intersection of construction, material engineering, and energy. Its primary objective is to promote sustainable practices in infrastructure development, including the use of eco-friendly construction materials, energy-efficient technologies, and renewable energy integration in infrastructure projects.
3. Lublin Cluster of Enterprises: This cluster brings together a diverse group of members, with construction companies playing a significant role. However, it also includes companies operating in areas such as quality of life, tourism, and recreation. This multidisciplinary approach fosters collaboration and innovation across various sectors that contribute to the regional economy.
4. Polish Cluster of Composite Technologies: This cluster operates within the field of materials engineering, focusing on the development and application of composite technologies. The products and technologies created by cluster members have wide-ranging applications across industries such as automotive, aviation production, construction, metal production, and processing. The cluster serves as a hub for advancing composite technologies and facilitating their adoption in different sectors.

The number of cluster members has been steadily increasing in recent years, indicating a growing interest and participation in cluster activities. Among the surveyed clusters, there are a total of 4,208 members, representing a significant 16.8% increase compared to the previous

edition of the study conducted two years ago. This growth in membership suggests a trend towards interdisciplinary collaboration within clusters as they expand to include members from industries forming wide value chains.

It is important to note that the increase in membership should be considered in the context of the limited population of enterprises and other organizations operating within specific industries and geographical locations. As clusters attract members from various industries, it reflects the development of interdisciplinarity within clusters and the potential for cross-sectoral collaboration.

The data indicates that approximately 60% of cluster members operate within the cluster's leading industry, as classified by the Polish Classification of Activities (PKD). This finding further confirms the previous conclusion regarding the industry focus of clusters and the presence of a significant majority of members within the leading industry.

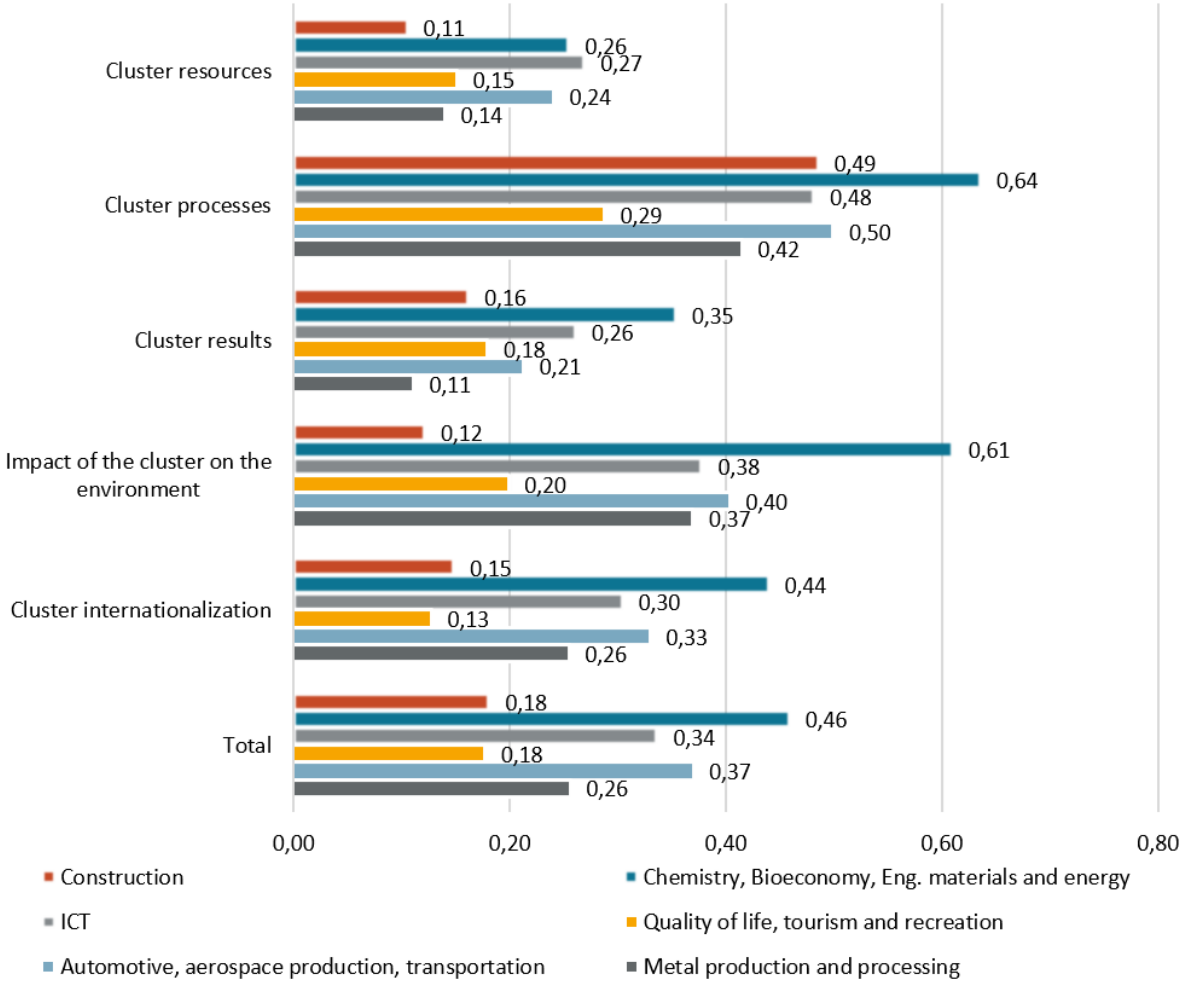
Cross-sectoral analyses were conducted for all 19 sub-areas, providing detailed insights into collaborations and interrelationships among industries within clusters. The data presented includes calculations based on median and benchmark values, facilitating comparative analysis and evaluation of cluster performance across sub-areas and the overall industry landscape.

Upon analyzing the results, clusters from the chemistry, bioeconomy, materials engineering, and energy sectors achieved the highest median value of 0.46. This indicates that at least half of the clusters in this group attained exceptionally high results in the overall benchmarking. These clusters also excelled in each sub-area, except for cluster resources, where ICT clusters reached a slightly higher median value.

Conversely, clusters in the construction and quality of life, tourism, and recreation industries received the lowest median value of 0.18. This suggests that at least half of these clusters performed poorly in the overall assessment. Cluster coordinators can use this information to identify the major weaknesses of clusters within specific areas and take remedial action accordingly.

For instance, construction clusters should concentrate on enhancing activities related to resources, environmental impact, and internationalization.

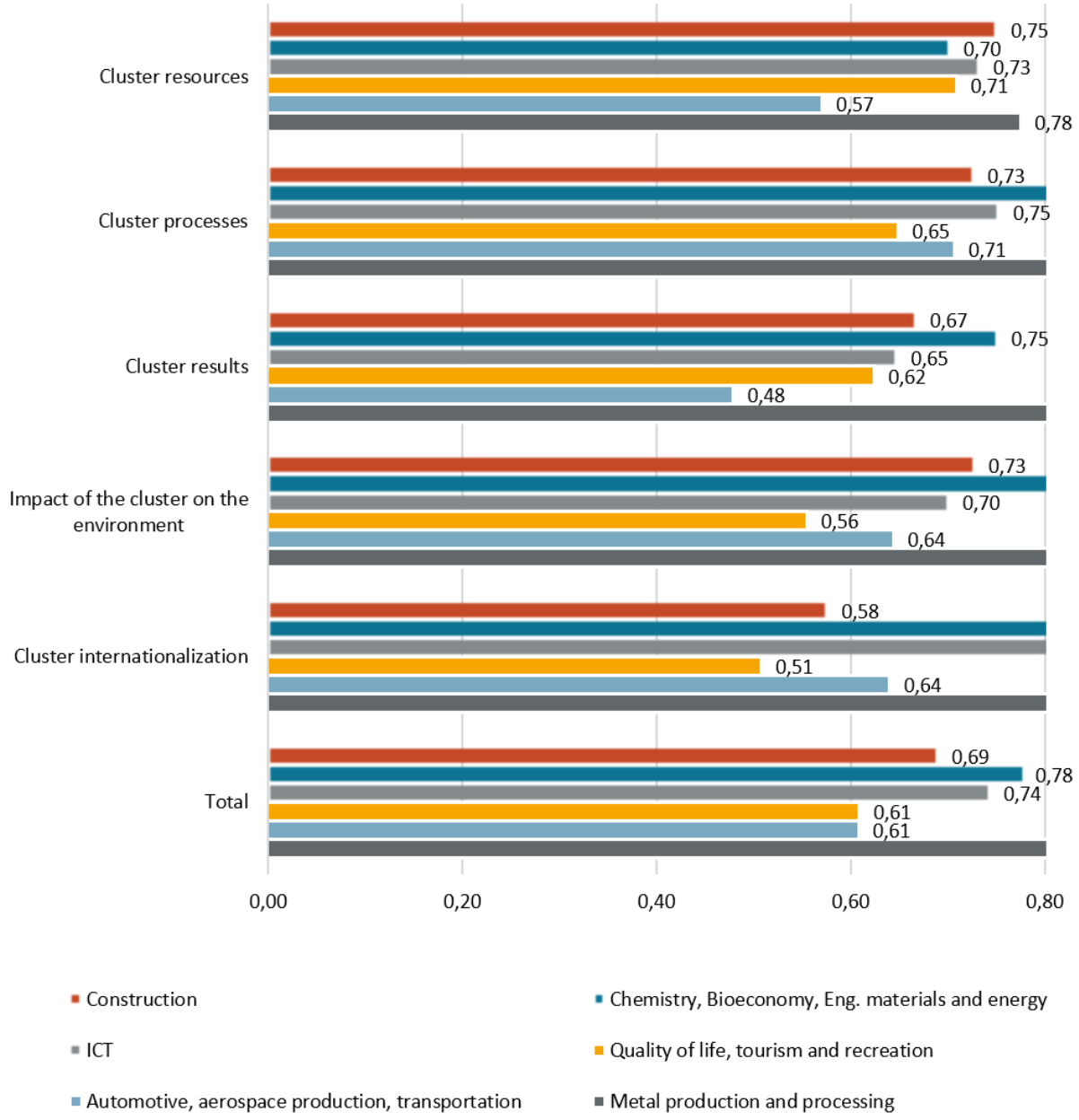
Graph 76. Median value for clusters by industries and benchmarking areas and in total



Source: own elaboration based on research involving cluster coordinators (N=41).

The subsequent presentation focused on benchmark results, emphasising the best values achieved by clusters within specific industries as well as overall. The differences among clusters in various industries were not significant, suggesting that at least one cluster in every industry performed exceptionally well or achieved satisfactory results.

Graph 77. Average value of the median for clusters broken down by industries and benchmarking areas



Source: own elaboration based on research involving cluster coordinators (N=41).

Following the benchmark results, the analysis shifted to examining the positions of clusters within their respective industries, focusing on select key indicators. The accompanying table illustrates these indicators, and the subsequent discussion will delve into interpreting the results.

Table 22. Results for selected individual indicators obtained by clusters broken down by industries

Industry / Indicator	Construction	Chemistry, bioeconomy, materials engineering and energy	ICT	Quality of life, tourism and recreation	Automotive, manufacturing airline, transport	Production and processing metals
Change in total sales revenue for 2020-2021	12.5%	29.2%	25.3%	20.4%	23.0%	26.7%
Number and type of individual Industry 4.0 technologies used in the cluster	30.6	31.5	34.8	24.8	32.6	28.6
Number of jointly implemented innovative projects and R&D projects which result in/will be innovative products or technologies in the cluster	2.4	5.0	3.5	2.5	2.4	6.8
Taking actions by the cluster with a positive impact on society	0.4	0.8	0.9	0.5	0.9	0.8
Number and type of cluster activities aimed at improving the condition of the natural environment	2.6	4.8	2.6	2.1	3.8	4.2
Number of cluster entities with involvement of foreign units in them in the form of shares, branches or other forms (foreign direct investment in the cluster (inward)	8.0	4.5	12.1	6.6	12.9	2.6
Number of foreign markets (countries) where cluster enterprises are present	18.4	36.0	47.9	25.4	23.4	41.0

Source: own elaboration based on research involving cluster coordinators (N=41).

The first indicator examines the change in total sales revenues of cluster enterprises between 2020 and 2021, providing insights into the effects of the COVID-19 pandemic during its initial two years. Notably, all industries experienced an increase in sales revenue, with the chemical, bioeconomy, material engineering, and energy sectors leading the way with a growth rate of 29.2%, followed by metal production and processing at 26.7%. These figures surpassed the average increase in total sales revenues for all enterprises, which stood at approximately 23% based on data from the Central Statistical Office. Conversely, the construction sector exhibited the lowest growth rate at only 12.5%. This discrepancy can be attributed to the fact that while

most industries faced significant declines in 2020, the construction sector remained relatively stable during that period. As a result, other industries experienced a rebound in 2021, while construction maintained a consistent growth trajectory in recent years.

Another indicator examined the level of adoption of 13 specified Industry 4.0 technologies within each cluster, with a maximum possible value of 36.0. Given that many of these technologies relate to information systems – such as digital platforms, blockchain, the Internet of Things, industrial Internet of Things, artificial intelligence, cloud computing, and big data analytics – it is not surprising that ICT clusters achieved near-maximum scores. These clusters not only utilize these technologies but also actively participate in their development and sale. In contrast, the quality of life, tourism, and recreation industries exhibited the lowest adoption rates for these technologies.

In terms of the average number of jointly implemented innovative and R&D projects, clusters representing the metal production and processing industry emerged as clear leaders, with an average of 6.8 projects per cluster. Conversely, the construction, automotive, aviation production, and transport industries, along with the quality of life, tourism, and recreation industry, displayed the lowest performance, averaging 2.4 and 2.5 projects per cluster, respectively.

Another measurement focused on the actions taken by clusters that positively impact society, particularly through the concept of creating shared value (CSV). Details regarding recommended actions in this area can be found in Chapter 5.4.2. The evaluation for this indicator was binary, with a value of 1 indicating active engagement by the cluster. In this regard, ICT clusters and those representing the automotive, aerospace production, and transport industries demonstrated the most favorable results, with an average value of 0.9.

Conversely, the indicator measuring the number and type of actions aimed at improving the natural environment involved aggregating various activities, such as adopting circular economy practices, obtaining environmental certifications, conducting research and development in low-emission technologies or the green economy, and generating and distributing energy from renewable sources. Detailed discussions on actions in this area can be found in Chapter 5.4.3. The indicator presented in Table 22 shows the average number of activities per cluster, considering the entire population. Notably, the chemical, bioeconomy, material engineering, and energy industries exhibited the highest performance in this area, which is unsurprising, given that entities in these clusters often serve as suppliers of technology products that contribute to environmental improvement. In contrast, clusters in the quality of life, tourism, and recreation industries, as well as the construction industry, demonstrated the lowest performance. Coordinators of these clusters should consider implementing broader measures to enhance their positive environmental impact, such as leveraging the experiences of clusters in the bioeconomy and energy sectors.

Another indicator pertains to the average presence of entities with foreign capital (direct foreign investments) within the cluster. In this regard, the automotive, aerospace production, and transport industries demonstrate notable performance, with an average of 12.9 such entities, closely followed by the ICT sector with an average of 12.1 entities.

Lastly, the indicator examines the average number of foreign markets in which cluster enterprises actively engage. Given the digital nature of their products and technologies, the ICT sector stands out as a leader, with an average presence in nearly 48 markets. Conversely, the production and distribution of building materials, along with construction services, often exhibit strong geographical limitations. Consequently, construction clusters received the lowest rating in this regard, with an average presence in 18 markets. Further details on the specific markets in which Polish clusters operate can be found in Chapter 5.5.3.

Cross-industry analysis summary

- The clusters participating in the benchmarking were categorized into six groups based on their dominant industry, with the largest representation found in the quality of life, tourism, and recreation sectors.
- The number of cluster members participating in the benchmarking increased by approximately 17% compared to the previous edition, leading to greater interdisciplinary collaboration among clusters.
- The median results showed that clusters in the bioeconomy, material engineering, and energy sectors performed the best (0.46), while the quality of life, tourism, recreation, and construction sectors had the lowest median scores (0.18).
- All industry groups experienced an increase in total sales revenues from 2020 to 2021. The highest growth was observed in the chemistry, bioeconomy, material engineering, and energy (29.2%), metal production and processing (26.7%), and ICT (25.3%) industries, surpassing the overall economy's index published by the Central Statistical Office (approximately 23% increase).
- Clusters with the highest level of internationalization, considering their presence in foreign markets, were primarily from the ICT, metal production and processing, and chemistry, bioeconomy, material engineering, and energy sectors.

8. Conclusions

The current edition of the study was conducted in the second half of 2022 and focused on analyzing phenomena from 2020 and 2021. When comparing the results across different editions of the study, it is important to consider the potential errors that may arise due to various factors. These include differences in the selection of clusters and the method of calculating benchmarks and medians based on unitarization of results[86], and modifications in the scope of indicators in the research methodology. for example, in the previous edition of the study, the benchmarking system was based on 114 indicators, while in the current edition, it has been reduced to 88 indicators (some of which were more complex, such as using complex answer cafeterias)[87]. Comparing the values of synthetic indicators may not yield precise information between individual editions of the study. However, these changes allow for capturing new and interesting phenomena in the activities of clusters, thereby broadening the understanding of the potential of Polish clusters.

The conclusions drawn from the analysis of cluster trends in the subsequent part of the report primarily rely on selected values of several partial indicators, which were quoted in the 2020 report. These indicators provide insights into specific aspects of cluster performance and serve as valuable reference points for understanding cluster dynamics.

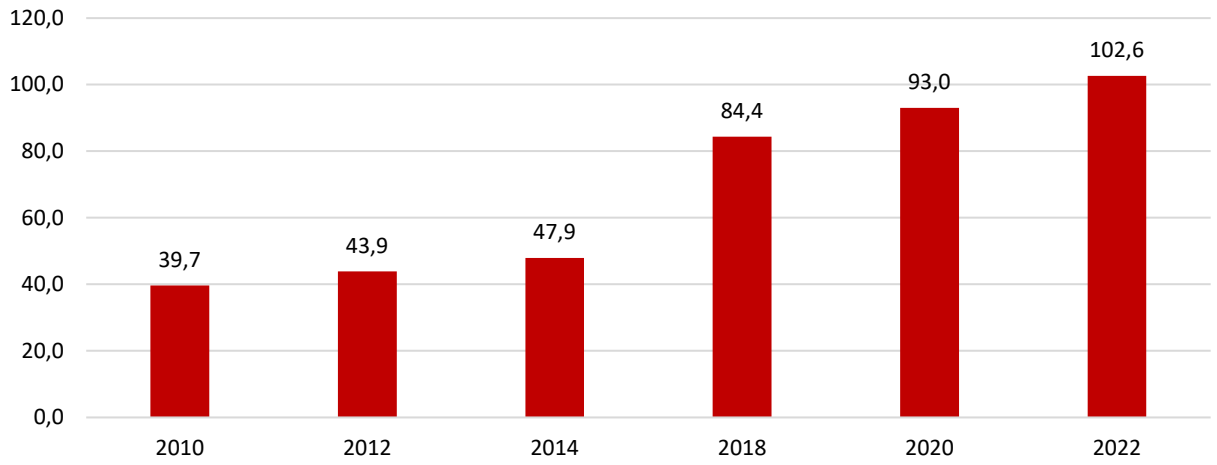
- In the 2010 study, a total of 47 clusters participated, bringing together 1,866 entities, including 1,469 entrepreneurs. The number of entities belonging to the surveyed clusters decreased in subsequent editions. In the 2012 study, there were 35 clusters with approximately 1,535 organizations, of which 1,137 were enterprises. In the 2014 edition, there were 40 clusters with 1,917 entities (1,550 enterprises), and in the 2018 edition, the number rose to 3,374 entities (2,718 enterprises). According to the collected data, from 2018 to 2019, 872 organizations joined the surveyed clusters, while 326 organizations resigned from membership. By the end of 2019, in the surveyed 41 clusters (an increase of 1 cluster compared to the 2018 edition), there were 3,813 organizations (3,133 enterprises), as reported by the coordinators. The current edition of the study also involved 41 clusters, and there has been a noted increase in the number of members. Currently, the surveyed clusters are associated with 4,208 organizations, of which 3,534 are enterprises. This indicates a significant increase in the number of cluster members since 2018, with an average growth rate of around 10%.

[86] In the process of unitarization of results, information about measurement units and actual values achieved by clusters is lost. For example, a value of 1 means the best-rated cluster in a given criteria, without being able to decide what value it refers to (if the actual values are not known).

[87] The modification of the methodology was related to the need to update the scope of the acquired data to take into account new phenomena in clusters while limiting the number of indicators. It was, for example, an answer to the postulate of the cluster environment.

However, it is important to note that, while the overall number of cluster members has increased, there has been a decrease in the number of active clusters that meet the entry requirements for the study. Additionally, many new clusters do not yet meet the criteria for participation in the study, particularly regarding the required period of activity to be eligible for benchmarking.

Graph 78. Average number of members per cluster participating in particular editions of the benchmarking



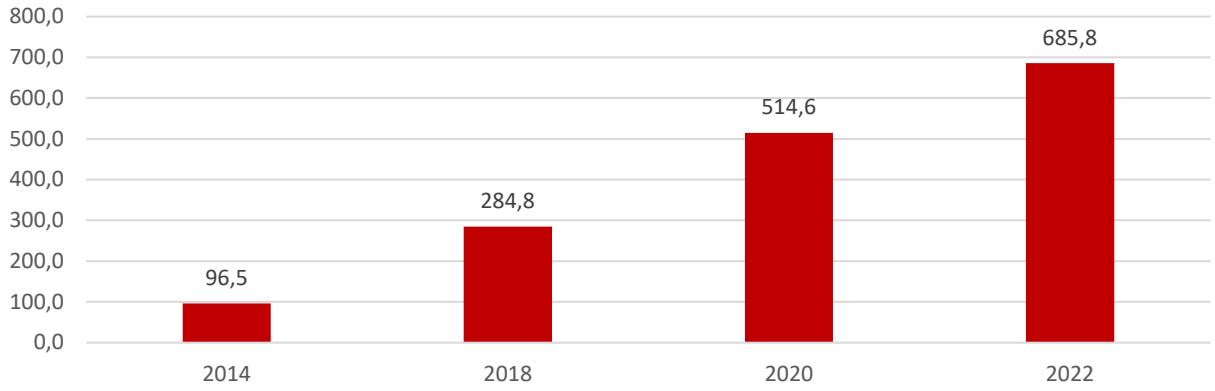
Source: own elaboration based on research involving cluster coordinators (N=41).

- The majority of clusters continue to maintain a regional focus. The study examined the percentage of cluster members based in the same voivodship (province) as the coordinator. The average percentage was found to be 70.7%, with a median of 74.0% in the current edition of the study. In comparison, the previous edition had an average of 71.8% and a median of 77.0%. These findings indicate trends towards clusters expanding their presence outside their home region, but it cannot be concluded that this is a common direction of cluster development at present. However, in the current financial perspective (2021-2027), supra-regional clusters are expected to gain more importance. These clusters, together with KKK (Key National Cluster) clusters, may receive support under the 2.17 FENG instrument[88], which can significantly contribute to the implementation of public policies. In light of this, the anticipated development direction for clusters, especially those not classified as KKK clusters, should concentrate on quantitative expansion. This could involve entering voivodships with low cluster activity, like Warmińsko-Mazurskie and Opolskie, or extending into neighboring voivodships where comparable clusters do not exist.

[88] Recruitment for this action, along with the applicable documentation and rules, was announced on April 25, 2023, www.parp.gov.pl/harmonogram-naborow (access: April 19, 2023).

- In recent years, there has been a significant increase in employment among entities that are members of the surveyed clusters. In 2014, total employment stood at 96.5 thousand people. This number rose to 284.8 thousand people in the 2018 edition of the study. According to estimated data from the 2020 edition, total employment among cluster members reached 514.6 thousand people. Between these two editions, total employment nearly doubled. In the current edition, there is further estimated growth in employment, reaching approximately 685.8 thousand people. This indicates a continued upward trend in job creation within cluster member entities.

Graph 79. Employment in entities that are members of clusters in individual editions of benchmarking (thousand people)



Source: own elaboration based on research involving cluster coordinators (N=41).

- In the current benchmarking analysis, an increase in the number of employees assigned to service clusters in coordinating institutions has been observed. The total number of employees rose from 135 Full-Time Equivalents (FTE) at the end of 2019 to 251 FTE at the end of 2021. This improvement in the staffing of clusters offers greater opportunities to initiate various development activities. It is important to note that errors in estimating these phenomena may arise from the selection of different clusters participating in the 2020 and current editions. However, no clusters significantly overestimated the level of this indicator, with the number of assigned employees exceeding 10 in only 9 clusters and not surpassing 20 in any cluster.
- Regarding the budgets of the surveyed clusters, fluctuations have occurred over the years. In 2012-2013, the budget amounted to PLN 139.4 million. This significantly decreased to PLN 35.25 million in 2016-2017, with PLN 23.5 million provided by external funds. In the period 2018-2019, there was a substantial increase in the cluster budgets, reaching PLN 222.1 million. Own funds accounted for over PLN 17.3 million, while over PLN 200 million came from external sources, primarily through grants associated with cluster coordination activities. However, in the period 2020-2021, there was a marked

decline in the availability of external funds (grants) due to the termination of calls for proposals under specific operational programs and the conclusion of the financial perspective. Consequently, the total amount of cluster budgets was reduced to approximately PLN 96.0 million. It is worth noting that the COVID-19 pandemic likely affected the accumulation of payments from specific sub-measures, such as sub-measure 2.3.3 of the Smart Growth Operational Program (SG OP), which supports physical participation in foreign fairs. Conversely, activities related to designing and contracting under sub-measure 2.3.7 SG OP were carried out during the period under review, and co-financing payments are anticipated at a later stage. It is important to consider these factors when interpreting the budgetary changes and the availability of external funds for clusters during the specified time periods.

8.1. Specific and atypical phenomena for individual groups of clusters

Here are specific and unusual phenomena identified for various groups of clusters in the study:

- Impact of the COVID-19 Pandemic: The analysis shows that the COVID-19 pandemic did not significantly impact the level of cluster development during the analyzed period of 2020-2021. Revenues generated by cluster entities rebounded in 2021 after a relatively weak 2020. Despite the pandemic, there has been a continued increase in the number of cluster members.
- Impact of the COVID-19 Pandemic on cluster processes: the pandemic has significantly affected cluster processes, especially in the area of cooperation development. The restrictions and safety measures imposed during the pandemic led to an increased reliance on online communication for organizing meetings and events within clusters. This shift to virtual platforms has become essential and gained great importance. The adoption of online communication tools has enabled cluster coordinators to develop valuable skills in managing clusters remotely. This skillset can be particularly beneficial for large clusters with members scattered across different locations. Instead of depending on traditional in-person meetings with high absenteeism, conducting online meetings with a broader group has proven to be more effective. One positive outcome of the shift to online meetings is the increased attendance of cluster members. With no need to travel, participants find it more convenient to join the meetings. As a result, cluster coordinators have experienced higher participation rates among cluster members during virtual meetings.
- Cluster Certification: In the previous edition of the survey, a noticeable trend emerged among clusters to resign from having the badge endorsed by EUCLES (European Union Cluster Excellence Initiative). Unfortunately, the current situation remains unfavorable, as only 12 out of 41 clusters possess any form of certification from EUCLES. Among

these certified clusters, there are 8 with a bronze badge, 3 with a silver badge, and 1 with a gold badge. The decline in cluster certifications may be attributed to recent changes, as EUCLES has assumed the role of the certification authority. These changes might have prompted some clusters to reconsider their certification status. However, it is important for cluster coordinators to recognize the value that cluster certification holds in the European market. Renewing or obtaining a new EUCLES certification can offer several benefits for clusters, particularly regarding their image and reputation in the international arena. Certified clusters enjoy enhanced credibility and are more likely to engage in fruitful cooperation with other clusters, creating partnerships for joint projects and implementation. To support the certification efforts, National Key Clusters (KKK) and supra-regional development clusters utilize the 2.17 FENG funds[89], which are available for certification purposes. Additionally, other clusters should actively advocate for and encourage local authorities to allocate funding for certification. This financial support will positively impact the clusters by facilitating their certification processes and contributing to the overall development of the individual regions in which these clusters operate.

- Local government unit (LGU) involvement: The percentage of LGUs among cluster members is below 1%. However, the situation improves when considering contracts signed with public authorities at both the local and central government levels. In this case, 26 clusters have at least one active cooperation agreement with public authorities. It is worth noting that over one-third of the clusters have not utilized or obtained any public funds. The cooperation between clusters and local government units is particularly important in the current financial perspective. Clusters have the potential to be entrusted with public tasks and responsibilities, receiving support from national and regional funds. This alignment is in accordance with the provisions outlined in the document titled "*Directions of the cluster policy after 2020*". Tightening cooperation between clusters and local governments is deemed important for this process. Such collaboration can lead to clusters being assigned public tasks and projects, enabling them to contribute to regional development and leverage the available funds for their initiatives. Strengthening the relationship between clusters and local government units can foster a mutually beneficial environment for both parties.
- Recently established clusters: Similar to the previous edition of the study, during the cluster recruitment stage, a group of clusters that have been formed in the last 2-3 years with significant development ambitions was identified. These clusters have implemented innovative solutions in areas such as management processes, communication, and digitization. These advancements can also be observed in longer-

[89] The European Funds for Smart Economy.

operating clusters. However, it is important to note that most of these recently established clusters did not meet all the criteria for participation in the current edition of benchmarking. Despite this, it is advisable to consider their potential and factor them in when organizing various cluster events and when recruiting for future editions of the benchmarking study. These emerging clusters with promising development ambitions and innovative practices can bring fresh perspectives and contribute to the overall growth and advancement of the cluster ecosystem. Including them in cluster activities and future benchmarking studies can provide valuable insights and foster collaboration among different generations of clusters.

- Management Processes Assessment: When evaluating management processes, the activities of cluster coordinators were compared with the opinions of cluster members. Establishing a network of relationships with cluster enterprises and fostering cooperation among members received high ratings (about 2/3 positive votes). However, the fulfilment of objectives related to creating local supply chains, enhancing product/service quality, reducing business costs, and influencing public authorities and institutions garnered lower ratings (approximately 30% positive assessments in each area).
- Benefits of Cluster Participation: The survey indicates that the majority of respondents (70%) associate participation in clusters with significant benefits. In the previous edition, only 50% of respondents held this view, while 26% believed the benefits were minimal. This suggests a growing perception of the value of cluster membership among respondents.

8.2. Strengths and weaknesses of clusters

Strengths and weaknesses of clusters were assessed by considering the median scores obtained in individual sub-areas. Strengths were identified as elements where the median score for the entire cluster group exceeded 0.30, while weaknesses were determined by elements with a median score below 0.20. Importantly, compared to the previous edition, there has been an increase in the value of these indicators and a reduction in the number of cluster weaknesses. These improvements primarily stem from the overall better performance observed in the current edition of the survey.

Table 23. Strengths and weaknesses of the examined clusters broken down by benchmarking sub-areas (median value in brackets)

Strengths	Weaknesses
Management processes (0.68)	Financial resources (0.13)
Cluster communication (0.34)	infrastructure resources (0.14)
Market activity (0.33)	Development of innovation in the cluster (0.13)
Marketing activity (0.34)	
Cluster digitization (0.71)	
Impact on the natural environment (0.43)	
Impact on shaping the environmental conditions (0.44)	
Internationalization potential (0.33)	

Source: own elaboration based on research involving cluster coordinators (N=41).

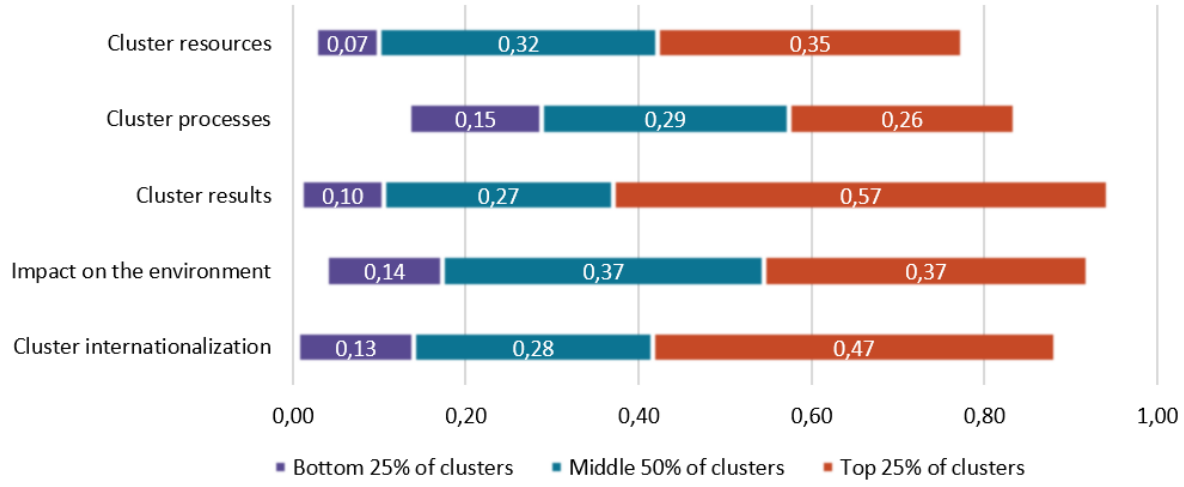
Based on the findings of the study, it can be concluded that the position of clusters within individual sub-areas and between sub-areas has become more equal. While the range between the median values is small, there are relatively few glaring weaknesses observed. However, the median values indicate that at least half of the clusters performed poorly in three areas: financial resources, infrastructural resources, and the development of innovation. These results align with the earlier analysis, which noted that young clusters with a small number of members, without the KKK status, and lacking the ambition to obtain this status, received the lowest scores. These clusters, particularly in sectors such as construction, quality of life, tourism, and recreation, exhibit relatively weak performance.

On the other hand, the analysis emphasises the strengths of clusters in management processes and cluster digitization, which were assessed particularly well. This indicates that clusters have made notable progress in these aspects and have effectively implemented strategies to enhance their management practices and leverage digital technologies.

An additional analysis of the synthetic indicators obtained by clusters, considering their distribution among the bottom 25%, middle 50%, and top 25%, provided further conclusions. The analysis revealed that the most significant differentiation among clusters was observed among the top-performing clusters, with a range of values from 0.26 to 0.57. This indicates that weaker clusters shouldn't compare their position with the indicators of the top-performing clusters but rather focus on average values (as shown in the statistical annex), the median, or the range of values for the middle-performing clusters.

Comparing the current edition of the study to the previous one, the disparity between clusters was found to have decreased in areas such as processes within the cluster and impact on the environment. This indicates a more balanced performance in these aspects among the clusters. However, the disparity increased in the area of cluster results, suggesting greater variation in performance outcomes among the clusters. It is worth noting that the area of processes within the cluster was identified as the strongest, with no clusters reporting minimal or negligible activity. This indicates that all clusters are actively engaged in processes related to their functioning and collaboration within the cluster.

Graph 80. Values of synthetic indicators for cluster groups (bottom 25%, middle 50%, top 25%)



Source: own elaboration based on research involving cluster coordinators (N=41).

The chart highlights the presence of clusters in the study that demonstrated no activity or achievements in certain areas, specifically cluster results and internationalization. This observation aligns with the findings from the previous edition of the study, indicating a continued lack of progress in these areas for specific clusters.

9. Recommendations

The key sources informing the formulation of recommendations include:

- Benchmarking results highlight the strengths and weaknesses of clusters. Weaknesses identified through benchmarking have been utilized to develop recommendations aimed at improving performance in specific areas.
- Qualitative insights derived from conversations and interviews with representatives of the surveyed clusters have provided valuable additional information about the state of individual clusters or clusters in Poland as a whole, along with suggested solutions.
- In-depth analysis of best practices employed by both domestic and foreign clusters draws inspiration from proven and effective solutions to be implemented in other cluster structures.
- Findings from opinion polls conducted among cluster members specifically focus on areas of cluster activity identified as weaknesses.

Several recommendations have been proposed, encompassing both new suggestions and those carried over from the previous edition of cluster benchmarking. These recommendations address current challenges, development goals, and issues faced by cluster coordinators and public administrations responsible for cluster policies. While some recommendations draw from the previous benchmarking edition, they have been updated and tailored to the existing situation of clusters in Poland, considering the latest study results.

The formulated recommendations consider the cluster ecosystem in Poland, which includes government and local government institutions, business support organizations, universities, and other entities within the higher education and science system. They are designed to provide guidance and support for various stakeholders. The recommendations are organised into different sections. First, recommendations target institutions responsible for shaping cluster policies at the national level. Next, horizontal areas of cluster activity, such as cooperation development and quantitative growth, are addressed. Finally, recommendations focus on specific areas of activity, including enhancing competencies, promoting cluster digitization, implementing Industry 4.0 technologies, and fostering internationalization efforts.

Table 24. Recommendation table

Recommendation name	Addressee	Recommendation content
Regular reviews and updates of the cluster policy, considering the financing sources in the financial perspective 2021-2027	▪ Ministry of Development and Technology ▪ Ministry of Development Funds and Regional Policy ▪ Managing and intermediate bodies in the 2021-2027 financial perspective (including regional government) ▪ Cluster representatives	In 2020, a document outlining the future direction of cluster policy in Poland was published. However, it has not been revised despite significant changes in the economic landscape, such as the COVID-19 pandemic, the conflict in Ukraine, and the energy crisis. Therefore, it is necessary to update the underlying assumptions and operationalization of the policy model to reflect the current situation. This need for revision is particularly evident at the regional level, where a unified approach, especially regarding the involvement of clusters in public task implementation, is lacking. It is advisable to establish a body comprising all stakeholders in cluster policy that would play a pivotal role in shaping and making decisions regarding cluster policy. This body should aim to maintain a regular cycle of activity, ideally every two years, similar to the benchmarking process.
Promotion and dissemination of knowledge about instruments, activities, and initiatives aimed at engaging clusters in the implementation of public tasks	▪ Ministry of Development and Technology ▪ Ministry of Development Funds and Regional Policy ▪ Managing and intermediate bodies in the 2021-2027 financial perspective (including regional government) ▪ Polish Clusters Association	The current dissemination of information regarding cluster support instruments for implementing public policies is inadequate. There is a lack of a central, reliable, and comprehensive source of information on available instruments, activities, and initiatives in this area. Given the limited resources of cluster coordinators, establishing a dedicated website to publish information on the needs and offerings of local governments would be justifiable. Involving partners from the cluster ecosystem, such as the Polish Clusters Association, would also be appropriate to ensure the timely dissemination of up-to-date information. Furthermore, the service can be expanded in the future to include additional information, such as evaluation reports on the outcomes of implemented actions.

Support for regional governments in shaping development policies through the use of clusters	▪ Ministry of Development and Technology ▪ Ministry of Development Funds and Regional Policy ▪ Managing and intermediate bodies in the 2021-2027 financial perspective (in particular regional government)	The findings from the qualitative research conducted, which included engaging with cluster policy stakeholders and analysing desk research, suggest that regional governments face challenges in effectively utilizing cluster-driven instruments for implementing public policies. One reason behind this is the complexity of translating various legal and strategic documents to the regional level, along with additional requirements associated with the utilisation of European Funds. To address these issues, the following actions are recommended: ▪ Conduct a thorough analysis of legal compliance across various levels, including EU, national, regional, strategic, and European funds programming documents. This analysis should focus on evaluating the feasibility of involving clusters in the implementation of public policies. ▪ Develop a detailed guide for local governments on effectively implementing public policy instruments through clusters. This guide should specifically address the use of instruments based on European funds within the current financial perspective. ▪ Promote and share examples of successful practices in instrument implementation, particularly targeting representatives from local governments. This dissemination of best practices will facilitate knowledge exchange and enable local governments to benefit from proven approaches. By taking these steps, regional governments can improve their understanding and use of cluster-driven instruments for the effective implementation of public policies.

The role of clusters in shaping industry development and forecasting strategies	▪ Ministry of Development and Technology ▪ Ministry of Development Funds and Regional Policy ▪ Cluster coordinators	Currently, clusters show moderate engagement in shaping development strategies at both the industry and regional/national levels. However, it is important to recognize the significant potential within clusters and their associated entities in areas such as creating Business Technology Roadmaps (BTR), forecasting, and developing strategies for specific industries. Introducing changes that leverage this potential can yield substantial benefits and serve as an incentive for increased cluster involvement. For instance, we can examine examples of cluster participation in selecting regional smart specializations, such as Automotive in Podkarpacie or offshore and port logistics technologies in Pomerania. Therefore, it is recommended to enhance cluster participation in shaping development strategies and other documents that outline technological and industry advancements at both regional and national levels.
Unifying the approach to reporting obligations and research activities of clusters	▪ Ministry of Development and Technology ▪ Polish Agency for Enterprise Development (as the entity commissioning the cluster benchmarking study) ▪ Polish Clusters Association (as a national representative in the European Clusters Alliance and in EUCLES)	During the study, cluster coordinators expressed a pressing need to standardise reporting obligations across various types of instruments and activities. This need is particularly prominent in areas such as KKK recruitment or renewal, KKK monitoring, cluster benchmarking, and EUCLES certification. Standardization efforts should focus on several aspects, including using consistent indicators (e.g., implementing a unified set of indicators with standardized units of measurement), providing a selection of relevant indicators, and establishing a consistent reporting period. By implementing these standardization measures, the contractor responsible for benchmarking would be able to collect the necessary data in a streamlined manner for the study.

European benchmarking (KKK against the background of European structures)	▪ Ministry of Development and Technology ▪ Polish Agency for Enterprise Development	In both the current and previous editions of the study, National Key Clusters (KKK) have demonstrated a significant advantage over other cluster structures, both in terms of overall performance and across various areas and sub-areas. As a result, these clusters receive fewer recommendations and suggestions for improvement in the dedicated reports. This situation may lead to a disadvantage where KKK coordinators might not recognise the development challenges highlighted in the benchmarking results. Consequently, their interest in participating in the study may diminish. To address this issue, it is recommended to adopt a European perspective by providing a comparative analysis between KKK and European cluster leaders. This could be achieved by establishing a recognition system, such as a silver or gold EUCLES badge, which recognizes excellence in European clusters. However, obtaining primary data on a larger group of European clusters may present challenges in terms of organization and cost. Therefore, it is suggested to collaborate with the EUCLES organization to explore the possibility of obtaining aggregated data for selected indicators used in the cluster assessment process. Ideally, these indicators should align as closely as possible with those used in benchmarking, which may require adjusting certain benchmarking indicators to match the EUCLES certification system. By incorporating this comparative analysis into future benchmarking editions, the contractor can conduct a comprehensive benchmarking assessment of KKK against European structures using selected indicators. This approach would provide valuable insights and enable KKK coordinators to gain a better understanding of their position in the European context.
Creation of a platform for exchanging effective cluster practices	▪ Cluster coordinators ▪ Polish Agency for Enterprise Development ▪ Polish Clusters Association	The implementation of both the previous and current editions of benchmarking has revealed that cluster coordinators are eager to share successful practices from their clusters. In both editions, more than 50 initial ideas for showcasing good practices were gathered. However, due to the formatting limitations of the benchmarking report and its two-year cycle, including all the identified good practices becomes challenging. Moreover, good practices often emerge in response to the ever-changing socio-economic landscape, such as the COVID-19

		pandemic or conflicts like the one in Ukraine. Recognizing this dynamic nature of good practices, it is recommended to establish a dedicated website where cluster coordinators can routinely publish information about the innovative initiatives implemented in their clusters. Having a dedicated platform would allow cluster coordinators to continuously share and promote their successful practices, enabling others to learn from their experiences. This website would serve as a valuable resource for the cluster community, fostering knowledge exchange and facilitating the adoption of effective strategies across different clusters.
Increasing collaboration among clusters in Poland	▪ Cluster coordinators	The clusters participating in the study encompass a wide range of industries, presenting a valuable opportunity to foster networking and collaboration among clusters. This can be achieved by creating comprehensive offerings tailored to entities from different clusters, thereby promoting cross-industry cooperation and knowledge exchange. For instance, IT clusters could develop specialized services aimed at assisting members from various industries in implementing Industry 4.0 technologies. Similarly, clusters focused on bioeconomy, sustainable development, and energy could offer expertise in enhancing energy efficiency and waste management practices. By establishing cross-cluster collaborations, the credibility and reliability of cluster offerings can be improved. Additionally, it is worthwhile to explore the implementation of a preferential access system for services or products provided by clusters, specifically targeting members of other clusters. This system would facilitate easier access to relevant services and promote inter-cluster cooperation. To facilitate the dissemination of cluster offerings and access to information, the creation of a dedicated platform should be considered. This platform would serve as a centralized hub for publishing and promoting the services, products, and expertise offered by clusters, enabling interested parties to easily access and engage with these offerings.

Engaging in activities focused on seeking and acquiring new sources of financing (internal and external)	▪ Cluster coordinators ▪ Business support institutions	Ensuring adequate financing for cluster activities is vital for their long-term sustainability and operational capacity. This requires the efficient identification of new funding sources and the effective use of available financial resources. Cluster coordinators are responsible for securing funding for both their own activities and joint initiatives undertaken by cluster members, such as the implementation of specific projects. Coordinators have various avenues to bolster their budgets, drawing from both member contributions and public funding providers. They can explore opportunities to increase revenue from their members, such as expanding the range of paid services offered by the cluster or developing business activities centered around members' products and services. Additionally, profits derived from shared intellectual property rights can enhance the cluster's financial resources. Public funds, especially those available through EU programs in the new financial perspective, play a crucial role in supporting cluster initiatives at both the national level, such as the FENG program, and the regional level. Cluster coordinators should actively engage with public funding administrators to effectively access these resources. Furthermore, acquiring new members who offer financial services can benefit cluster members by providing access to additional external sources of funding. This may include facilitating access to commercial financial instruments, thereby diversifying the financing options available to cluster participants.

Cluster internationalization activities	▪ Cluster coordinators ▪ Polish Clusters Association (as a national representative in the European Clusters Alliance)	Based on the findings of the benchmarking, it can be deduced that the internationalization of Polish clusters is moderately advanced. However, there remains a subset of clusters that have yet to be included in the European Cluster Collaboration Platform database, an initiative by the European Commission. Being listed in this database is a preliminary and cost-free step that enhances the visibility of clusters on the international stage and validates their operations. Subsequently, clusters can assess their management standards and operations. Initially, this can be accomplished through the self-assessment tool provided by PARP, which offers cluster management standards available free of charge on the PARP website. This evaluation will help determine if the clusters meet the requirements for obtaining the EUCLES bronze badge. A more advanced approach involves obtaining an international quality certificate under the EUCLES initiative. Currently, only 12 out of 41 clusters possess a quality label. For National Key Clusters (KKK) and supra-regional development clusters, it is advisable to utilize the FENG 2.17 funds for certification purposes. Other clusters should engage in lobbying efforts to encourage local authorities to finance certification, as this will enhance their credibility on the international stage. Clusters that have reached a high level of development can also consider joining the TCI Network, the oldest global cluster organization. Being part of various collaboration networks and obtaining quality certificates can act as a gateway for cluster coordinators to establish international partnerships and implement projects funded under programs like Horizon Europe 2021-2027.

Further quantitative development of clusters	▪ Cluster coordinators ▪ Ministry of Development and Technology (with regard to the criterion of geographical concentration in the recruitment for KKK)	Through successive benchmarking editions, the increasing significance of clusters can be observed, as indicated by factors such as the number of associated entities, average membership per cluster, and total employment in cluster entities. Drawing insights from Canada's best practices in establishing "superclusters," it is deemed justifiable for certain clusters to pursue gaining new members, expanding activities beyond their region, and diversifying operations within extensive value chains. Clusters aiming to enhance their potential should primarily focus on geographical expansion at the supra-regional level. It may be warranted to enter regions with limited cluster activity, including the Opolskie and Warmińsko-Mazurskie voivodeships, where no clusters were included in the current and previous benchmarking editions. Additionally, considering expansion into other voivodeships where no clusters with similar business profiles exist can be contemplated. Such actions could enable clusters without National Key Cluster (KKK) status to apply for the FENG 2.17 competition as supra-regional growth clusters. Lastly, it is important to acknowledge that the establishment of supra-regional clusters, involving members from across the country following the model of global innovation clusters in Canada, may encounter challenges in obtaining the KKK status. In the most recent recruitment process, the preliminary substantive assessment stage applied a criterion of geographical concentration, requiring that over 50% of cluster members have their headquarters within a distance of no more than 200 km (+/- 10 km) from the cluster coordinator's location. It may be worthwhile to consider revising or modifying this condition to ensure it does not hinder the formation of large clusters that are significantly important to the national economy.

Promotion of solutions in the area of Industry 4.0, digitization of clusters and enterprises, and green transformation, along with the implementation of solutions in the area of key enabling technologies (KET)	▪ Cluster coordinators	Among the clusters surveyed, a notable group demonstrates significant expertise in developing and implementing solutions related to Industry 4.0, digitization, and entrepreneurship (ICT clusters), green transformation (chemistry, bioeconomy, and energy clusters), as well as key enabling technologies (KET) such as photonics, materials engineering, and bioeconomy. The successful implementation of these solutions requires adequate preparation and technical knowledge. Therefore, it is recommended to organize training sessions and workshops for both cluster coordinators and members. These initiatives will help them acquire the necessary knowledge and skills to effectively implement advanced technological solutions. Building on the previous recommendation, it is appropriate for experienced cluster coordinators in the mentioned areas to share their expertise with clusters that are less advanced in these fields. This would allow companies from less technologically advanced clusters to gain from the knowledge and skills of experts from more advanced clusters. As a result, it would improve their competitiveness and operational efficiency. The results of the member survey support this approach, with more than 50% showing interest in services related to digital transformation, Industry 4.0 technology implementation, and green transformation. Collaboration between clusters fosters mutual benefits. Technological solution providers gain more orders and business development opportunities, while clusters that utilise these solutions experience improved quality, productivity, and competitiveness, resulting in better financial outcomes and market positioning.

Engaging in activities to search for and secure new sources of financing (internal and external)	▪ Cluster coordinators ▪ Business support institutions	Securing financing for cluster activities is crucial for their sustainability and level of engagement. This requires the efficient identification of new funding sources and effective utilization of available financial resources. Cluster coordinators are responsible for ensuring the financing of their own activities, as well as the collaborative efforts of their members, such as project implementations. They can explore various avenues to enhance their budget, including contributions from cluster members through paid services, leveraging the cluster's business activities based on members' products and services, and capitalizing on shared intellectual property rights. Additionally, coordinators can seek financial support from public fund administrators, with EU funds playing a significant role in the new financial landscape at both the national level (e.g., FENG) and the regional level. Furthermore, expanding the cluster's membership to include entities that provide financial services can give cluster members access to additional external funding sources, such as commercial financial instruments.
Development of the cluster offering and building a portfolio of services	▪ Cluster coordinators ▪ Universities and other entities of the higher education and science system ▪ Business support institutions	The previous recommendation emphasised the importance of cluster coordinators developing a service offering that serves both coordinators and members of other clusters. Coordinators have the flexibility to create their own independent service offerings or act as intermediaries in facilitating services provided by third parties, including cluster members or external organizations and experts. Based on the findings of the opinion survey among cluster members, there is significant interest in specific categories of services, including promotion, marketing, internationalization activities, training (including specialized training), and networking within the cluster and with external entities. Some members are willing to pay higher membership fees or make additional payments for access to these services. Coordinators should concentrate on crucial areas of activity to address these needs, such as: ▪ Pro-innovation services: This could involve offering services related to green transformation, digital transformation, and the implementation of Industry 4.0 technologies. Although more than 50% of surveyed

		members have not utilized these services yet, there is a strong interest in accessing them in the future. ▪ Internationalization services: This category encompasses services designed to facilitate cooperation with foreign entities, initiate international projects, organise trips to trade fairs and foreign economic missions, as well as arrange international industry events. The survey reveals that over 85% of members express interest in each of these areas. By focusing on these areas and tailoring their service offerings accordingly, cluster coordinators can effectively address the needs and interests of their members while promoting growth and collaboration within the cluster ecosystem.
The inclusive nature of the process for creating strategic cluster documents	▪ Cluster coordinators and members	The analysis conducted highlights the pivotal role of the cluster coordinator in strategic planning and implementation activities. To ensure effectiveness and member involvement in these processes, it is crucial for the coordinator to foster their participation in the creation of strategic documents. Currently, in the benchmarking study, over 46% of cluster members did not participate in this process. To enhance member involvement in shaping the strategy and operational documents, the following activities should be taken into account: ▪ Utilizing various forms of consultation: This can involve publishing a document and allowing members to propose changes or additions. Online platforms can also be utilized to facilitate this form of consultation. By actively seeking input and feedback from members, the coordinator can foster a sense of ownership and engagement. ▪ Regular organization of strategic workshops: Conducting annual strategic workshops with the active participation of cluster members and organizing task groups can be instrumental in creating a collaborative environment. By working together, exchanging perspectives, and co-creating solutions, it becomes possible to update documents that resonate more effectively with cluster members. ▪ Developing operational plans with member involvement: It is essential to include the largest

		possible groups of cluster members in the planning of operational activities. These plans should outline the necessary resources for successful implementation, along with an implementation schedule. By transparently communicating operational goals and priorities, cluster members can gain a better understanding of the overall direction and actively contribute to achieving the desired outcomes. By implementing these measures, cluster coordinators can foster ownership, engagement, and alignment among cluster members. This collaborative approach to strategic and operational planning will not only lead to more effective implementation but also contribute to a stronger and more cohesive cluster ecosystem.
Supporting enterprises in developing employee competencies and qualifications while attracting new staff	▪ Cluster coordinators ▪ Universities and other entities of the higher education and science system	The research findings emphasize the need to continue and enhance efforts to support enterprises in developing their employees' competencies, attracting new staff, and addressing the challenges of a rapidly changing labor market. Clusters, universities, and entities within the higher education and science system can play a pivotal role in providing enterprises with access to modern training programs, qualification development initiatives, and innovative employee exchange programs. It is essential to foster partnerships between these stakeholders to create a comprehensive ecosystem that supports the needs of businesses. Consideration should be given to organizing specialist job fairs targeted at students and graduates, particularly in fields such as information technology (including Industry 4.0) and the green economy. Additionally, sectors like automotive, construction, chemistry, energy, and medicine can benefit from dedicated job fairs. Such initiatives provide companies with opportunities to recruit highly qualified specialists who can contribute to the development of innovative solutions. Establishing partnerships between clusters, universities, and other entities within the higher education and science system is highly recommended. These collaborations can facilitate advancements in education, training, and research and development. By joining forces, tailored training programs can be created to address the specific needs of enterprises within

		the cluster. This ensures that enterprises have access to specialized training and qualification development programs that meet the current demands of the labor market. Cluster coordinators can also initiate staff exchange programs between cluster enterprises and universities. This enables representatives from enterprises to access the scientific expertise and knowledge of specialists from universities, along with research infrastructure. By facilitating this exchange of knowledge and expertise, enterprises gain access to new technological solutions, while universities acquire insights into the practical aspects of business operations. Cluster representatives should actively participate in developing educational standards for specific industries through Sectoral Competence Councils[90] at relevant institutions such as PARP. By contributing to these councils, clusters can help shape the educational landscape and ensure that the industry's skill requirements are effectively met.

[90] www.parp.gov.pl/component/site/site/sektorowe-rady-ds-energetyi#about (accessed on April 19, 2023).

10. Attachments

10.1. Statistical annex - surveys of cluster coordinators - total

The tables below present a summary of selected measures calculated for sub-areas and main areas of the study. To determine the sub-synthetic and synthetic indicators for individual areas, it was necessary to standardize the values. The indicators collected in the study are expressed in various units and take on values from different numerical ranges. To be comparable (the postulate of comparability of variables), they must be unified. For this purpose, the data was unitarized in accordance with the provisions of the OPZ. The aim of unitarization was to obtain variables with a uniform range of variability, defined - in the classical approach - by the difference between their maximum and minimum values, which equals a constant of 1. In this benchmarking study, all determined indicators are stimulants and were carried out in accordance with the following formula:

$$z_{ik} = \frac{x_{ik} - \min_i\{x_{ik}\}}{\max_i\{x_{ik}\} - \min_i\{x_{ik}\}}$$

Where:

X_{ik} – actual value of variable x ik

with $_{ik}$ – normalized value of variable *x and k*

i – cluster number (*i* = 1, 2, 3, …, *n)*

k – indicator number (*k* = 1, 2, 3, …, *m)*

$\max_i\{x_{ik}\}$ – the maximum value of *the k* -th indicator. In the obtained data, there are outliers / extreme values for many indicators. In this situation, the maximum value was also determined as the value of the third quartile increased by one and a half times the interquartile range.

$\min_i\{x_{ik}\}$ – the minimum value of *the k* -th index

The results are presented in the form of calculated measures for all clusters and for the examined cluster.

Table 25. List of selected measures for clusters in total

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.00	0.00	0.03	0.26	0.04	0.00	0.04	0.00	0.00	0.13	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.06
First quartile	0.14	0.05	0.01	0.10	0.50	0.24	0.14	0.23	0.07	0.36	0.29	0.05	0.03	0.15	0.10	0.17	0.20	0.14	0.07	0.17	0.18	0.05	0.09	0.14	0.17
Median	0.28	0.14	0.13	0.19	0.68	0.34	0.33	0.34	0.24	0.71	0.46	0.20	0.13	0.30	0.22	0.31	0.44	0.43	0.23	0.32	0.33	0.22	0.26	0.26	0.29
Mean	0.34	0.24	0.27	0.28	0.66	0.38	0.33	0.35	0.36	0.64	0.45	0.23	0.26	0.34	0.27	0.30	0.45	0.44	0.29	0.37	0.34	0.28	0.29	0.30	0.34
Third quartile	0.50	0.38	0.45	0.42	0.81	0.47	0.48	0.47	0.57	0.92	0.57	0.36	0.40	0.52	0.37	0.37	0.62	0.71	0.45	0.55	0.46	0.42	0.43	0.42	0.45
Benchmark	1.00	0.95	1.00	0.78	1.00	0.93	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	1.00	0.92	0.91	0.97	0.88	0.88	0.86

Source: own elaboration based on research involving cluster coordinators (N=41).

Table 26. Summary of selected measures for clusters by size class (small clusters: 20-53 members)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.02	0.00	0.03	0.40	0.15	0.03	0.08	0.02	0.04	0.16	0.00	0.00	0.00	0.01	0.04	0.04	0.00	0.01	0.08	0.00	0.00	0.00	0.01	0.07
First quartile	0.05	0.03	0.01	0.10	0.42	0.22	0.08	0.18	0.03	0.25	0.25	0.03	0.00	0.07	0.03	0.11	0.12	0.14	0.04	0.15	0.12	0.02	0.03	0.08	0.13
Median	0.25	0.08	0.03	0.12	0.47	0.32	0.12	0.22	0.09	0.47	0.32	0.04	0.01	0.11	0.09	0.16	0.27	0.21	0.09	0.19	0.13	0.11	0.08	0.16	0.18
Mean	0.23	0.12	0.06	0.14	0.51	0.35	0.20	0.25	0.15	0.46	0.32	0.08	0.05	0.14	0.09	0.16	0.28	0.27	0.11	0.21	0.19	0.14	0.10	0.14	0.18
Third quartile	0.27	0.16	0.09	0.14	0.54	0.44	0.22	0.29	0.23	0.66	0.35	0.08	0.03	0.19	0.11	0.23	0.43	0.29	0.19	0.24	0.28	0.24	0.16	0.20	0.23
Benchmark	0.78	0.38	0.21	0.42	0.75	0.69	0.84	0.58	0.54	1.00	0.50	0.34	0.32	0.43	0.27	0.28	0.56	0.86	0.23	0.37	0.41	0.42	0.26	0.25	0.29

Source: own elaboration based on a survey of cluster coordinators (N=10).

Table 27. List of selected measures for clusters by size class (medium clusters: 54-77 members)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.03	0.00	0.00	0.03	0.26	0.04	0.00	0.04	0.00	0.15	0.13	0.02	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.04	0.00	0.00	0.02	0.01	0.06
First quartile	0.09	0.02	0.00	0.07	0.43	0.11	0.13	0.16	0.04	0.32	0.24	0.09	0.06	0.15	0.13	0.16	0.03	0.04	0.02	0.14	0.09	0.01	0.08	0.10	0.16
Median	0.12	0.05	0.05	0.11	0.57	0.23	0.25	0.32	0.22	0.50	0.31	0.22	0.08	0.31	0.20	0.21	0.30	0.14	0.14	0.19	0.19	0.14	0.17	0.13	0.18
Mean	0.17	0.14	0.09	0.13	0.56	0.23	0.26	0.29	0.24	0.55	0.35	0.21	0.15	0.28	0.21	0.23	0.32	0.30	0.16	0.25	0.20	0.19	0.21	0.20	0.23
Third quartile	0.20	0.18	0.15	0.18	0.71	0.27	0.33	0.44	0.34	0.78	0.45	0.25	0.21	0.42	0.25	0.34	0.46	0.57	0.26	0.35	0.30	0.37	0.33	0.33	0.28
Benchmark	0.55	0.59	0.34	0.32	0.82	0.47	0.60	0.47	0.79	1.00	0.65	0.51	0.54	0.55	0.50	0.40	0.91	0.71	0.46	0.58	0.55	0.51	0.49	0.46	0.48

Source: own elaboration based on a survey of cluster coordinators (N=10).

Table 28. Summary of selected measures for clusters by size class (large clusters: 78-121 members)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.14	0.05	0.00	0.09	0.50	0.17	0.07	0.11	0.05	0.32	0.21	0.00	0.00	0.11	0.08	0.10	0.17	0.00	0.00	0.12	0.22	0.00	0.07	0.14	0.15
First quartile	0.16	0.14	0.02	0.12	0.67	0.28	0.23	0.27	0.28	0.59	0.43	0.08	0.15	0.21	0.22	0.31	0.37	0.43	0.22	0.35	0.29	0.14	0.24	0.26	0.28
Median	0.33	0.26	0.17	0.29	0.70	0.36	0.39	0.33	0.55	0.72	0.52	0.21	0.31	0.29	0.30	0.34	0.57	0.57	0.35	0.45	0.36	0.31	0.29	0.30	0.40
Mean	0.33	0.29	0.23	0.29	0.70	0.42	0.37	0.33	0.47	0.70	0.50	0.22	0.28	0.35	0.28	0.31	0.50	0.51	0.31	0.41	0.39	0.27	0.30	0.32	0.36
Third quartile	0.48	0.44	0.30	0.42	0.80	0.39	0.53	0.36	0.68	0.82	0.57	0.37	0.44	0.52	0.35	0.37	0.61	0.68	0.45	0.51	0.46	0.37	0.39	0.40	0.45
Benchmark	0.57	0.59	0.95	0.54	0.87	0.93	0.55	0.60	0.76	1.00	0.74	0.49	0.51	0.63	0.50	0.39	0.73	0.86	0.56	0.61	0.61	0.52	0.49	0.49	0.45

Source: own elaboration based on a survey of cluster coordinators (N=10).

Table 29. Summary of selected measures for clusters by size class (very large clusters: 122 and more)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.33	0.00	0.00	0.11	0.38	0.19	0.00	0.23	0.20	0.00	0.17	0.00	0.00	0.16	0.05	0.02	0.33	0.00	0.00	0.09	0.27	0.00	0.00	0.11	0.11
First quartile	0.42	0.10	0.56	0.40	0.80	0.37	0.38	0.47	0.36	0.86	0.54	0.22	0.26	0.39	0.30	0.35	0.43	0.64	0.34	0.54	0.33	0.22	0.39	0.37	0.44
Median	0.54	0.22	0.68	0.67	0.90	0.47	0.45	0.51	0.52	0.94	0.70	0.31	0.49	0.55	0.48	0.47	0.62	0.71	0.56	0.61	0.56	0.51	0.53	0.51	0.61
Mean	0.60	0.41	0.65	0.56	0.85	0.51	0.48	0.52	0.58	0.85	0.63	0.39	0.52	0.55	0.49	0.49	0.67	0.66	0.54	0.59	0.57	0.49	0.54	0.53	0.56
Third quartile	0.72	0.73	0.82	0.72	0.97	0.66	0.57	0.62	0.84	1.00	0.74	0.54	0.84	0.70	0.66	0.65	0.88	0.86	0.71	0.71	0.80	0.70	0.76	0.73	0.72
Benchmark	1.00	0.95	1.00	0.78	1.00	0.81	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	1.00	0.92	0.91	0.97	0.88	0.88	0.86

Source: own elaboration based on a survey of cluster coordinators (N=11).

Table 30. List of selected measures by KKK status (the cluster has the KKK status)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.16	0.07	0.02	0.15	0.69	0.27	0.30	0.23	0.22	0.46	0.48	0.08	0.06	0.17	0.18	0.18	0.22	0.29	0.23	0.30	0.21	0.07	0.23	0.19	0.37
First quartile	0.33	0.14	0.26	0.32	0.79	0.35	0.38	0.40	0.52	0.84	0.56	0.25	0.29	0.35	0.31	0.35	0.49	0.57	0.33	0.47	0.33	0.36	0.33	0.38	0.41
Median	0.47	0.26	0.56	0.46	0.86	0.43	0.50	0.48	0.65	0.93	0.61	0.36	0.43	0.48	0.40	0.38	0.65	0.71	0.46	0.59	0.47	0.48	0.48	0.44	0.47
Mean	0.50	0.36	0.55	0.47	0.86	0.50	0.51	0.49	0.62	0.88	0.64	0.39	0.46	0.49	0.45	0.47	0.66	0.70	0.51	0.58	0.49	0.49	0.50	0.49	0.53
Third quartile	0.60	0.55	0.81	0.68	0.96	0.63	0.56	0.57	0.77	1.00	0.73	0.51	0.59	0.62	0.54	0.55	0.88	0.86	0.67	0.66	0.61	0.55	0.63	0.59	0.63
Benchmark	1.00	0.95	1.00	0.78	1.00	0.93	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	1.00	0.92	0.91	0.97	0.88	0.88	0.86

Source: own elaboration based on a survey of cluster coordinators (N=16).

Table 31. List of selected measures by KKK status (the cluster does not have the KKK status, but is interested in applying)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.02	0.00	0.03	0.34	0.09	0.07	0.04	0.02	0.10	0.19	0.00	0.00	0.04	0.03	0.01	0.00	0.00	0.00	0.08	0.07	0.00	0.00	0.04	0.11
First quartile	0.09	0.05	0.01	0.08	0.46	0.19	0.13	0.15	0.05	0.36	0.27	0.03	0.01	0.09	0.08	0.12	0.12	0.14	0.04	0.15	0.18	0.04	0.08	0.13	0.17
Median	0.15	0.10	0.06	0.11	0.57	0.27	0.23	0.23	0.14	0.59	0.35	0.10	0.06	0.15	0.14	0.21	0.36	0.29	0.11	0.24	0.27	0.14	0.17	0.21	0.21
Mean	0.19	0.21	0.14	0.18	0.57	0.29	0.29	0.27	0.23	0.56	0.37	0.15	0.16	0.24	0.18	0.22	0.32	0.34	0.17	0.26	0.31	0.17	0.19	0.22	0.24
Third quartile	0.25	0.26	0.19	0.18	0.68	0.37	0.43	0.32	0.42	0.71	0.45	0.23	0.21	0.25	0.24	0.30	0.49	0.54	0.21	0.32	0.36	0.25	0.27	0.25	0.25
Benchmark	0.63	0.88	0.61	0.71	0.81	0.48	0.84	0.66	0.68	1.00	0.65	0.49	0.80	0.84	0.62	0.47	0.62	0.86	0.56	0.56	0.80	0.42	0.52	0.51	0.61

Source: own elaboration based on a survey of cluster coordinators (N=14).

Table 32. Summary of selected measures by KKK status (the cluster does not have the KKK status and does not plan to apply for this status)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.03	0.00	0.00	0.03	0.26	0.04	0.00	0.07	0.00	0.00	0.13	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.06
First quartile	0.08	0.01	0.00	0.06	0.41	0.18	0.04	0.18	0.05	0.18	0.19	0.03	0.00	0.10	0.05	0.11	0.09	0.00	0.00	0.13	0.05	0.00	0.02	0.06	0.11
Median	0.25	0.03	0.01	0.11	0.50	0.22	0.11	0.26	0.20	0.33	0.27	0.06	0.03	0.26	0.11	0.16	0.33	0.14	0.07	0.16	0.13	0.03	0.08	0.11	0.17
Mean	0.28	0.12	0.04	0.14	0.48	0.32	0.12	0.26	0.16	0.41	0.29	0.10	0.08	0.24	0.14	0.17	0.30	0.21	0.12	0.20	0.16	0.11	0.12	0.13	0.18
Third quartile	0.42	0.10	0.03	0.15	0.53	0.41	0.18	0.33	0.23	0.62	0.38	0.13	0.10	0.33	0.20	0.22	0.42	0.21	0.23	0.19	0.27	0.21	0.17	0.17	0.23
Benchmark	0.78	0.55	0.21	0.42	0.71	0.81	0.29	0.43	0.41	1.00	0.50	0.43	0.32	0.63	0.33	0.37	0.73	0.86	0.36	0.55	0.41	0.29	0.40	0.30	0.39

Source: own elaboration based on a survey of cluster coordinators (N=11).

Table 33. Summary of selected measures for clusters by year of establishment (until 2009)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.02	0.00	0.08	0.34	0.09	0.07	0.04	0.05	0.32	0.21	0.00	0.01	0.04	0.07	0.01	0.11	0.14	0.00	0.08	0.07	0.00	0.03	0.11	0.15
First quartile	0.15	0.12	0.02	0.12	0.66	0.27	0.28	0.22	0.23	0.66	0.41	0.09	0.08	0.16	0.14	0.24	0.28	0.43	0.14	0.27	0.23	0.08	0.20	0.17	0.21
Median	0.35	0.26	0.28	0.30	0.75	0.35	0.33	0.35	0.53	0.71	0.49	0.20	0.24	0.26	0.23	0.36	0.49	0.57	0.35	0.44	0.33	0.22	0.26	0.27	0.38
Mean	0.38	0.31	0.36	0.35	0.74	0.40	0.40	0.37	0.47	0.73	0.52	0.28	0.33	0.38	0.33	0.35	0.50	0.55	0.36	0.44	0.42	0.33	0.36	0.37	0.40
Third quartile	0.52	0.43	0.62	0.51	0.86	0.43	0.49	0.53	0.71	0.94	0.66	0.37	0.49	0.60	0.42	0.37	0.66	0.71	0.55	0.57	0.57	0.45	0.45	0.45	0.45
Benchmark	0.98	0.95	1.00	0.78	1.00	0.93	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	1.00	0.92	0.91	0.97	0.88	0.88	0.86

Source: own elaboration based on a survey of cluster coordinators (N=15).

Table 34. Summary of selected measures for clusters by year of establishment (2010 to 2014)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.03	0.00	0.00	0.03	0.26	0.04	0.00	0.07	0.00	0.04	0.13	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.06
First quartile	0.09	0.03	0.02	0.08	0.50	0.22	0.11	0.19	0.12	0.36	0.27	0.03	0.01	0.13	0.11	0.16	0.14	0.14	0.08	0.16	0.13	0.02	0.05	0.09	0.15
Median	0.25	0.10	0.11	0.16	0.63	0.27	0.23	0.42	0.24	0.79	0.46	0.22	0.11	0.36	0.22	0.23	0.40	0.29	0.23	0.25	0.33	0.21	0.27	0.29	0.29
Mean	0.33	0.23	0.26	0.27	0.63	0.36	0.28	0.35	0.32	0.63	0.43	0.22	0.23	0.34	0.26	0.29	0.41	0.35	0.27	0.33	0.31	0.24	0.27	0.27	0.31
Third quartile	0.52	0.38	0.50	0.42	0.81	0.47	0.46	0.47	0.51	0.94	0.57	0.31	0.40	0.47	0.38	0.35	0.62	0.71	0.33	0.53	0.46	0.44	0.47	0.40	0.48
Benchmark	1.00	0.89	1.00	0.75	0.98	0.81	0.60	0.66	0.91	1.00	0.73	0.57	0.88	0.84	0.67	0.74	0.91	0.86	0.85	0.73	0.80	0.57	0.82	0.64	0.69

Source: own elaboration based on a survey of cluster coordinators (N=21).

Table 35. Summary of selected measures for clusters by year of establishment (2015 and later)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.16	0.00	0.00	0.11	0.38	0.19	0.00	0.25	0.02	0.00	0.17	0.00	0.00	0.04	0.03	0.02	0.17	0.00	0.00	0.09	0.11	0.00	0.00	0.11	0.11
First quartile	0.25	0.03	0.00	0.11	0.41	0.34	0.10	0.25	0.02	0.10	0.34	0.02	0.00	0.14	0.05	0.17	0.33	0.29	0.01	0.22	0.11	0.26	0.13	0.17	0.22
Median	0.28	0.09	0.02	0.15	0.41	0.44	0.14	0.29	0.07	0.55	0.35	0.05	0.03	0.16	0.10	0.24	0.44	0.43	0.04	0.32	0.21	0.28	0.14	0.21	0.23
Mean	0.26	0.11	0.05	0.14	0.53	0.38	0.32	0.28	0.21	0.43	0.36	0.15	0.13	0.18	0.16	0.21	0.44	0.49	0.14	0.32	0.24	0.27	0.19	0.23	0.24
Third quartile	0.29	0.17	0.03	0.15	0.69	0.45	0.55	0.29	0.20	0.69	0.36	0.34	0.31	0.26	0.27	0.24	0.56	0.86	0.20	0.37	0.33	0.37	0.26	0.25	0.24
Benchmark	0.33	0.27	0.21	0.19	0.75	0.48	0.84	0.33	0.72	0.83	0.58	0.36	0.32	0.32	0.33	0.39	0.70	0.86	0.47	0.61	0.46	0.42	0.43	0.42	0.42

Source: own elaboration based on a survey of cluster coordinators (N=5).

Table 36. Summary of selected measures for clusters by location (central macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.04	0.03	0.00	0.03	0.34	0.09	0.07	0.11	0.02	0.10	0.21	0.02	0.00	0.04	0.08	0.09	0.17	0.00	0.00	0.12	0.07	0.09	0.07	0.11	0.15
First quartile	0.13	0.04	0.03	0.11	0.41	0.27	0.12	0.17	0.07	0.32	0.26	0.07	0.03	0.19	0.15	0.16	0.32	0.14	0.03	0.18	0.11	0.15	0.15	0.16	0.18
Median	0.29	0.17	0.12	0.19	0.47	0.46	0.19	0.27	0.15	0.57	0.35	0.17	0.18	0.26	0.17	0.21	0.42	0.29	0.08	0.24	0.19	0.22	0.19	0.19	0.23
Mean	0.38	0.16	0.27	0.27	0.59	0.45	0.32	0.31	0.25	0.59	0.42	0.20	0.23	0.31	0.25	0.25	0.44	0.41	0.22	0.33	0.26	0.33	0.30	0.29	0.31
Third quartile	0.51	0.22	0.38	0.38	0.73	0.61	0.48	0.39	0.31	0.88	0.55	0.32	0.34	0.42	0.30	0.30	0.52	0.75	0.25	0.43	0.28	0.35	0.32	0.27	0.34
Benchmark	0.98	0.38	1.00	0.73	1.00	0.81	0.84	0.65	0.76	1.00	0.75	0.52	0.74	0.68	0.65	0.57	0.88	0.86	1.00	0.70	0.80	0.97	0.88	0.88	0.74

Source: own elaboration based on a survey of cluster coordinators (N=8).

Table 37. Summary of selected measures for clusters by location (south-western macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.06	0.00	0.00	0.06	0.38	0.19	0.00	0.23	0.20	0.00	0.17	0.00	0.00	0.11	0.05	0.02	0.00	0.00	0.00	0.08	0.28	0.00	0.00	0.11	0.11
First quartile	0.14	0.02	0.00	0.09	0.51	0.24	0.07	0.23	0.22	0.36	0.29	0.02	0.00	0.16	0.21	0.10	0.22	0.00	0.00	0.09	0.33	0.00	0.05	0.13	0.15
Median	0.33	0.14	0.11	0.11	0.63	0.24	0.17	0.25	0.24	0.55	0.42	0.03	0.06	0.55	0.22	0.17	0.33	0.14	0.00	0.18	0.33	0.07	0.23	0.19	0.24
Mean	0.28	0.23	0.14	0.22	0.59	0.37	0.22	0.28	0.38	0.48	0.39	0.12	0.19	0.40	0.24	0.19	0.35	0.31	0.18	0.26	0.35	0.13	0.17	0.22	0.26
Third quartile	0.37	0.42	0.28	0.40	0.68	0.38	0.33	0.26	0.57	0.70	0.52	0.08	0.37	0.58	0.34	0.32	0.57	0.57	0.33	0.42	0.33	0.23	0.27	0.29	0.37
Benchmark	0.50	0.59	0.31	0.42	0.75	0.81	0.54	0.41	0.68	0.79	0.53	0.49	0.51	0.63	0.37	0.33	0.62	0.86	0.56	0.52	0.46	0.37	0.32	0.37	0.44

Source: own elaboration based on a survey of cluster coordinators (N=5).

Table 38. Summary of selected measures for clusters by location (southern macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.03	0.05	0.00	0.03	0.41	0.04	0.00	0.07	0.00	0.29	0.13	0.08	0.07	0.00	0.05	0.15	0.00	0.00	0.00	0.04	0.13	0.00	0.09	0.07	0.06
First quartile	0.23	0.14	0.12	0.23	0.69	0.33	0.32	0.34	0.52	0.55	0.55	0.24	0.25	0.18	0.24	0.34	0.42	0.46	0.30	0.44	0.34	0.37	0.31	0.37	0.42
Median	0.42	0.26	0.51	0.51	0.75	0.37	0.43	0.39	0.59	0.82	0.57	0.30	0.35	0.26	0.34	0.36	0.53	0.64	0.46	0.49	0.42	0.41	0.39	0.42	0.45
Mean	0.44	0.33	0.45	0.41	0.74	0.38	0.38	0.38	0.51	0.70	0.52	0.30	0.33	0.30	0.31	0.36	0.50	0.55	0.40	0.45	0.41	0.38	0.41	0.40	0.42
Third quartile	0.54	0.40	0.68	0.56	0.86	0.39	0.53	0.49	0.65	0.86	0.58	0.37	0.45	0.35	0.40	0.39	0.67	0.71	0.52	0.59	0.53	0.50	0.48	0.47	0.49
Benchmark	1.00	0.89	0.95	0.67	0.98	0.81	0.55	0.60	0.72	0.94	0.71	0.49	0.49	0.71	0.48	0.54	0.82	0.86	0.70	0.64	0.61	0.54	0.82	0.64	0.61

Source: own elaboration based on a survey of cluster coordinators (N=6).

Table 39. Summary of selected measures for clusters by location (north-western macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.09	0.02	0.00	0.08	0.52	0.17	0.18	0.04	0.06	0.64	0.34	0.03	0.03	0.15	0.07	0.01	0.11	0.00	0.13	0.21	0.18	0.03	0.18	0.13	0.17
First quartile	0.11	0.05	0.01	0.08	0.65	0.28	0.20	0.20	0.37	0.68	0.41	0.09	0.06	0.15	0.11	0.19	0.41	0.57	0.15	0.28	0.19	0.22	0.32	0.25	0.26
Median	0.21	0.34	0.01	0.14	0.71	0.37	0.33	0.31	0.41	0.72	0.45	0.17	0.10	0.34	0.25	0.37	0.47	0.57	0.36	0.37	0.22	0.29	0.34	0.30	0.29
Mean	0.33	0.30	0.18	0.27	0.71	0.39	0.36	0.31	0.44	0.77	0.50	0.25	0.28	0.35	0.29	0.36	0.52	0.54	0.35	0.44	0.37	0.36	0.39	0.37	0.37
Third quartile	0.50	0.54	0.09	0.35	0.73	0.39	0.33	0.44	0.44	0.81	0.46	0.22	0.32	0.47	0.27	0.37	0.73	0.71	0.46	0.55	0.35	0.42	0.40	0.36	0.39
Benchmark	0.76	0.55	0.80	0.70	0.96	0.73	0.76	0.56	0.91	1.00	0.82	0.75	0.89	0.62	0.75	0.83	0.88	0.86	0.66	0.81	0.91	0.85	0.70	0.82	0.78

Source: own elaboration based on a survey of cluster coordinators (N=5).

Table 40. Summary of selected measures for clusters by location (northern macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.04	0.02	0.02	0.03	0.42	0.16	0.03	0.08	0.22	0.04	0.16	0.03	0.00	0.00	0.01	0.04	0.04	0.14	0.07	0.14	0.00	0.00	0.00	0.01	0.07
First quartile	0.25	0.02	0.04	0.10	0.55	0.25	0.06	0.19	0.22	0.21	0.25	0.03	0.03	0.07	0.04	0.16	0.39	0.14	0.22	0.16	0.13	0.02	0.03	0.05	0.12
Median	0.29	0.09	0.20	0.22	0.79	0.27	0.38	0.23	0.23	0.87	0.48	0.10	0.06	0.22	0.18	0.18	0.40	0.29	0.33	0.30	0.33	0.22	0.25	0.27	0.37
Mean	0.29	0.08	0.28	0.22	0.70	0.39	0.28	0.27	0.33	0.61	0.43	0.14	0.15	0.29	0.19	0.22	0.48	0.37	0.27	0.34	0.26	0.16	0.20	0.21	0.28
Third quartile	0.35	0.10	0.45	0.30	0.85	0.35	0.38	0.36	0.24	0.92	0.52	0.20	0.13	0.52	0.23	0.36	0.59	0.57	0.35	0.48	0.33	0.22	0.26	0.31	0.38
Benchmark	0.52	0.15	0.68	0.43	0.86	0.93	0.54	0.50	0.76	1.00	0.74	0.37	0.51	0.62	0.50	0.38	0.97	0.71	0.38	0.60	0.48	0.32	0.47	0.39	0.45

Source: own elaboration based on a survey of cluster coordinators (N=5).

Table 41. Summary of selected measures for clusters by location (eastern macroregion)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.00	0.00	0.03	0.26	0.09	0.10	0.10	0.00	0.15	0.19	0.00	0.00	0.04	0.03	0.06	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.01	0.11
First quartile	0.14	0.07	0.01	0.11	0.51	0.21	0.20	0.32	0.03	0.46	0.28	0.06	0.01	0.12	0.09	0.22	0.13	0.25	0.14	0.16	0.19	0.03	0.03	0.13	0.18
Median	0.25	0.10	0.17	0.17	0.71	0.30	0.37	0.44	0.17	0.71	0.45	0.23	0.12	0.31	0.21	0.31	0.40	0.36	0.22	0.32	0.39	0.20	0.18	0.25	0.23
Mean	0.31	0.31	0.27	0.30	0.66	0.32	0.37	0.44	0.34	0.68	0.47	0.29	0.30	0.36	0.32	0.36	0.43	0.45	0.30	0.39	0.39	0.27	0.28	0.31	0.36
Third quartile	0.54	0.58	0.31	0.42	0.82	0.47	0.47	0.58	0.60	0.97	0.65	0.45	0.61	0.46	0.53	0.42	0.65	0.71	0.37	0.56	0.57	0.47	0.50	0.47	0.51
Benchmark	0.67	0.95	1.00	0.78	0.96	0.51	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	0.85	0.92	0.80	0.83	0.88	0.84	0.86

Source: own elaboration based on a survey of cluster coordinators (N=12).

Table 42. List of selected measures for clusters according to having a strategy (no written cluster strategy)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.03	0.00	0.00	0.03	0.26	0.04	0.00	0.07	0.00	0.00	0.13	0.00	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.06
First quartile	0.09	0.00	0.00	0.04	0.38	0.12	0.03	0.26	0.01	0.19	0.18	0.03	0.01	0.18	0.07	0.16	0.05	0.00	0.00	0.10	0.03	0.00	0.03	0.08	0.11
Median	0.20	0.01	0.01	0.10	0.41	0.20	0.12	0.35	0.05	0.31	0.24	0.15	0.05	0.28	0.14	0.18	0.26	0.00	0.00	0.14	0.12	0.10	0.08	0.10	0.16
Mean	0.23	0.02	0.02	0.09	0.41	0.23	0.12	0.32	0.12	0.38	0.26	0.16	0.07	0.25	0.16	0.18	0.24	0.17	0.12	0.18	0.15	0.15	0.11	0.14	0.17
Third quartile	0.32	0.04	0.02	0.11	0.48	0.34	0.17	0.43	0.17	0.60	0.32	0.22	0.07	0.31	0.23	0.22	0.41	0.11	0.21	0.25	0.28	0.26	0.12	0.16	0.21
Benchmark	0.55	0.05	0.09	0.19	0.52	0.45	0.29	0.44	0.44	0.81	0.46	0.43	0.25	0.47	0.33	0.31	0.47	0.86	0.46	0.37	0.35	0.42	0.32	0.36	0.29

Source: own elaboration based on a survey of cluster coordinators (N=6).

Table 43. List of selected measures for clusters according to the strategy (the strategy is in writing, it is not updated)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	int cluster internationalization -	Total for all areas
Minimum value	0.04	0.02	0.00	0.03	0.34	0.09	0.03	0.08	0.02	0.04	0.16	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.01	0.07
First quartile	0.06	0.02	0.01	0.06	0.41	0.16	0.07	0.15	0.05	0.21	0.22	0.03	0.00	0.07	0.04	0.10	0.10	0.14	0.04	0.14	0.11	0.00	0.03	0.05	0.12
Median	0.14	0.10	0.03	0.10	0.44	0.25	0.11	0.19	0.22	0.36	0.27	0.03	0.01	0.14	0.17	0.12	0.36	0.14	0.07	0.17	0.13	0.09	0.16	0.13	0.17
Mean	0.22	0.12	0.07	0.14	0.48	0.35	0.19	0.20	0.16	0.38	0.29	0.09	0.07	0.24	0.13	0.14	0.29	0.16	0.09	0.17	0.17	0.10	0.13	0.14	0.17
Third quartile	0.25	0.17	0.10	0.15	0.55	0.48	0.18	0.25	0.24	0.45	0.35	0.08	0.06	0.43	0.21	0.17	0.40	0.14	0.10	0.18	0.31	0.18	0.21	0.21	0.24
Benchmark	0.78	0.38	0.34	0.42	0.65	0.81	0.84	0.36	0.24	1.00	0.50	0.34	0.32	0.63	0.27	0.28	0.62	0.43	0.23	0.25	0.33	0.26	0.32	0.29	0.29

Source: own elaboration based on a survey of cluster coordinators (N=9).

Table 44. Summary of selected measures for clusters according to the strategy (the strategy is in writing and is updated)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.02	0.00	0.08	0.50	0.17	0.07	0.04	0.02	0.32	0.21	0.00	0.00	0.04	0.03	0.01	0.11	0.14	0.00	0.08	0.18	0.00	0.03	0.13	0.15
First quartile	0.20	0.09	0.14	0.15	0.69	0.27	0.33	0.29	0.23	0.70	0.46	0.10	0.11	0.18	0.17	0.31	0.39	0.46	0.22	0.33	0.27	0.21	0.24	0.25	0.28
Median	0.39	0.26	0.29	0.36	0.79	0.38	0.44	0.42	0.53	0.84	0.55	0.24	0.34	0.35	0.34	0.36	0.57	0.64	0.34	0.52	0.40	0.37	0.35	0.38	0.43
Mean	0.40	0.34	0.40	0.38	0.78	0.42	0.43	0.41	0.49	0.80	0.55	0.30	0.36	0.39	0.35	0.38	0.55	0.60	0.39	0.48	0.44	0.37	0.39	0.40	0.43
Third quartile	0.54	0.55	0.67	0.56	0.87	0.47	0.54	0.55	0.71	0.96	0.68	0.46	0.51	0.57	0.49	0.40	0.75	0.71	0.55	0.61	0.56	0.51	0.51	0.48	0.50
Benchmark	1.00	0.95	1.00	0.78	1.00	0.93	0.88	0.81	0.93	1.00	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	1.00	0.92	0.91	0.97	0.88	0.88	0.86

Source: own elaboration based on a survey of cluster coordinators (N=26).

Table 45. Summary of selected measures for clusters by industry (construction)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.02	0.05	0.00	0.03	0.41	0.04	0.00	0.07	0.00	0.29	0.13	0.08	0.01	0.00	0.05	0.06	0.00	0.00	0.00	0.04	0.13	0.00	0.03	0.07	0.06
First quartile	0.03	0.05	0.00	0.10	0.50	0.17	0.07	0.11	0.07	0.32	0.21	0.11	0.07	0.07	0.09	0.15	0.11	0.14	0.00	0.08	0.24	0.05	0.07	0.14	0.15
Median	0.14	0.28	0.13	0.11	0.51	0.33	0.25	0.44	0.51	0.71	0.49	0.20	0.12	0.26	0.16	0.18	0.17	0.14	0.01	0.12	0.33	0.12	0.09	0.15	0.18
Mean	0.26	0.37	0.37	0.33	0.60	0.29	0.26	0.36	0.41	0.63	0.42	0.29	0.30	0.25	0.28	0.33	0.23	0.37	0.26	0.30	0.33	0.22	0.22	0.26	0.32
Third quartile	0.42	0.58	0.70	0.67	0.69	0.39	0.45	0.58	0.54	0.81	0.56	0.49	0.40	0.36	0.42	0.54	0.39	0.71	0.45	0.53	0.37	0.44	0.30	0.36	0.51
Benchmark	0.67	0.89	1.00	0.75	0.90	0.51	0.54	0.59	0.91	1.00	0.73	0.57	0.88	0.55	0.67	0.74	0.46	0.86	0.85	0.73	0.61	0.51	0.61	0.58	0.69

Source: own elaboration based on a survey of cluster coordinators (N=5).

Table 46. Summary of selected measures for clusters by industry (chemistry, bioeconomy, materials engineering and energy)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.16	0.10	0.01	0.12	0.40	0.15	0.11	0.10	0.02	0.36	0.19	0.00	0.01	0.09	0.03	0.10	0.10	0.29	0.08	0.14	0.13	0.00	0.00	0.04	0.11
First quartile	0.22	0.15	0.01	0.14	0.61	0.30	0.44	0.27	0.40	0.71	0.48	0.24	0.23	0.26	0.26	0.32	0.55	0.61	0.24	0.49	0.24	0.28	0.33	0.33	0.34
Median	0.33	0.22	0.26	0.26	0.82	0.47	0.57	0.45	0.62	0.84	0.64	0.34	0.36	0.37	0.35	0.48	0.79	0.79	0.38	0.61	0.37	0.47	0.48	0.44	0.46
Mean	0.40	0.27	0.33	0.33	0.76	0.45	0.50	0.41	0.54	0.76	0.57	0.35	0.40	0.36	0.37	0.47	0.64	0.68	0.38	0.54	0.44	0.45	0.41	0.44	0.45
Third quartile	0.50	0.34	0.58	0.45	0.97	0.63	0.64	0.58	0.77	0.88	0.73	0.45	0.53	0.47	0.47	0.63	0.88	0.86	0.52	0.66	0.57	0.64	0.57	0.55	0.57
Benchmark	0.76	0.54	0.80	0.70	0.98	0.73	0.76	0.65	0.91	1.00	0.82	0.75	0.89	0.62	0.75	0.83	0.88	0.86	0.66	0.81	0.91	0.85	0.70	0.82	0.78

Source: own elaboration based on a survey of cluster coordinators (N=4).

Table 47. Summary of selected measures for clusters by industry (ICT)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.11	0.02	0.00	0.08	0.51	0.25	0.06	0.19	0.23	0.21	0.25	0.03	0.00	0.07	0.04	0.10	0.04	0.00	0.00	0.14	0.13	0.00	0.03	0.05	0.12
First quartile	0.18	0.12	0.02	0.10	0.54	0.35	0.14	0.30	0.24	0.68	0.45	0.07	0.02	0.41	0.21	0.15	0.45	0.00	0.23	0.18	0.19	0.22	0.25	0.26	0.28
Median	0.27	0.19	0.09	0.27	0.68	0.54	0.19	0.36	0.42	0.88	0.48	0.20	0.19	0.45	0.26	0.27	0.59	0.36	0.30	0.38	0.27	0.31	0.32	0.30	0.34
Mean	0.41	0.26	0.20	0.29	0.70	0.56	0.28	0.36	0.48	0.78	0.53	0.24	0.28	0.46	0.33	0.25	0.52	0.38	0.36	0.38	0.31	0.36	0.36	0.35	0.37
Third quartile	0.57	0.42	0.19	0.37	0.83	0.81	0.47	0.45	0.76	1.00	0.67	0.41	0.52	0.62	0.50	0.36	0.65	0.71	0.40	0.52	0.34	0.44	0.42	0.37	0.46
Benchmark	0.98	0.59	1.00	0.73	1.00	0.93	0.60	0.50	0.79	1.00	0.75	0.52	0.74	0.68	0.65	0.37	0.76	0.86	1.00	0.70	0.80	0.97	0.88	0.88	0.74

Source: own elaboration based on a survey of cluster coordinators (N=8).

Table 48. Summary of selected measures for clusters by industry (quality of life, tourism and recreation)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.04	0.00	0.00	0.03	0.26	0.09	0.00	0.04	0.00	0.00	0.16	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.01	0.07
First quartile	0.11	0.01	0.01	0.10	0.39	0.17	0.16	0.16	0.05	0.13	0.21	0.05	0.01	0.14	0.09	0.07	0.15	0.14	0.05	0.16	0.03	0.02	0.02	0.10	0.15
Median	0.28	0.07	0.04	0.15	0.50	0.21	0.29	0.25	0.20	0.33	0.29	0.22	0.24	0.16	0.18	0.23	0.22	0.29	0.15	0.20	0.18	0.07	0.16	0.13	0.18
Mean	0.31	0.21	0.17	0.23	0.54	0.26	0.28	0.29	0.24	0.42	0.34	0.18	0.24	0.26	0.23	0.21	0.28	0.30	0.22	0.25	0.23	0.13	0.16	0.18	0.24
Third quartile	0.53	0.32	0.31	0.31	0.74	0.39	0.33	0.41	0.36	0.69	0.44	0.29	0.35	0.31	0.33	0.31	0.40	0.50	0.40	0.32	0.36	0.20	0.24	0.20	0.31
Benchmark	0.63	0.88	0.61	0.71	0.87	0.48	0.84	0.66	0.66	1.00	0.65	0.43	0.80	0.84	0.62	0.47	0.62	0.57	0.56	0.56	0.80	0.52	0.52	0.51	0.61

Source: own elaboration based on a survey of cluster coordinators (N=11).

Table 49. Summary of selected measures for clusters by industry (automotive, aerospace production, transport)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.06	0.02	0.03	0.06	0.41	0.24	0.07	0.23	0.02	0.36	0.29	0.02	0.00	0.04	0.03	0.17	0.00	0.14	0.00	0.08	0.11	0.00	0.05	0.13	0.15
First quartile	0.26	0.06	0.15	0.15	0.72	0.32	0.13	0.27	0.18	0.53	0.35	0.05	0.05	0.21	0.16	0.18	0.43	0.29	0.16	0.32	0.30	0.22	0.14	0.23	0.23
Median	0.32	0.09	0.33	0.24	0.79	0.39	0.37	0.37	0.22	0.78	0.50	0.15	0.08	0.32	0.21	0.29	0.56	0.64	0.28	0.40	0.41	0.33	0.31	0.33	0.37
Mean	0.39	0.09	0.40	0.30	0.75	0.42	0.30	0.39	0.27	0.72	0.48	0.14	0.14	0.36	0.21	0.28	0.58	0.54	0.27	0.42	0.40	0.31	0.34	0.35	0.35
Third quartile	0.45	0.10	0.63	0.46	0.83	0.45	0.40	0.50	0.31	0.93	0.55	0.24	0.15	0.53	0.23	0.37	0.84	0.71	0.34	0.59	0.55	0.43	0.48	0.46	0.41
Benchmark	1.00	0.26	0.95	0.57	0.98	0.81	0.51	0.60	0.64	1.00	0.71	0.25	0.49	0.71	0.48	0.40	0.97	0.86	0.70	0.64	0.61	0.54	0.82	0.64	0.61

Source: own elaboration based on a survey of cluster coordinators (N=8).

Table 50. Summary of selected measures for clusters by industry (production and metalworking)

Standard	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovative activity	Cluster digitization	Cluster Processes - total for the area	Cooperation development	Development of innovation	Competency development	Cluster results - total for the area	Cooperation with the environment	Impact on shaping the environment	Environmental impact	Specialization and advanced technologies	Impact on the environment -	Internationalization potential	International activity	Export and pro-export activities	Cluster internationalization -	Total for all areas
Minimum value	0.04	0.03	0.00	0.03	0.44	0.24	0.18	0.18	0.05	0.45	0.27	0.00	0.00	0.11	0.08	0.28	0.33	0.14	0.10	0.25	0.19	0.00	0.17	0.21	0.17
First quartile	0.09	0.08	0.03	0.09	0.65	0.26	0.33	0.20	0.05	0.64	0.41	0.03	0.01	0.15	0.08	0.31	0.41	0.43	0.13	0.32	0.31	0.16	0.22	0.25	0.23
Median	0.16	0.34	0.03	0.14	0.67	0.28	0.46	0.23	0.37	0.71	0.42	0.09	0.10	0.21	0.11	0.33	0.49	0.57	0.21	0.37	0.46	0.22	0.27	0.26	0.26
Mean	0.24	0.40	0.24	0.29	0.68	0.31	0.48	0.35	0.42	0.71	0.49	0.31	0.30	0.34	0.32	0.45	0.56	0.60	0.30	0.48	0.46	0.32	0.37	0.38	0.39
Third quartile	0.37	0.59	0.31	0.42	0.68	0.31	0.54	0.34	0.68	0.79	0.53	0.49	0.51	0.23	0.37	0.37	0.57	0.86	0.33	0.52	0.54	0.37	0.34	0.37	0.44
Benchmark	0.54	0.95	0.83	0.78	0.96	0.47	0.88	0.81	0.93	0.96	0.84	0.94	0.89	0.99	0.94	0.95	1.00	1.00	0.72	0.92	0.80	0.83	0.88	0.84	0.86

Source: own elaboration based on a survey of cluster coordinators (N=5).

10.2. Statistical annex - opinion survey of cluster members

A total of 642 entities took part in the opinion survey of cluster members. Each cluster participating in the study was represented by min. 5 members. Summary results from the survey of members of all clusters are presented below.

Table 51. Results from the survey of cluster members[91]

Question	Answers
1. Role in the cluster:	
▪ Cluster membership without participation in the work of specialized bodies of the cluster (cluster board, cluster council, scientific council, audit committee, working group, etc.)	**73.5%**
▪ Delegating an employee/employees to 1 specialized body of the cluster	**19.3%**
▪ Delegation of employees to 2 or more specialized bodies of the cluster	**7.2%**
2. Representing the cluster in economic, social and scientific consultative bodies (e.g. NCBR[92], NCN[93]):	
▪ Yes	**10.2%**
▪ No	**79.0%**
▪ I don't know/I don't know	**10.8%**
3. Participation in shaping the cluster's strategy:	
▪ Yes, we were part of the cluster strategy team	**19.6%**
▪ Yes, we consulted the cluster strategy (although we were not members of the cluster strategy team)	**34.1%**
▪ No	**46.3%**

[91] In surveys obtained from cluster members, not all respondents commented on every possible form of joint market activity, hence the sum of partial answers in a given question is not always equal to the number of collected surveys.

[92] National Centre for Research and Development Poland.

[93] National Science Center Poland.

Question	Answers
4. Participation in the implementation of the cluster project[94]:	
▪ Yes	**43.5%**
▪ No	**56.5%**
[if there was an affirmative answer to question 4] 5. Participation in the implementation of an innovative and/or research and development project in the cluster:	
▪ Yes	**27.7%**
▪ No	**72.3%**
6. Employees of the organization participated in joint forms of raising professional competences initiated in the cluster (such as training, workshops, courses) in the last 2 years:	
▪ Yes	**60.7%**
▪ No	**39.3%**
7. Participation in the following forms of joint market activity in the cluster:	"Yes" | "No, but we would like to in the future" | " No, and we don't want to in the future"
▪ Product and/or service development and planning	**36.9%** | **51.8%** | **11.4%**
▪ Procurement (in raw materials and semi-finished products)	**13.7%** | **48.4%** | **38.0%**
▪ Production and/or performance of the service	**30.3%** | **54.6%** | **15.0%**
▪ Marketing and sales	**39.4%** | **45.7%** | **14.9%**
▪ Distribution	**17.9%** | **51.6%** | **30.6%**
▪ after-sales service	**16.6%** | **49.3%** | **34.1%**
▪ Export activities	**29.1%** | **48.6%** | **22.3%**

[94] With the participation of the coordinator and min. 2 members or with the participation of min. 3 cluster members without a coordinator. This approach to the cluster project also applies to questions 6-8.

Question	Answers
8. Using the following pro-innovation services provided in the cluster by or through the cluster:	"Yes" | "No, but we would like to in the future" | " No, and we don't want to in the future"
▪ Monitoring of technological trends	**38.3% | 45.0% | 16.6%**
▪ Technological audit	**20.9% | 48.2% | 30.9%**
▪ Commercialization plans	**23.5% | 45.9% | 30.6%**
▪ Consulting in the field of industrial protection	**17.2% | 46.7% | 36.2%**
▪ Specialized training	**47.2% | 45.6% | 7.2%**
▪ Digital transformation and the use of Industry 4.0 technologies (such as: Internet of Things, Big Data, Intelligent Industrial Robots, Data Cloud, Simulations, 3D Printing, automated, robotic and digitized production systems, etc.)	**34.6% | 51.5% | 13.8%**
▪ Green transformation (e.g.: use of the circular economy concept in operations, possession and implementation of environmental certificates for technologies (ETV) or for products (Ecolabel) and others, implementation of solutions resulting from energy efficiency audits, R&D works in the field of low-emission technologies or innovations technologies in the area of green economy, production and distribution of energy from renewable sources (e.g. own photovoltaic installations, heat pumps, biogas plants), implementation of low-emission economy projects conducted by the cluster coordinator or members.	**27.6% | 53.2% | 19.2%**
▪ Other technological consultancy	**32.1% | 49.1% | 18.8%**
9. Using services for internationalization provided in the cluster by or through the cluster:	
▪ No - we have not received an offer of internationalization services	**39.6%**
▪ No - we received an offer of services for internationalization, but we did not take it up	**26.8%**
▪ Yes - we have used internationalization services provided by or through the cluster	**33.6%**
10. Assessment of the achievement of development goals in the cluster:	"Unachieved" | "Average" | "Reached" | "I don't know/hard to say"
▪ Building a network of relations with cluster enterprises	**3.7% | 18.1% | 66.1% | 12.0%**
▪ Gaining access to tangible and intangible resources	**9.3% | 22.8% | 47.7% | 20.3%**
▪ Increasing the quality of products and services and/or reducing the cost of running a business.	**11.7% | 19.6% | 40.9% | 27.9%**
▪ Impact on public authorities and other institutions (e.g. educational)	**10.2% | 31.0% | 30.7% | 28.1%**
▪ Development of cooperation between cluster members	**4.1% | 20.7% | 64.9% | 10.3%**
▪ Creating local supply chains - faster access to production materials and the ability to choose a supplier, lower transport costs	**13.8% | 23.7% | 30.1% | 32.4%**

Question	Answers
▪ Joint marketing activities with partners from the cluster and greater possibilities of product distribution	**9.0% | 19.2% | 49.0% | 22.8%**
11. The scale of benefits from participation in the cluster for the period 2020-2021:	
▪ None	**2.8%**
▪ Small benefits	**20.4%**
▪ Big benefits	**53.6%**
▪ I don't know/hard to say	**23.2%**
12. Assessment of the adequacy of the contribution to the benefits obtained by the organization from participation in the cluster:	
▪ We get more than we expected with this amount of premium	**20.6%**
▪ What we get is adequate to the amount of the premium	**51.0%**
▪ We get less than we expected with this amount of premium	**8.2%**
▪ Not applicable (we do not pay a cluster membership fee)	**20.3%**
13. Readiness to pay higher membership fees provided that the coordinator provides additional services:	
▪ No	**89.3%**
▪ Yes	**10.7% (representing 22 clusters)**
▪ up to the amount (annually)[95]:	**PLN 10,500**
▪ in exchange for the following services[96]:	**The following were most often indicated: promotion, marketing, activities in the field of internationalization, training (including specialist training), networking within the cluster and with external entities)**
14. Improvement of the organization's activity on the market thanks to participation in the cluster:	"No" | "I don't know/hard to say" | "Yes"
▪ regional market	**19.1% | 30.8% | 50.1%**
▪ Domestic market	**22.1% | 30.4% | 47.5%**
▪ Foreign market	**31.7% | 33.0% | 35.4%**
15. Improvement of the functioning of the organization in the following areas:	"No" | "I don't know/hard to say" | "Yes"
▪ Number of sub-suppliers	**38.1% | 30.0% | 31.9%**
▪ Production volume, volume of services	**36.2% | 32.8% | 31.0%**
▪ Increasing revenue	**30.3% | 30.0% | 39.7%**
▪ Number of introduced innovations	**33.8% | 28.1% | 38.2%**

[95] Average for surveyed cluster members who answered "Yes", rounded to hundreds of zlotys.

[96] Original answers given by cluster members were presented (they were not edited).

Question	Answers
▪ The level of digitization and the use of Industry 4.0 technologies (such as: Internet of Things, Big Data, Intelligent Industrial Robots, Data Cloud, Simulations, 3D Printing, automated, robotic and digitized production systems, etc.)	**40.1% | 28.1% | 31.8%**
▪ Green transformation (e.g.: use of the circular economy concept in operations, possession and implementation of environmental certificates for technologies (ETV) or in terms of products (Ecolabel) or other, implementation of solutions resulting from energy efficiency audits, R&D works in the field of low-emission technologies or innovations technologies in the area of green economy, production and distribution of energy from renewable sources (e.g. own photovoltaic installations, heat pumps, biogas plants), implementation of low-emission economy projects conducted by the cluster coordinator or members.	**41.0% | 30.6% | 28.4%**
▪ Number of contractors	**28.5% | 25.5% | 46.0%**
▪ Number of new investments	**41.2% | 26.4% | 32.4%**
▪ Increase advancement technological	**37.4% | 21.5% | 41.1%**
▪ The amount of expenditure on research and development	**43.6% | 25.9% | 30.5%**
▪ Export height	**47.7% | 27.2% | 25.1%**
▪ Sourcing new customers / markets	**26.0% | 25.5% | 48.5%**
▪ Meeting the challenges of the COVID-19 pandemic	**35.6% | 33.7% | 30.8%**
16. Thanks to participation in the cluster, the organization introduced product innovations or business process innovations:	
▪ Product innovations (a service or product that is new or significantly improved)	**37.1%**
▪ Business process innovations (e.g. production methods, logistics, delivery or distribution methods, creation and provision of services, as well as new organizational methods)	**32.4%**
▪ We have not introduced any innovations	**50.9%**
17. Thanks to participation in the cluster, the organization established and/or intensified cooperation with scientific units:	
▪ No	**31.5%**
▪ I don't know/hard to say	**18.5%**
▪ Yes	**50.0%**
18. Thanks to participation in the cluster, the organization has established business relations with foreign partners:	
▪ Yes	**38.4%**
▪ No	**42.3%**
▪ I don't know/hard to say	**19.2%**
19. Assessment of resource availability in the cluster:	

Question	Answers
[rating scale from 1 - low score to 5 - high score] [97]	
▪ Research infrastructure	**4.0**
▪ Production infrastructure	**3.8**
▪ communication platform	**4.2**
▪ IT devices and software	**3.9**
▪ Financial instruments (e.g. loan and guarantee fund, venture capital, seed capital)	**3.5**
20. Assessment of the suitability of the research and production infrastructure in the cluster to the needs of the organization: [rating scale from 1 - low score to 5 - high score]	
▪ Research infrastructure	**4.1**
▪ Production infrastructure	**3.9**
21. Evaluation of the number of employees of the cluster coordinator employed to service the cluster:	
▪ Insufficient	**16.1%**
▪ Hard to say/I have no opinion	**30.6%**
▪ Sufficient	**53.2%**
22. Surveys of needs or satisfaction of cluster participants were conducted in the cluster:	
▪ No, they weren't conducted	**30.8%**
▪ Yes, they were conducted *ad hoc* (on an ad hoc basis)	**34.6%**
▪ Yes, they were conducted regularly (i.e. at regular intervals)	**34.6%**

[97] The following answers were available in the survey: "Low rating", "Average", "High rating", "I don't know/hard to say". To increase the readability of the analysis, the answers were quantified by presenting them in numerical form, where 1 means a low score and 5 means a high score. The average for the results of the cluster members was calculated. The answers to questions 20 and 24 are similarly presented.

Question	Answers
[if there were affirmative answers to question 22] 23. In the cluster, after the research on the needs or satisfaction of cluster participants, improvement actions are implemented (aimed at better meeting the needs and increasing the satisfaction of cluster participants):	
▪ They are not implemented at all	**0.7%**
▪ Yes, but only a few actions are implemented	**13.2%**
▪ Yes, numerous measures are being implemented	**56.7%**
▪ I don't know/hard to say	**29.4%**
24. Assessment of the activities of the cluster coordinator in the following areas: *[rating scale from 1 - low score to 5 - high score]*	
▪ Integration and development of relations in the cluster	**4.7**
▪ Market activity (e.g. common products/services, sourcing, distribution)	**4.2**
▪ Marketing activity (e.g. joint promotion)	**4.5**
▪ Innovative activity (e.g. pro-innovation services, innovation development)	**4.3**
▪ Activities for the digitization of the cluster / implementation of Industry 4.0 technology	**4.3**
▪ Actions for the green transformation of the cluster	**4.2**
▪ Development of cooperation in the cluster (e.g. joint projects)	**4.4**
▪ Development of cluster cooperation with external entities (e.g. R&D sector, business support institutions, other clusters)	**4.4**
▪ Development of competences in the cluster (e.g. training, courses)	**4.5**
▪ International activity (e.g. internationalization services)	**4.3**
▪ Responding to the challenges of the COVID-19 pandemic	**4.3**
25. Significant areas from the point of view of the organization in the next 2 years: *[rating scale from 1 - no to 5 - yes]*[98]	
▪ Integration and development of relations in the cluster	**4.7**
▪ Market activity (e.g. common products/services, sourcing, distribution)	**4.4**
▪ Marketing activity (e.g. joint promotion)	**4.6**
▪ Innovative activity (e.g. pro-innovation services, innovation development)	**4.5**
▪ Activities for the digitization of the cluster / implementation of Industry 4.0 technology	**4.3**
▪ Actions for the green transformation of the cluster	**4.2**
▪ Development of cooperation in the cluster (e.g. joint projects)	**4.7**

[98] The following answers were available in the survey: "No", "Average", "Yes", "I don't know/hard to say". To increase the readability of the analysis, the answers were quantified by presenting them in numerical form, where 1 means no and 5 means yes. The average for the results of the cluster members was calculated. The answers to question 26 are similarly presented.

Question	Answers
▪ Development of cluster cooperation with external entities (e.g. R&D sector, business support institutions, other clusters)	4.5
▪ Development of competences in the cluster (e.g. training, courses)	4.5
▪ International activity (e.g. internationalization services)	4.5
▪ Preparations for challenges related to situations of rapid change (e.g. as in the case of the COVID-19 pandemic, war in Ukraine, etc.) - increasing the so-called economic *resilience* _	4.3
26. Actions that the cluster should implement for the internationalization of cluster members in the next 2 years: *[rating scale from 1 - no to 5 - yes]*	
▪ Participation in foreign fairs	4.7
▪ Organization of international industry events	4.6
▪ Participation in foreign business trips (including economic missions)	4.7
▪ Initiating international projects	4.8
▪ Activities stimulating exports	4.6
▪ Opening of a representative office of a foreign cluster	3.7
▪ Implementation of services for the internationalization of activities	4.6
▪ Cooperation with foreign entities	4.8

Source: own elaboration based on surveys of cluster members (N= 642).

10.3. List of graphs

10.4. List of tables

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