PARP
PFR Group

Cluster benchmarking in Poland – edition 2022

General report

This report was commissioned by the Polish Agency for Enterprise Development as a result of a cyclical benchmarking study of clusters in Poland. The Polish Agency for Enterprise Development is not responsible for the opinions expressed in the study, which are the opinions of the authors and as such do not reflect the position of the Polish Agency for Enterprise Development, nor are they binding on it in any way.

Contents

1. Introduction

This publication was prepared as part of the sixth edition of the study entitled **"Cluster benchmarking in Poland - 2022 edition"**, serving to deepen knowledge about the condition and current state of cluster development in Poland, and carried out for the **Polish Agency for Enterprise Development (PARP).**

Benchmarking is a method of identifying the best practices for private and public sector organisations by comparing them with other reference organizations. The primary objective of the study was to identify and present the best standards and good practices selected in the clusters researched, as well as to make recommendations on the desired directions of cluster development, addressed to cluster coordinators and institutions responsible for the appearance of cluster policy in Poland. At the same time, it provides a basis for improving various aspects of the clusters' functioning in Poland.

The study covered 41 clusters from all over Poland (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

It is worth mentioning that the Polish Agency for Enterprise Development is one of the first institutions that has been involved in popularizing the idea of clustering in Poland, but also in direct support for cluster development. This activity, dating back to 2005, provides a strong basis for the Agency's active involvement in shaping and implementing the main directions of cluster policy.

2.   Glossary of key terms

3D production (additive manufacturing). The process of materializing a digital (virtual) 3D-model of an object by applying a layer by layer of material using a 3D-printer[1].

Arithmetic average. The sum of the variable values of all units of 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, allows you to optimize research and development and reduce 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 you to better control the purchases of customers and provide them with a greater experience[3].

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

Autonomous robots. A technical device that, in order to perform a given task, moves smoothly in a specific environment and, without the direct intervention of the operator, carries out, under the control of a supervisory system, a sequence of activities 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 functioning in the organization process for many years. It is a technique that allows you to learn best-in-class solutions and implement them through observation and existing examples.

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[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, PAED, Warsaw 2021.

Positive imitation, as the method can be called in another way, is a way of learning and adapting, devoid of the risk of making mistakes to a large extent[7].

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

Block chains (blockchain). A data structure in the form of a block chain that is combined to form a set of records, called the master ledger, with cryptography as a key component of the whole process. Applications of blockchain technology in the value chain, e.g. in clusters, may consist in their use in an integrated chain monitoring and control system, allowing for tracking the implementation of various stages of this chain, e.g. validation of product deliveries, verification of payments or increasing their security. This technology has no declared storage mechanism – instead, it has a set of protocols regulating how to grow the data string[9].

CATI (*Computer Assisted Telephone Interview).* Telephone interview conducted with the support of a computer program supporting the research process, in particular the mechanism of recording and archiving the obtained data[10].

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

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

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[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.

connected to the network regardless of location, flexibility to change the resources needed, measurability of the service and charging fees depending on the resources used[12].

Cluster coordinator. An institutional entity (hence also the term cluster organization) that organizes and animates the development of interactions, connections and cooperation in the cluster, and also provides specialized services to companies and other entities operating in 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 intensifying the growth and competitiveness of clusters in the region, involving cluster companies, government and/or the research community[14].

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

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

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

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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, PAED 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, PAED 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.

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

Cybersecurity (cybersecurity). Ensuring safe conditions for the use of digital technologies. In the case of Industry 4.0 technology, the risk related to cyber security is significantly increased. The problem of ensuring cyber security should be considered in two aspects: protection of digital infrastructure and data protection. Many current plants and production lines are insufficiently adapted to functioning in the digital world, therefore, with the implementation of new technological solutions enabling data flow and integration of various systems, it will be necessary to ensure their safe use[19].

Desk research. A research technique that consists in analyzing already available data (secondary/existing data) in order 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. Secondary data sources - before they are used - should be analyzed in terms of their credibility[20].

Digital platforms. Diversified technological solutions that allow overcoming territorial barriers and enable cooperation between two or more entities, often to an extent unavailable for traditional forms of cooperation[21].

Digitization (digitization). The process of converting individual analog streams of information into digital form[22].

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

DIH - Digital Innovation Hub. Institutions supporting the digital transformation of enterprises in order to increase their market competitiveness through the use of innovative solutions in the

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[18] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.

[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.

field of broadly understood digital technologies. They are selected in a competition at the national level (organized by the minister responsible for the economy)[24].

EDIH - European Digital Innovation Hub. EDIHs are centers that gather knowledge and competence in the field of digital transformation of business. Their role is to help increase the competitiveness of companies by supporting them in the process of digital transformation. They are selected at the European level[25].

ESG. An approach that takes into account environmental, social and corporate governance criteria (Environmental, Social and Governance - ESG) in assessing the organization's activities in non-financial terms in order to motivate the integration of the concept of sustainable development with strategic management[26].

Expert method. A research method from the group of qualitative methods, consisting in formulating conclusions based on group judgments, in which the aim is to select a variant consistent with the opinion of the majority or all experts who are people with knowledge and experience in the researched area[27].

Expert. A person with specialist knowledge in the field of clustering, at the same time having experience in conducting empirical research using interview questionnaires[28].

Good practices (best practices). The concept of good practices comes from the sphere of organization management and is directly related to benchmarking. [...] Good practices are not new solutions, they are actions proven in practice, actions previously successfully applied in other organizations. Their implementation is aimed at improving the performance of the organization, increasing its efficiency and 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 the Internet of Things technology in industry, in particular for measurement, supervision and management of dispersed assets, as well as processing of the obtained data in order to acquire knowledge, manage processes, systems and value chains, as well as optimize their operation. According to research, four typical stages of

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[24] Description of the subject of the contract for the Benchmarking of clusters in Poland study - 2022 edition, PARP, Warsaw 2021.

[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, PAED, 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.

the implementation of the Internet of Things are: 1) objects are networked, 2) monitoring of objects is introduced, 3) entities use the collected data to optimize processes, 4) companies transfer the acquired information to their product range and develop new offers and services[31].

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 according to which objects and devices can collect, process and exchange data with each other using communication networks, in particular the Internet. Thanks to the measurement of the effectiveness of individual operations and the automation of business processes, quality is improved, predictability is increased and costs are reduced. It is therefore a complex ecosystem of technologies, including modules and devices, means of communication, platforms built specifically for it, mass storage, servers, analytics software, IT services and security[33].

IT system. A time, spatial, technical, technological and logical part of the information system of a given organizational object (enterprise, institution), the task of which is to acquire, process and provide decision-makers with the necessary data and information for decision-making management processes, implemented using computer technology[34].

Median. The median divides the ordered population into two equal parts in such a way that 50% of individuals have trait values lower and 50% higher than the 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 the following criteria: 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: creating innovative socio-economic solutions, increasing the added value of the economy and increasing its competitiveness on the international arena[37].

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[31] Bartkiewicz W., Czerwonka P., Pamuła A. (2020). Modern tools for the digitization of organizations, Łódź: University of Łódź Publishing House.

[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).

Normalization. The purpose of normalizing variable values is to bring the variables into comparability. This is achieved by depriving the measurement results of their denominations and unifying their orders of magnitude[38].

Polish Classification of Activities (PKD). Conventionally accepted, hierarchically structured division of a set of types of socio-economic activity, adopted for use in statistics, records and documentation and accounting, as well as in official registers and information systems of public administration[39].

Quartiles. Values of the examined feature that divide it into specific parts in terms of the number of units. The first quartile divides the ordered population into two parts in such a way that 25% of units have lower and 75% higher values than the first quartile. The third quartile divides the ordered population into two parts in such a way that 75% of individuals have values lower than and 25% higher than the third[40] quartile.

Regional Smart Specialization (RIS) - regional smart specialization means identified, unique assets and resources of the region, emphasizing the competitive advantage and bringing together regional partners and resources. EU Member States were obliged to introduce RIS at the regional level as a tool for specialization and increasing competitiveness[41].

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

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

Stimulant. A variable whose high value is desirable from the point of view of the general characteristics of the phenomenon under study[44].

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[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.
[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.

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

Support institutions (business environment). An organizationally diverse group of non-commercial institutions active in the area of supporting entrepreneurship and self-employment, technology transfer and commercialization and improving the competitiveness of SMEs[46].

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

Unitarianization. Normalization of variables in order to obtain a uniform range of variation (equal to constant 1), defined - in classical terms - 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. Basic 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].

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[45] Ibid.

[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.

3.   Summary

The current edition of the Cluster Benchmarking in Poland study is a continuation of the series of studies started by PARP in 2010. Previous studies were carried out in 2010, 2012, 2014, 2018 and 2021. This report for the 2022 edition presents the results of the study of 41 selected clusters in Poland and 642 of their members.

The report contains the most important conclusions on the state of cluster development in the period covered by the study, i.e. in 2020-2021. The further part of the study includes an analysis of good practices and recommendations addressed to various groups of stakeholders, including cluster coordinators, as well as entities from the cluster environment, government and local government administration institutions shaping cluster policy in Poland.

The most important results of the study are presented below:

1. benchmarking analysis was conducted in 5 main areas. The research results at the level of these areas were as follows:

    a. **Cluster resources** - display a moderate median value (0.28) with a moderately high benchmark value (0.78). In the surveyed population, there is no clear leader when it comes to the area of resources (receiving maximum marks for most of the partial indicators). At the same time, at least half of the clusters achieve quite good results in this area. Both in terms of the median and the benchmark, the area of human resources in the cluster was rated the best (0.28 and 1.00, respectively). Relatively low values of the median for the sub-area of infrastructural resources (0.13) and financial resources (0.14) mean that at least half of the examined clusters achieve very poor results. The best results were obtained by very large clusters (121 and more members[50]), having the status of KKK, operating since at least 2009 and having an orderly situation in terms of strategic documents (strategy written down and subject to updating). In geographical terms, the best results are achieved by clusters located in the southern macroregion. In terms of industry, there is no clear group of leaders. In this case, we can talk about relatively poor results obtained by the construction industry and the production and processing of meta*ls.* For subsequent areas, information about the leaders of the rankings is repeated.

    b. **Cluster processes** – display a very high median value (0.46) with a relatively high benchmark value (0.84). The clusters present an even level (as in the case of the

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[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).

previous edition of the survey). At least half of the clusters can be assessed as good or very good in processes. The best rated sub-area is the digitization of the cluster (median 0.71) and management processes (0.68), and the lowest rated is innovative activity (0.24). In the area of processes, apart from very large clusters established by 2009, good results are also achieved by large clusters and those established in 2010-2014. There are no clear differences when it comes to the location of clusters. The leader is still the southern macroregion. But they have no advantage in the case of cluster resources. The lowest scores are achieved by clusters regarding the quality of life, tourism and recreation.

c. **Cluster results** – show a quite low median value (0.22) with a very high benchmark value (0.94). At least half of the clusters achieve very low results in this category. There is at least one cluster that can be considered a clear leader. The sub-area of competence development was rated the best (median 0.30) and the development of innovation in the cluster the lowest (0.13). Similar results are achieved by large and very large clusters. For industries, the best group of clusters are within the chemistry, bioeconomy, materials engineering and energy sectors. The clusters with the lowest scores belong to the sectors of metal production and processing as well as construction.

d. **Impact on the environment** – show a moderate median value (0.32) with a very high benchmark value (0.92). A large spread between the median and the benchmark means a significant differentiation of the level of development of clusters in this area. The list includes at least one cluster that can be considered a clear leader. The sub-area of influence on shaping the surrounding conditions and impact on the natural environment was rated the best (median 0.45 and 0.44, respectively) and specialization and advanced technologies the lowest (0.23). As in the case of the cluster's resources, the eastern macroregion has a clear advantage. Regarding industries, the group of clusters representing chemistry, bioeconomy, material engineering and energy, are definite leaders. The weakest group includes construction, quality of life, tourism and recreation.

e. **Cluster internationalization** – display a low median value (0.22) with a relatively high benchmark value (0.88). A large spread between the median and the benchmark means a significant differentiation of the level of development. At least half of the clusters achieved very low results in this area. There is at least one cluster that can be considered a clear leader. The sub-area of internationalization potential was rated the best (median 0.34) and international activity the lowest (0.22). In the area of internationalization, better results are achieved by clusters established in 2010-2014 than clusters established before

2009. Again, clusters in construction, quality of life, tourism and recreation perform the worst.

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

   a. **Cluster resources**. Compared to previous benchmarking, we can see an increase in the number of people serving the clusters (1-2 people declared 10 out of 41 clusters, with an average of 6.1 people). 53% believe that this number is sufficient and 16% believe otherwise. Researchers actively participate in the work of the cluster and on average, about 22 scientists work with a given cluster. Research infrastructure is made available by 22 clusters (average area of 3.6 thousand m2), with 16 clusters having invested in this infrastructure in 2020-2021. In turn, the production infrastructure is provided by 16 clusters (average area of 1.7 thousand m2) with only 9 clusters investing. Clusters actively use IT platforms, which are primarily used for communication (83% of clusters), knowledge repository (51%) and cooperation management (41%). The budget of the surveyed clusters in the period 2020-2021 was very diverse (average 4.2 million PLN with a median of 122,000 PLN). 13 clusters had a budget exceeding 1 million PLN, while for 11 clusters it did not exceed 100,000 PLN. zloty. Public funds are one of the sources of financing clusters (25 clusters declared their acquisition, with an average value of 2.8 million PLN and a median of 45,000) PLN. Ensuring access to financial instruments is of little importance in the activity of clusters where loan funds and venture capital are often available (each of these forms is available in 19% of clusters).

   b. **Cluster processes**. Approx. 63% of clusters have a written strategy that is updated. The development of the strategy is often associated with the involvement of cluster members (54% of the surveyed representatives of this group confirmed this). Most of the clusters (95%) conducted research on the needs/satisfaction of cluster members, but only in the case of 34% of clusters was it done on a cyclical basis. Among the members, entities declaring great benefits from participation in the cluster prevail (70%). This is a significant improvement compared to the previous edition of the study when indications of high benefits concerned approx. 50% of members. Regular meetings are an important area of cluster activity. On average, 20 meetings were held in the surveyed clusters per year (a double increase compared to the previous edition of the study, which can be explained by the COVID-19 pandemic and the organization's transition to remote mode). Thanks to the presence in the cluster, approx. 48% of members established business relations with foreign partners. The stages of the value chain are also supported within these clusters. This applies in particular to marketing and sales as well as production and planning of

products and/or services. About ¾ of the surveyed cluster members highly evaluate the activities of coordinators in terms of supporting individual elements of common value chains. In terms of market activity, the best-rated activities relate to integration and development of relations in the cluster (85 high scores from members). For marketing activity, clusters most often take action in creating a cluster logo, advertising and public relations. 31 clusters took part in fairs, exhibitions and other national events for promotion purposes. In the case of innovative activity, coordinators provide members with access to pro-innovation services, such as specialized training (30 clusters), innovation consulting (28) and monitoring of technological trends (24). In 61% of clusters there is an institution supporting technology transfer, and in 34% knowledge and technology are purchased. In terms of digitization, IT systems for customer relationship management (80%), resource management (68%) and document management (66%) were most often used. Among the 13 Industry 4.0 technologies, widely understood IT systems (80%), cybersecurity solutions (73%) and 3D production (71%) are the most commonly used.

c. **Cluster results**. Within this area, research was centered on the development of cooperation in the cluster. Among others, the assessment implemented projects, creating a joint offer and obtaining orders for implementation. These projects co-financed from public funds were implemented in 32 clusters. This is a significant increase compared to the previous edition of the study (19 clusters). Over 43% of cluster members participated in these projects. The average value of these amounted to nearly 23 million PLN with a median of 2.1 million PLN. Considering the sales area; joint production/provision of services was recorded in 25 clusters with an average number of 7 members involved in this activity. Coordinators can play an active role in winning contracts. Such a situation took place in 19 clusters. A significant part of the projects indicated earlier concerned the implementation of innovations and conducting R&D work (27 indicated that they have implemented such initiatives with an average number of 4 projects). The implementation of these projects significantly contributes to product innovations (24 clusters) and process innovations (20 clusters) and technology transfers (22 clusters). In total, 638 product innovations and 373 process innovations were declared, which shows an approximate increase of 50% compared to the previous edition of the survey. Coordinators also support raising competences among their members, e.g. in the form of training, workshops, courses, conferences and seminars, and the organization of post-graduate studies (only 2 clusters did not indicate any activity in this respect). Participation in these activities was declared by 61% of cluster members.

d. **Impact on the environment**. One of the manifestations of this environmental cooperation are signed agreements. Active agreements were declared with public authorities - 26 clusters, with business environment institutions - 32 clusters and institutions of the R&D and education sector - 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 often of an individual nature with selected scientists (73%) institutions in the field of didactics (66%) and project implementation (61%). Clusters participating in the study declared the implementation of 1,310 internships and 1,092 apprenticeships, which can be considered a very high result. Cluster representatives often sit on various types of bodies (activity indicated by 34 clusters). They can often undertake activities that have a positive impact on the environment (e.g. in the area of CSR, support for educational activities, co-organization of social events or direct support for local non-governmental institutions). Such activity was declared by 28 clusters. Another area of their impact on the environment, are activities aimed at improving the condition of the natural habitat. In this regard, the use of the circular economy concept, the implementation of solutions resulting from the energy audit (59%), R&D works in the field of low-emission technologies (54%) and the production and distribution of energy from RES (54%) were most often indicated. The last element of the analysis in this area was specialization and advanced technologies. On average, 64.8% of the cluster's enterprises operate in the area of KIS (National Intelligent Specialization leading in the cluster), and 62% in the area of RIS which is dominant for the cluster. Significantly fewer cluster enterprises (34.8%), in turn, operate within KETs - technologies conditioning the future development of the EU (Key Enabling Technologies).

e. **Cluster internationalization.** Internationalization is perceived as a new stage in the development of clustering, in which the undertaken activity may significantly translate into the improvement of the situation of cluster members. 34 clusters offered support to their members in the field of internationalization by offering various types of services (the average number of these services is 6.4). At the same time, about 34% of cluster members participating in the study used these services. Most of the clusters (30) have at least one foreign language version of their website. This means that 11 clusters should consider creating their online business card with an English version. 28 clusters have signed cooperation agreements with foreign entities, where the average number of agreements per cluster exceeds 5. Over 2/3 of clusters (27) implemented international projects

and partnerships. The average value of these projects per cluster was 10.6 million PLN (with a median of 0.3 million PLN, which means a large variation in terms of project value). 29 clusters were involved in the organization of international events. 20 clusters declared the presence of entities with foreign capital among their members (mostly in the area of ICT and automotive). They are very active in organizing trips to fairs, exhibitions and other events abroad. In total, over 870 trips of this type were organized. This is largely due to sub-measure 2.3.3. Internationalization of National Key Clusters under the Operational Program Smart Growth. They also organize incoming missions for foreign clusters (24 with such activity).

In both areas and sub-areas of the study, as well as partial indicators, large or very large clusters, with the status of the National Key Cluster, established in the period before 2010 and in the years 2010-2015 and having a written strategy subject to updating, had an advantage.

3. In some sub-areas, exceptions to the above rule can be indicated,
    but they are most often industry-specific. An example may be ICT clusters gaining an advantage in digitization. Clusters in the field of chemistry, bioeconomy, material engineering and energy gaining an advantage regarding impact on the environment.

4. The number of cluster members was positively correlated with the result of the averaged benchmark value. This is because of indicators such as: cluster budget, employment in member entities and the number of organized events. Thus, large clusters automatically had an advantage over smaller ones. The exceptions were indicators that measured the percentage of occurrences of certain situations (e.g. the percentage of members operating in the field of high technology[51]). Nevertheless, the relationship between the number of members and the benchmark is clear (the greater the number of members, the higher the average value of the benchmark).

5. **Strengths and weaknesses of clusters.** In assessing the strengths and weaknesses of clusters, the value of the median of scores obtained in individual sub-areas was used. The strengths were those of the examined elements for which the median score for the entire group of clusters under study exceeded 0.30, while the weaknesses were those elements for which the median did not exceed 0.20. Compared to the previous edition, this is an increase in the value of these indicators and a reduction in the number of cluster weaknesses, which results primarily from generally better results of the current edition of the survey.

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[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.

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 a survey of cluster coordinators (N=41).

6. As part of the study, several dozen **good practices** implemented by national clusters were identified. Most willingly shared their achievements. According to the research methodology, 13 national and 3 foreign good practices were selected and described. For each of the good practices, a key area and other areas to which it applies have been indicated. Most often, the subject of good practices was cooperation with the environment (4 clusters), development of cooperation in the cluster and innovative activity (3 each).

7. The summary of the report is a list of recommendations addressed to various categories of institutions (including government and local government, cluster coordinators, business environment institutions as well as universities and other entities of the higher education and science system). Recommendations cover the following areas: system for the implementation of public tasks by clusters, processes related to the development and internationalization of clusters and cluster members, development of clusters' offer and cluster networking, unifying the approach in the area of cluster reporting (calls for KKK, benchmarking, European badges), impact on the external environment, including the natural environment and the implementation of modern solutions and technologies.

4.   Methodological introduction

4.1.   Research methodology

Benchmarking is a method of identifying exemplary operating practices of organizations from the private and public sectors by comparing them with other organizations. The main objective of the study was to identify and present the best models and good practices identified in the surveyed clusters, as well as to formulate recommendations regarding the desired directions of cluster development, addressed to cluster coordinators and institutions responsible for the shape of cluster policy in Poland. Thus, it provides a basis for improving various aspects of the functioning of clusters in Poland.

The basic assumption adopted in the concept of cluster benchmarking was to perform a comprehensive and cross-sectional analysis of clusters, therefore the logic and structure of the entire study was based on two integral elements:

- Cluster characteristics - a set of basic characteristics, which were used, among others, to perform cross-sectional analyzes as part of benchmarking (e.g. comparing clusters by age, size, location, industry specialization). The distinguished areas of cluster characteristics are: their formalization, size, geographical concentration and sectoral concentration (including in terms of KIS and RIS).
- Cluster benchmarking – comparing the state of development of clusters in various areas of their functioning together with the presentation of good practices used.
  As part of the adopted methodology, a division into 5 main areas of benchmarking and 19 detailed sub-areas was applied.

41 clusters from all over Poland took part in the sixth edition of the benchmarking. The study was carried out in the fourth quarter of 2022, and as part of it:

- interviews were conducted with the coordinators of 41 clusters participating in the benchmarking study;
- an opinion survey of 642 members participating in the survey using the CATI method and, additionally, CAWI was carried out;
- good practices were developed (based on the knowledge acquired as part of the desk research analysis and in-depth individual interviews of both Polish and foreign clusters).

The next step was to develop a general report and reports dedicated to each of the clusters participating in the study.

Opinion surveys of members were used to assess the perception of benefits and satisfaction of belonging to a cluster and were also used to confirm and verify the data obtained in the survey

of cluster coordinators. Data collected during interviews with cluster coordinators were verified by researchers and supplemented with information collected in the desk research analysis.

In total, 90 indicators concerning the functioning of clusters were analyzed, on the basis of which the state and level of development of clusters in Poland was determined for the period covered by the study (2020-2021). The list of the examined areas and sub-areas is presented in the table below.

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 needed to estimate the value of 88 indicators was collected on the basis of research cluster coordinators. The estimation of the 2 indicators was based on the analysis of secondary data carried out 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).

As part of the study, the above-mentioned areas were analyzed both for the entire group of clusters, as well as for individual groups. The report presents cross-sectional analyzes according to the following criteria:

1. **Cluster status:** having the status of a National Key Cluster, no status with plans to obtain and no status without plans to obtain.
2. **Cluster size:** small (this study assumes 20-47 members), medium (48-77 members), large (78-120 members) and very large (121 and more members).
3. **Cluster age:** mature (created before 2010), clusters created in 2010-2014 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, transportation;
   - metal production and processing.

The comparison was made on the basis of unified indicators - the values of individual indicators were reduced to the form in the range from 0 to 1 (to enable, among others, averaging and comparing the results). The comparison and analysis within cluster benchmarking was made using the following indicators:

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

Within these indicators, various combinations of their values could occur. Interesting from the point of view of the analysis of cluster phenomena are, among others:

- **Low value of the median** (close to 0) – at least half of the clusters obtained very poor results compared to the others.
- **High benchmark value** (close to 1) – one or a certain group of clusters achieved a very high position in benchmarking, clearly distancing other clusters.

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[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 was evenly distributed in a given area or sub-area of benchmarking
(there is no strong leaders among any group of clusters nor weak clusters).

Finally, it is worth noting that it is not possible to fully compare the benchmarks from the previous and the current edition, which results from changes in the list of indicators and a different list of clusters.

4.2.   Cluster selection

The following criteria were used to select clusters for the study:

- the cluster must have had a legal form and been active for at least three years;
- the cluster had to have an appropriate critical mass (at least 20 cluster members);
- the cluster had to have a specific organizational form (formalized cooperation of its constituent entities);
- there was a geographical concentration of the majority of cluster members, which means that more than half of the cluster members were located within a distance of not more than 200 km from the seat of the Cluster Coordinator;
- the sample included clusters representing various sectors of the economy.

Efforts were also made to include in the sample clusters representing each of the voivodships of Poland (through the coordinator's seat), but this was not achieved due to the lack of entities meeting the criteria qualifying for the study (this applies to the Opolskie and Warmińsko-Mazurskie voivodeships).

Summing up the recruitment process, some of the created merged database of about 80 active clusters[53] were rejected due to the lack of fulfillment of the above criteria or no activity. From the final number of approximately 60 clusters meeting the requirements, 41 clusters with characteristics reflecting the cluster environment in Poland took part in the study. The clusters selected for the study represented the KKK (16 with the current status in August 2022), as well as clusters that did not have such status (25). The examined clusters differed in the period of operation, critical mass and industry specialization.

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

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[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.

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
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
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

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
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
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

No.	Cluster name	Established year	Number members	Dominant sector (by NACE section)	The voivodeship where the cluster coordinator has its seat
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.

Taking into account the year of establishment, the study was dominated by clusters that were established in 2010–2015 (22) and before 2010 (14). It was a period in line with the financial perspective 2007–2014, under which instruments aimed at supporting the creation of clusters were available in Poland.

At the stage of recruiting clusters for the study, it turned out that in the period after 2015, a group of newly established clusters was identified, but most of them did not meet the criteria for the period of operation and the minimum number of members, and therefore did not participate in the study. 5 clusters established after 2015 participated in the study.

Graph 1. Characteristics of clusters participating in benchmarking - year of establishment
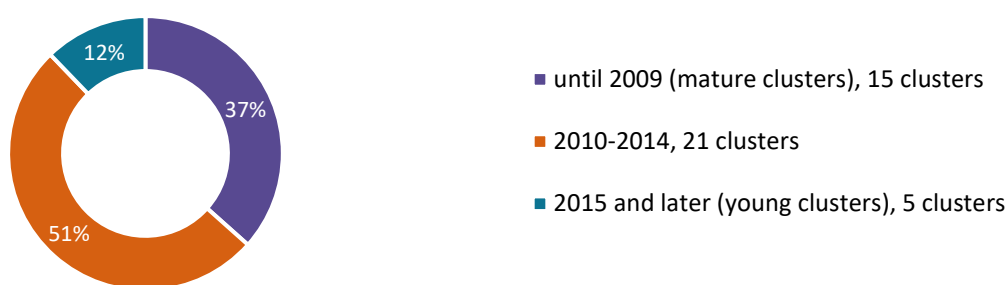
- until 2009 (mature clusters), 15 clusters
- 2010-2014, 21 clusters
- 2015 and later (young clusters), 5 clusters

Source: own elaboration based on a survey of cluster coordinators (N=41).

Taking into account the number of members, the clusters were divided into four groups of similar size: small clusters with 20-47 members (10), medium clusters with 48-77 members (10), large clusters with 78-120 members (10) and very large with over 120 members. The average number of members in all examined clusters was 102.6.

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

- small (20-47 members), 10 clusters
- medium (48-77 members), 10 clusters
- large (78-120 members), 10 clusters
- very large (121 and more members), 11 clusters
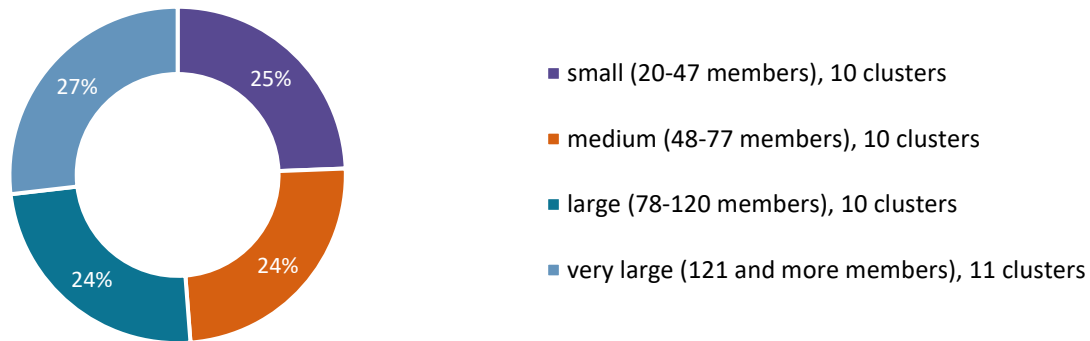
Source: own elaboration based on a survey of cluster coordinators (N=41).

The largest clusters in terms of the number of members at the stage of 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 more than 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 is worth noting that the above clusters operate in the sector of broadly understood services. It can be argued that in the area of services it is relatively easier to build a cluster with a large number of members, which, however, will not necessarily meet all the requirements for obtaining the status of a KKK.

The total number of members of all surveyed clusters, according to the submitted declarations, amounted to 4,208 at the end of the surveyed period (an increase of 16.8% compared to the previous edition of the survey), i.e. an average of 103 entities per cluster. The number of unique entities was lower by approx. 8%, as some of them were members of more than one cluster. This concerned in particular, business environment institutions, universities and other entities of the higher education and science system.

In the period covered by the benchmarking (i.e. in the years 2020-2021), an increase in the number of members was recorded. In total, the clusters participating in the benchmarking declared the acceptance of 809 new members. In the same period, the number of cancellations was 307.

The structure of clusters was dominated by enterprises (84%), followed by universities and other entities of the higher education and science system (6%), regional government units (5%), business environment institutions (4%) and the category "other" including e.g. educational institutions, health facilities or individuals (1%). In total, 3,534 enterprises were members of the surveyed clusters (increase by over 400 compared to the previous edition), 237 universities and entities of the higher education and science system (decrease by 5), 182 business environment institutions (decrease by 13) and 40 local government units (without changes).

<p style="text-align:center; color:#C00000;">Graph 3. Characteristics of clusters participating in benchmarking - type of entities</p>

- enterprises, 3 534 entities
- universities and other entities of the higher education and science system, 237 entities
- business environment institutions, 182 entities
- local government units, 40 entities
- other, 215 entities
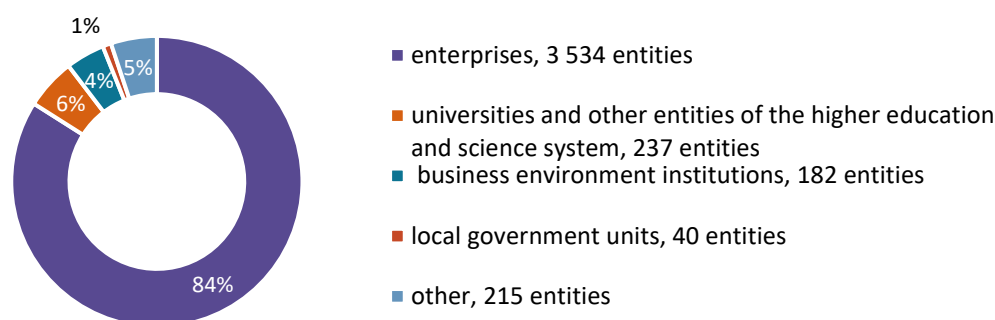
Source: own elaboration based on a survey of cluster coordinators (N=41).

The structure of enterprises being members of the surveyed clusters was also analyzed from the point of view of the size category. In this respect, the largest group were micro-enterprises (38%), followed by small enterprises (32%). A similar share concerned medium-sized and large entities in the structure of clusters (18% and 12%, respectively). The share of medium-sized and large entities in clusters was much higher than the share of these groups among all enterprises registered in the country[54].

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[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%.

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

- micro enterprises, 1 348 enterprises
- small enterprises, 1 121 enterprises
- medium enterprises, 652 enterprises
- large enterprises, 413 enterprises
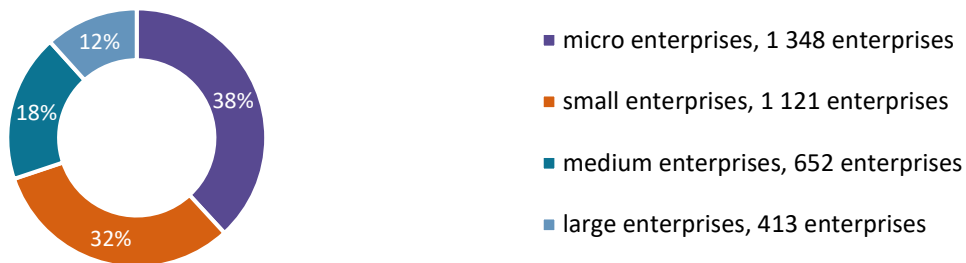
Source: own elaboration based on a survey of cluster coordinators (N=41).

Despite a relatively small number, business environment institutions play an important role in clusters. They can perform a number of functions. In the case of some clusters, they perform coordinating functions (especially in the case of regional agencies and advisory institutions). In addition, they can support a number of areas of cluster activity, in particular in the field of education, technological consulting and project engineering (support for project implementation throughout the entire life cycle, from obtaining financing, through implementation support, to material and financial closure).

Represented business environment institutions in clusters may be characterized by different levels of development and quality of services offered. An important determinant confirming the high position of a given unit is having the status of an innovation center accredited by the Ministry of Tourism and Technology, or having the status of Digital Innovation Hub (DIH), European Digital Innovation Hub (EDIH) or candidate status for EDIH.

Innovation centers include entities dealing with the transfer of technology and the provision of pro-innovation services as well as cooperation with business. The assumed effect of their activity is the development of innovation in the product and process aspect. Currently, the status of an accredited innovation center is granted by the Ministry of Development and Technology (the last recruitment ended 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

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[55] Innovation Centres, Ministry of Entrepreneurship and Technology, www.gov.pl/web/ Rozwoju-technologia/osrodki-innowacji (accessed on April 19, 2023).

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 justified to make efforts to include centers of this type in their structures (especially in the case of clusters considering applying for the status of a KKK).

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

■ Yes, 10 clusters

■ No, 31 clusters

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

Cluster members (usually business environment institutions) may also have the status of digital innovation hubs (DIH, EDIH or candidate for EDIH). Ultimately, they are a bridge between the entities creating the demand for services in the field of digital transformation (entrepreneurs and public administration whose activities may benefit from digital transformation) and their existing supply (providers of ready-to-implement technologies, entities providing education, training and support services, startups)[57].

Amongst members of clusters participating in benchmarking, the share of members of organizations with the status of DIH, EDIH or candidate for EDIH was relatively small (6 clusters with confirmed participation).

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[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).

[57] www.parp.gov.pl/component/content/article/83396:next-meeting-from-the-cycle-idea-of-your-business-development-european-digital-innovation-hubs-know-how-services-and-support- from-the-scope-of-digital-transformation-for-entrepreneurs (accessed on April 19, 2023).

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

- Yes, 6 clusters
- No, 35 clusters

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

At the same time, several clusters not participating in the current edition of benchmarking were identified, in which organizations of this type were members (these clusters were most often of a technological nature and did not meet some of the conditions for participation in the study).

The study took into account the regional division. Efforts were made to maintain a situation in which each geographical area would be represented by min. 4 clusters. Finally, a division covering macroregions was taken into account for further analysis (with the central macroregion covering both Mazowieckie, as well as Łódzkie and Świętokrzyskie voivodships). The most numerous is the eastern macroregion (12 clusters). It covers the Podlaskie, Lubelskie and Podkarpackie voivodeships. In this macroregion all clusters participating in the study were created by 2014.

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

- eastern, 12 clusters
- central, 8 clusters
- south, 6 clusters
- north, 5 clusters
- southwest, 5 clusters
- northwest, 5 clusters

Source: own elaboration based on a survey of cluster coordinators (N=41).

Looking at the geographical concentration of clusters broken down by voivodeships as part of the study, an attempt was made to acquire clusters from each province in Poland. However, some regions are characterized by low cluster activity, therefore two of them are not represented in the benchmarking (Warmińsko-Mazurskie and Opolskie Voivodeships). The Lubelskie, Dolnośląskie and Mazowieckie voivodships were the most numerous (5 each).

Graph 8. Characteristics of the clusters participating in the benchmarking - seat of the cluster coordinator
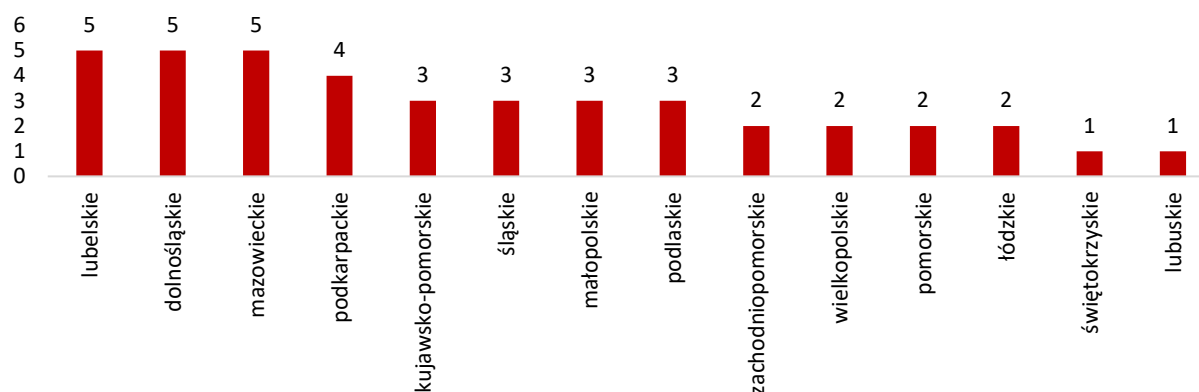
Source: own elaboration based on a survey of cluster coordinators (N=41).

The studied clusters are still characterized by a significant level of geographical concentration. The average percentage of members located in the province where the coordinator has its seat is 70.7% (with a median of 74.0%). Clusters with the lowest level of concentration include structures with a large or very large number of members (over 100) or clusters with a narrow technological specialization (e.g. photonics, composite technologies, information technologies in construction). In the second case, clusters concentrate leading centers developing a given technology from all over the country.

Considering the number of members from a region other than the seat of the cluster coordinator, the leader of the list is the province of Mazowieckie (300), then Podkarpackie (147), Wielkopolskie (125) and Śląskie (122). The list also includes entities from the Warmińsko-Mazurskie (69) and Opolskie (34) voivodships, where there are no clusters participating in benchmarking. The data is presented in the next graph.

Graph 9. Characteristics of clusters participating in benchmarking - number of members from a region other than the seat of the cluster coordinator
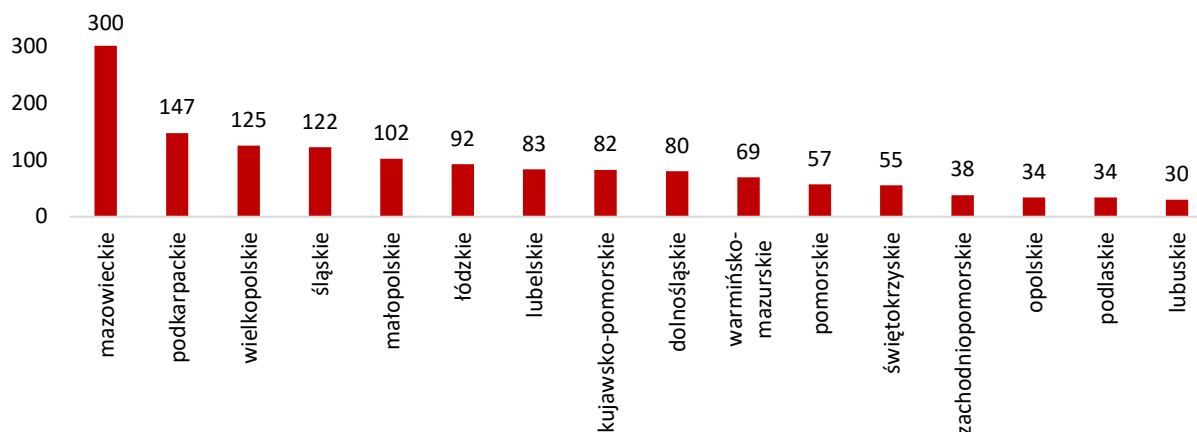
Source: own elaboration based on a survey of cluster coordinators (N=41).

Only in 7 clusters are there foreign entities among the members, and their number is marginal in the total number of all cluster members (less than 0.5%). Among the countries with the presence of members in Polish clusters, it is possible to indicate mainly border countries: Ukraine, Germany and the Czech Republic.

Among the surveyed clusters, relatively few (10) have the European Clusters Excellence Labeling badge Structure (EUCLES)[58]. In the authors' opinion, this is an area where cluster coordinators can increase their activity. It is worth mentioning that so far KKK coordinators could benefit from the co-financing of the certification process under sub-measure 2.3.7 of the Operational Program Smart Growth and probably KKK clusters and supra-regional growth clusters will be able to benefit from the planned measure 2.17 of European Funds of Modern Economy[59].

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

[59] 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

- cluster has no badge, 29 clusters
- the cluster has a bronze label, 8 clusters
- the cluster has a silver label, 3 clusters
- the cluster has a gold label, 1 cluster

Source: own elaboration based on a survey of cluster coordinators (N=41).

Regarding the industry structure, the clusters were divided into 6 groups. The most numerous sectors were related to the quality of life, tourism and recreation (11 clusters), industrial processing and transport (13 clusters representing metalworking, automotive, aviation and transport), as well as ICT clusters (8). In addition, 5 clusters operated in the construction industry, and the areas of activity of 4 clusters included chemistry, bioeconomy, materials engineering and energy.

Graph 11. Industry specialization of clusters participating in benchmarking

- quality of life, tourism and recreation, 11 clusters
- automotive, aviation production, transport, 8 clusters
- ICT, 8 clusters
- metal production and processing, 5 clusters
- construction, 5 clusters
- chemistry, bioeconomy, materials engineering and energy, 4 clusters
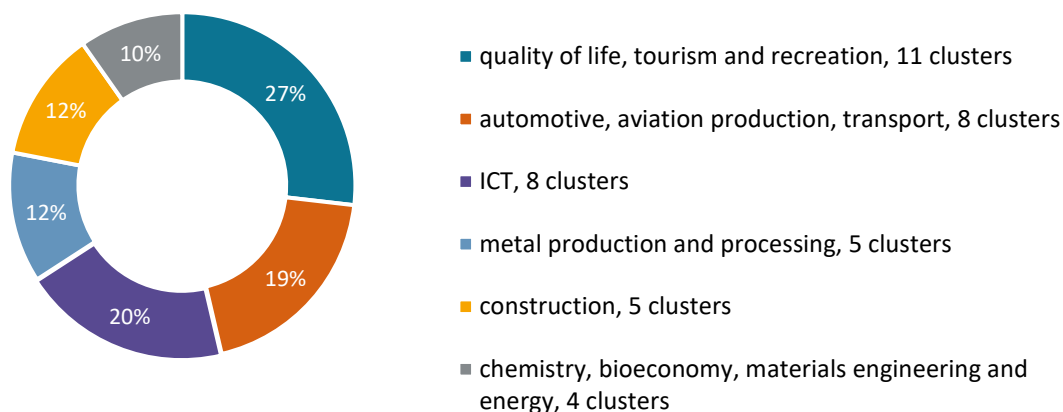
Source: own elaboration based on a survey of cluster coordinators (N=41).

The clusters covered by the study also belong to one or more National Smart Specializations (KIS)[60]. The analysis was based on the list of 13 KIS valid in the period from January 17, 2022 to February 12, 2023[61]. Each of the surveyed clusters indicated at least one KIS in which the area of its activity fits. 3 clusters participated in the study, which indicated at least 6 KIS constituting

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[60] 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.

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

secondary areas of activity. This is an example of clusters that include members that form vast networks of value that go beyond a single sector or industry.

Taking into account the division into the dominant area of KIS, which the cluster is part of, the largest number of clusters indicated automation and robotics of technological processes (10) as well as smart networks and information and communication technologies. Also geoinformation technologies (7).

Graph 12. Number of clusters participating in benchmarking – dominant KIS in which the cluster is included
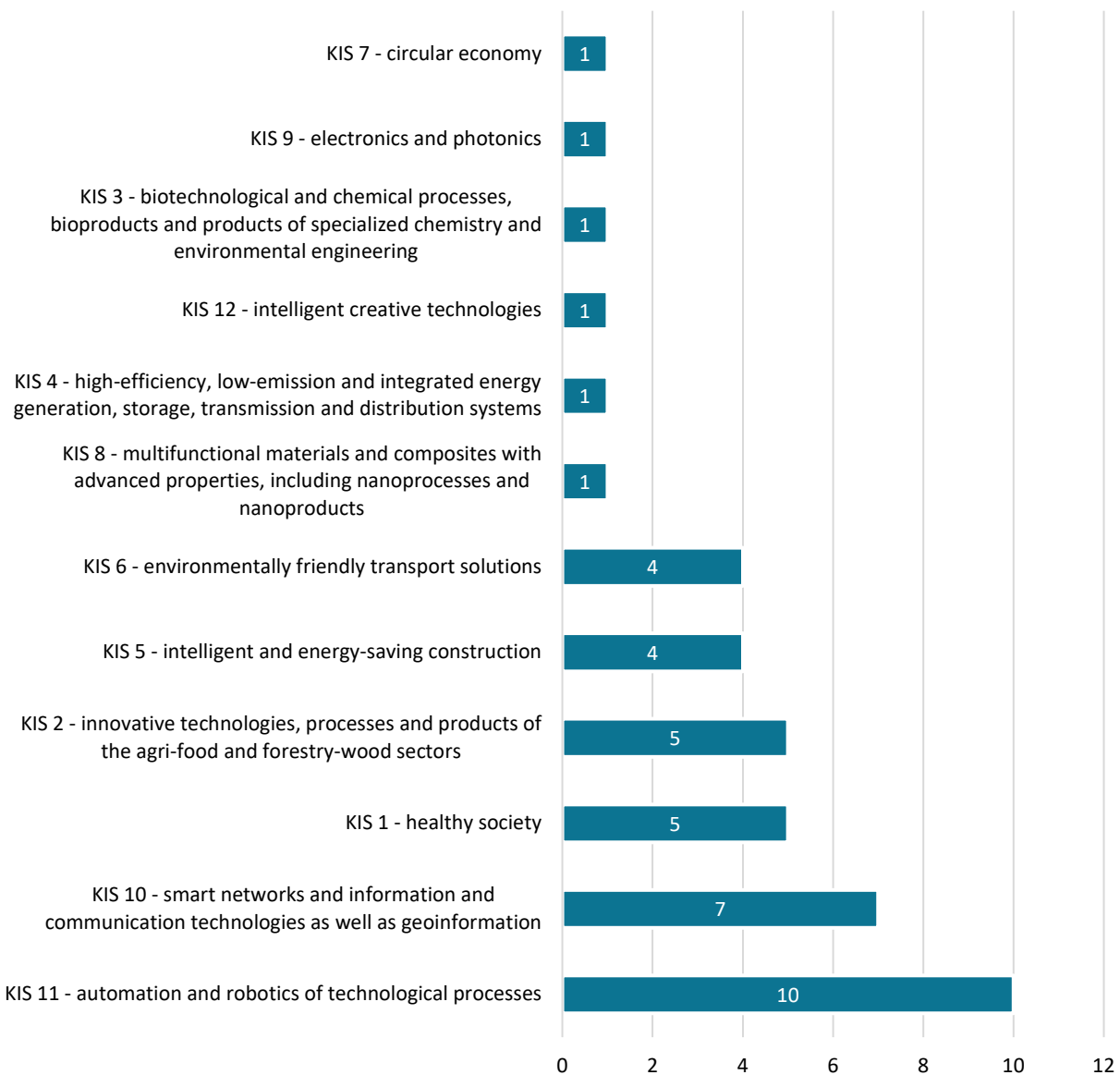
Source: own elaboration based on a survey of cluster coordinators (N=41).

5.   The research results

The report first presents the results of general data, and then in the subsequent sub-chapters, detailed results within individual areas and sub-areas. Firstly, the obtained values for synthetic indicators at the level of 5 analyzed areas were compared between the current edition of the benchmarking and the one from 2020[62]. The comparison was made on unitarized[63] values using the following measures:

- **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 better for a given area).

Comparing the values determined in this way between the two editions of the study is subject to certain estimation errors. In order to obtain full accuracy of the comparative analysis, the same group of clusters should be analyzed using the same set of indicators (which is not possible considering changes in indicators between editions).

The analysis was made for the following criteria:

1. **Cluster status:** having the status of a National Key Cluster, no status with plans to obtain and no status without plans to obtain.
2. **Cluster size:** small (20-47 members), medium (48-77 members), large (78-120 members) and very large (121 and more members) clusters[64].
3. **Cluster age:** mature clusters (created before 2010), clusters created in 2010-2014 and young clusters (created in 2015 and later).
4. **Cluster location:** the division was made according to macroregions in Poland.
5. **Having a cluster strategy:** having a strategy and updating it.
6. **Industry:** according to the division into 6 industries.

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[62] In the current edition, the benchmarking system consists of 88 partial indicators, while in the 2020 edition it was 114 indicators. Differences in the system of indicators, the method of calculating benchmarks using the unitarization process and a different set of clusters make it impossible to relate these results directly to each other. For example, it is unreliable to compare median or benchmark values between editions. On the other hand, the informative value of these charts is related to the possibility of comparing the positions of individual areas in relation to each other.

[63] The purpose of unitarization is to obtain variables with a uniform range of variability, defined - in classical terms - by the difference between their maximum and minimum values, equal to 1. More in the statistical annex.

[64] Changed cluster size taxonomy compared to the previous edition. The change is justified by a significant increase in the number of members in the largest clusters (striving to maintain a similar number of clusters in each size group).

The chart below illustrates the situation in which the best clusters improved their position in each of the benchmarking areas. In turn, the median reflects the situation of the entire group of clusters to a much greater extent. In this case, too, an improvement was noted for each of the areas. It is worth noting that the weaknesses in the previous edition of the benchmarking (cluster resources, cluster results, cluster internationalization) also remain as weaknesses in the current study.

Graph 13. Median and benchmark values for the 2020 and 2022 editions of the study
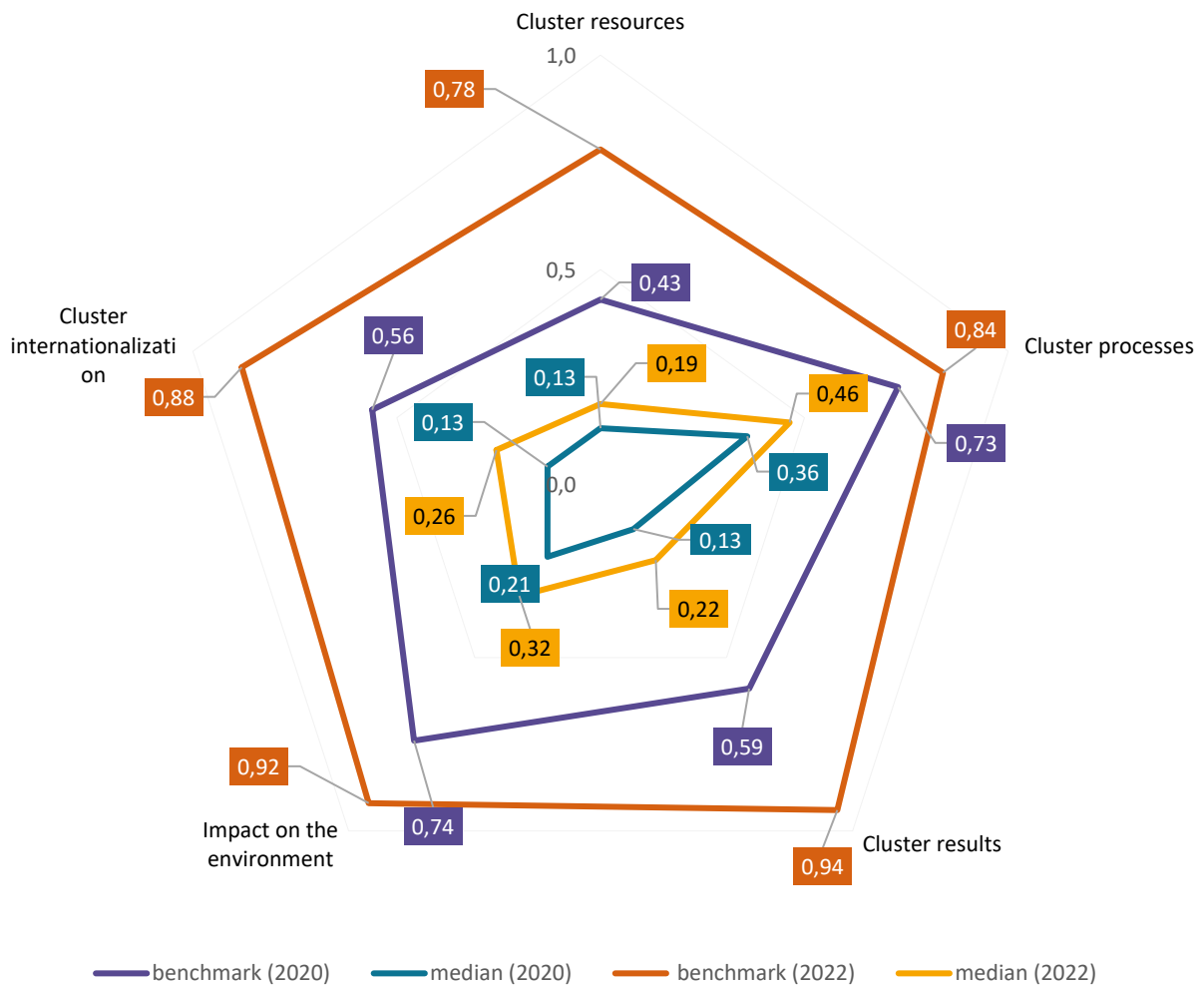
Source: own elaboration based on a survey of cluster coordinators (N=41).

In the first place, the analysis was made for the KKK and other clusters. For each of the criteria, KKK achieved better results measured by the median and the benchmark than the other clusters. Analyzing the median values, the largest difference in the development of clusters concerned the area of resources and results, and the smallest in the area of internationalization. When analyzing the benchmark values, it is worth noting that in the examined group of clusters there are structures that obtain very high results in resources and processes. This means highly developed clusters do not necessarily want or have not obtained the status of KKK so far.

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

Median

	No KKK, no plan to obtain	No KKK, plan to obtain	KKK
Cluster resources	0,11	0,11	0,46
Cluster processes	0,27	0,35	
Cluster results	0,11	0,14	0,4
Impact on the environment	0,16	0,24	0,59
Cluster internationalization	0,11	0,21	0,44
Total	0,17	0,21	0,47

Benchmark

	No KKK, no plan to obtain	No KKK, plan to obtain	KKK
Cluster resources	0,42	0,71	0,78
Cluster processes	0,50	0,65	0,84
Cluster results	0,33	0,62	0,94
Impact on the environment	0,55	0,56	0,92
Cluster internationalization	0,30	0,51	0,92
Total	0,39	0,61	0,86

- No KKK, no plan to obtain
- No KKK, plan to obtain
- KKK

Source: own elaboration based on a survey of cluster coordinators (N=41).

Another criterion of the analysis was the age of the clusters. A quite significant impact of the period of cluster operation on the results obtained in particular areas can be observed. The biggest difference concerned young clusters (established in 2015 and later) and other clusters. The difference was particularly clear in the case of cluster resources (median) and cluster internationalization and cluster performance (benchmark). Large differences between the median and the benchmark value indicate a situation in which a certain group of clusters achieved a very high level of development, significantly exceeding the average and the median for all clusters (the characteristics of the best clusters were presented in the further part of the analysis when discussing individual areas).

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

Source: own elaboration based on a survey of cluster coordinators (N=41).

Then, the relationship between the number of cluster members and the results obtained in the benchmarking were examined. Clusters were divided into four groups in terms of size (20-47, 48-77, 78-120 and 121 and more members). Those with a small number of members fared poorly in areas such as cluster internationalization and performance. Having over 121 members was almost a guarantee of a high position of the cluster in each of the researched areas. Small structures performed best in terms of processes in the cluster.

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

Median

Benchmark

Cluster resources
- small: 0,12 / Benchmark 0,42
- medium: 0,11 / Benchmark 0,32
- large: 0,29 / Benchmark 0,54
- very large: (0,60) / Benchmark 0,78

Cluster processes
- small: 0,32 / Benchmark 0,50
- medium: 0,31 / Benchmark 0,65
- large: 0,52 / Benchmark 0,74
- very large: / Benchmark 0,84

Cluster results
- small: 0,09 / Benchmark 0,27
- medium: 0,20 / Benchmark 0,50
- large: 0,30 / Benchmark 0,50
- very large: 0,48 / Benchmark 0,94

Impact on the environment
- small: 0,19 / Benchmark 0,37
- medium: 0,19 / Benchmark 0,58
- large: 0,45 / Benchmark 0,61
- very large: / Benchmark 0,92

Cluster internationalization
- small: 0,16 / Benchmark 0,25
- medium: 0,13 / Benchmark 0,46
- large: 0,30 / Benchmark 0,49
- very large: 0,51 / Benchmark 0,88

Total
- small: 0,18 / Benchmark 0,29
- medium: 0,18 / Benchmark 0,48
- large: 0,40 / Benchmark 0,45
- very large: / Benchmark 0,86

Legend:
- ■ small (20-47)
- ■ medium (48-77)
- ■ large (78-120)
- ■ very large (121 and more members)

Source: own elaboration based on a survey of cluster coordinators (N=41).

The confirmation of the earlier conclusions is the table illustrating the relationship between the number of members and the average value of synthetic indicators for the areas (each point symbolizes one cluster covered by the study). The trend line is quite clear. Only single clusters with less than 50 entities were able to obtain favorable total results in benchmarking. It is also worth emphasizing the higher value of the parameter with the "x" variable denoting the number of cluster members than in the previous edition of the study. This means the growing importance of cluster size in the overall benchmarking assessment.

Graph 17. Relationship between the number of cluster members and the average cluster score for benchmarking areas
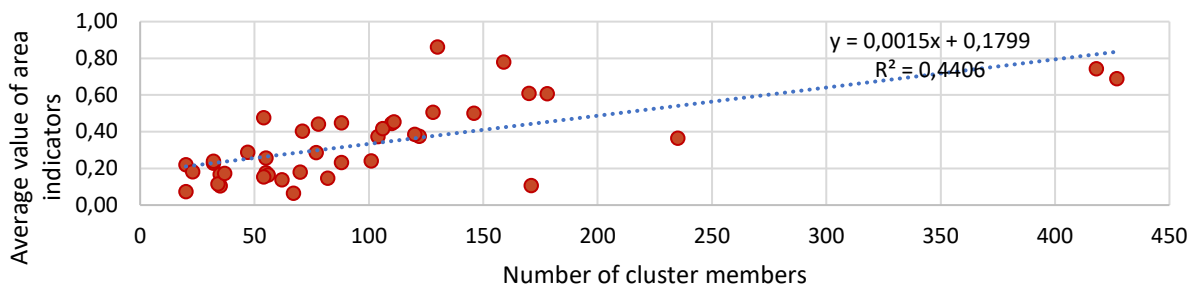
Source: own elaboration based on a survey of cluster coordinators (N=41).

A positive correlation also exists between the number of universities and other entities of the higher education and science system in the cluster and the average value of synthetic indicators for the areas. Four clusters participated in the study, and there was not a single university or other entity of the higher education and science system among its members (in the previous edition of the study there was only one such cluster). The record holder was a cluster with 20 members of this type. Contrary to the observed trend, it scored quite low in benchmarking.
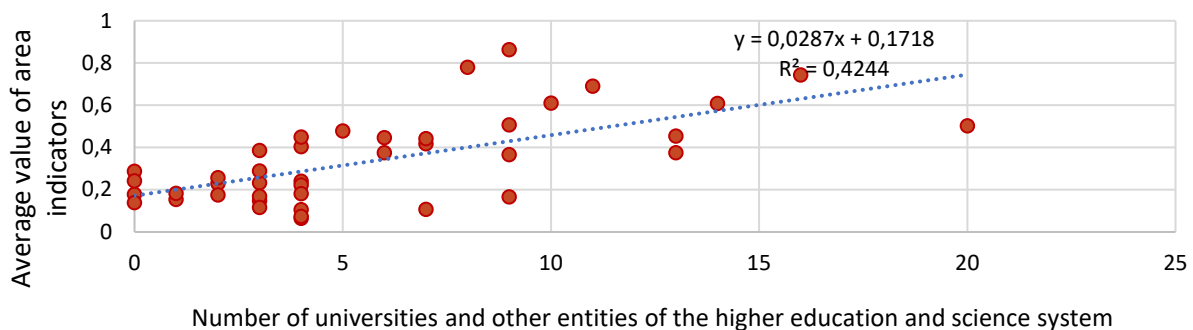
Graph 18. Relationship between the number of scientific units in a cluster and the average cluster score for benchmarking areas

Source: own elaboration based on a survey of cluster coordinators (N=41).

Another area of the analysis was the comparison of the results obtained by clusters depending on their activity strategy and its update. Contrary to the previous edition of the study, three groups of clusters were distinguished: having a written strategy that is updated (26 clusters), having a strategy without updating it (9 clusters) and lacking a written strategy (6 clusters). The results presented below clearly indicate that clusters with a strategy that is subject to updating achieve significantly better results than others. None of the clusters that do not have a strategy or have one but do not update it obtained a high position in the study, as evidenced by low benchmark values. In the results there is no particular difference between clusters without a strategy and clusters with a strategy but without its update. The situation in which the majority of clusters from this group (12 out of 15) was established before 2015 (medium-aged and mature clusters) should be assessed negatively. This proves that despite a long period of activity, these clusters were unable to build a solid basis for activity that translated into average or high results in benchmarking.

Graph 19. Values of the median and synthetic benchmarks, considering having a cluster strategy and its update
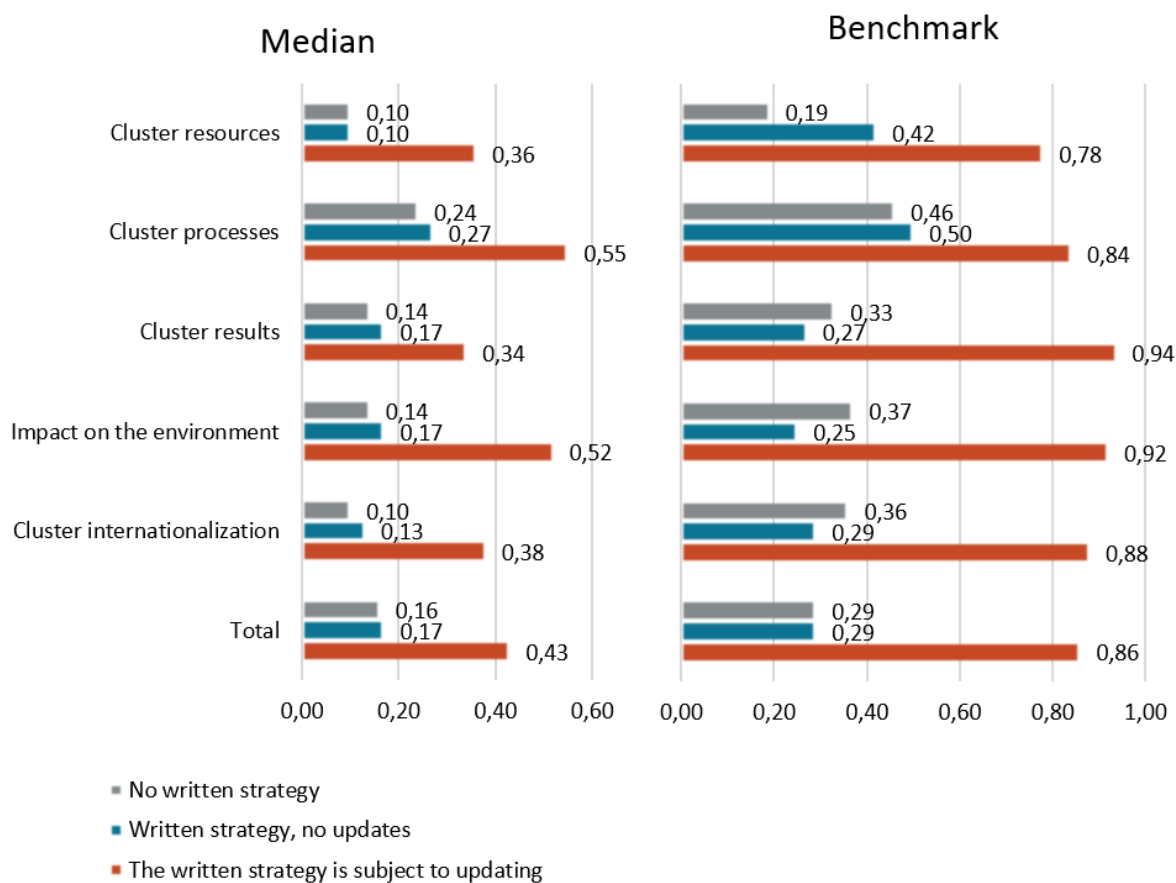
Source: own elaboration based on a survey of cluster coordinators (N=41).

The last area of comparison concerned the industry represented by the cluster. They were divided into six industry groups. For the obtained results (median), the chemical, bioeconomy, material engineering and energy industries perform best (the best grades in four out of five areas). At the other end, we can point to the construction industry and quality of life, tourism and recreation. Clusters from these industries receive poor scores in most areas. On the other hand, going to the benchmark analysis, the situation is much more even. This means that in each of the sectors there is at least one cluster obtaining very high scores in benchmarking.

<p style="text-align:center;color:red">Graph 20. Median values and synthetic benchmarks by industry</p>

Median / **Benchmark**

Cluster resources
- Median: 0,14; 0,24; 0,15; 0,27; 0,26; 0,11
- Benchmark: 0,78; 0,78; 0,71; 0,73; 0,70; 0,75

Cluster processes
- Median: 0,42; 0,5; 0,29; 0,48; 0,64; 0,49
- Benchmark: 0,84; 0,84; 0,65; 0,75; 0,82; 0,73

Cluster results
- Median: 0,11; 0,21; 0,18; 0,26; 0,35; 0,16
- Benchmark: 0,94; 0,94; 0,62; 0,65; 0,75; 0,67

Impact on the environment
- Median: 0,37; 0,42; 0,20; 0,38; 0,61; 0,12
- Benchmark: 0,92; 0,92; 0,56; 0,70; 0,81; 0,73

Cluster internationalization
- Median: 0,26; 0,33; 0,13; 0,30; 0,44; 0,15
- Benchmark: 0,84; 0,84; 0,51; 0,88; 0,82; 0,58

Total
- Median: 0,26; 0,37; 0,18; 0,34; 0,46; 0,18
- Benchmark: 0,86; 0,61; 0,61; 0,74; 0,78; 0,69

Legend:
- Metal production and processing
- Automotive, aerospace production, transportation
- Quality of life, tourism and recreation
- ICT
- Chemistry, bioeconomy, materials engineering and energy
- Construction

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.1. Cluster resources

For the purposes of 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 and the number of research workers involved in cluster work, as well as the coordinating staff delegated to service the cluster.
- **Infrastructure resources** - within the sub-area, the availability and adaptation to the needs of cluster members of research, production and IT infrastructure were assessed.
- **Financial resources** - in this sub-area, the budget of the cluster was examined, including its self-financing and public financing, as well as the availability of financial instruments for cluster members.

In the area of "Cluster resources", the best total score for two out of three areas (benchmark) was 1.00, while the median was 0.28. High benchmark values mean that there was one cluster in the surveyed population that obtained maximum scores for most indicators. Both in terms of the median and the benchmark, the area of human resources of the cluster was rated the best (respectively 1.00 and 0.28). This was an increase compared to the values obtained in the 2018 edition of the study (the median increased by 0.03, and the benchmark by 0.23).

Graph 21. Values of subsynthetic indicators in the area of cluster resources for the 2020 and 2022 research editions.
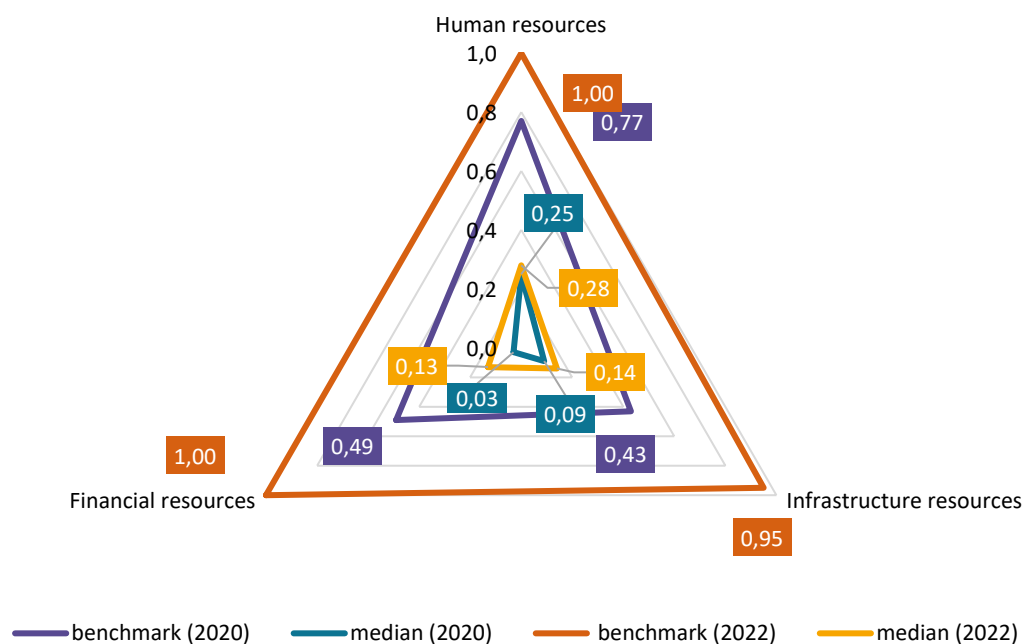
Source: own elaboration based on a survey of cluster coordinators (N=41).

5.1.1. Human resources

For each of the sub-areas of the study, the values of the median (dividing the studied group of clusters into two halves - clusters achieving better and worse results) and the benchmark (result for the best or a group of the best clusters) were presented. The data is presented taking into account the most important criteria characteristic for clusters. In the case of the assessment of human resources, the values obtained for very large clusters (median 0.54) and KKK (0.47) look much better.

<p align="center">Graph 22. Median and benchmark for the human resources sub-area</p>
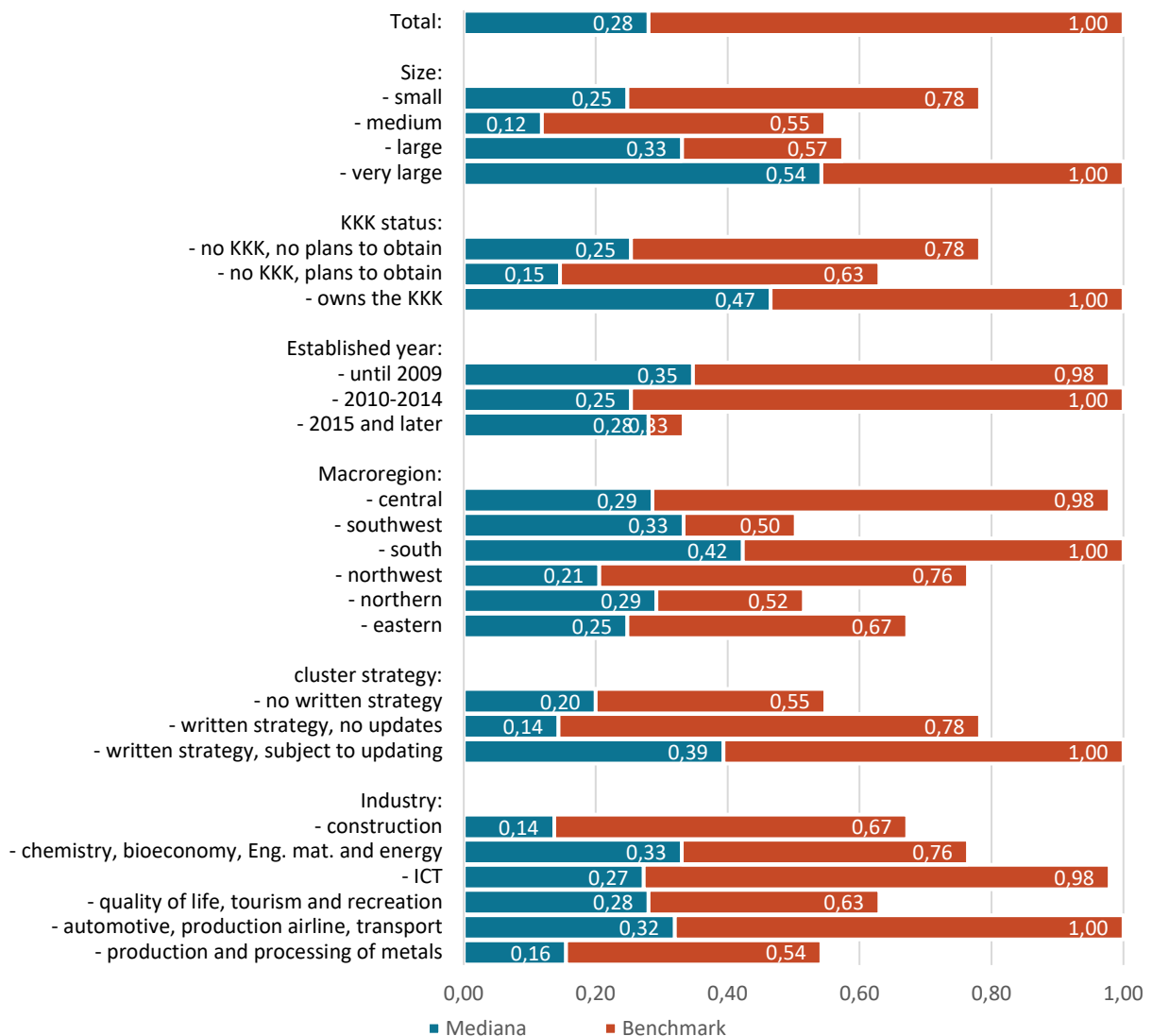
Source: own elaboration based on a survey of cluster coordinators (N=41).

It is worth noting that the moment of establishing a cluster is not so important for the results obtained (the youngest clusters still had at least a few years to build an appropriate level of

human resources). The advantage of clusters with a written strategy subject to updating is clearly visible. Taking into account the location, the best scores were obtained by clusters from the southern (0.42) and south-western (0.33) macroregions. On the other hand, in terms of industries, clusters in the area of construction and metal production and processing are the weakest.

The benchmark value shows that the best results were achieved by very large clusters, with the status of KKK, established until 2014 in the ICT, automotive, aviation production and transport sectors.

Analyzing the benchmark values, it can be seen that the best score for the cluster in terms of human resources was 1.00. This means that in the surveyed population there was a cluster that obtained maximum scores in all partial indicators for the sub-area of human resources. It was a cluster founded in 2010–2015, with the status of KKK and over 120 members.

Cluster members assessed the number of employees of cluster coordinators employed to service clusters as sufficient (53% of responses), and about 16% were of the opposite opinion. Compared to the previous edition of the survey, the expectations of the cluster members increased in relation to the coordinator's staff (previously 58% of the respondents considered the staff sufficient and 11% insufficient). It is worth for cluster coordinators to include this aspect in the analysis as part of the survey of members' opinions.

Graph 23. Evaluation of the coordinator's staff dedicated to servicing cluster entities
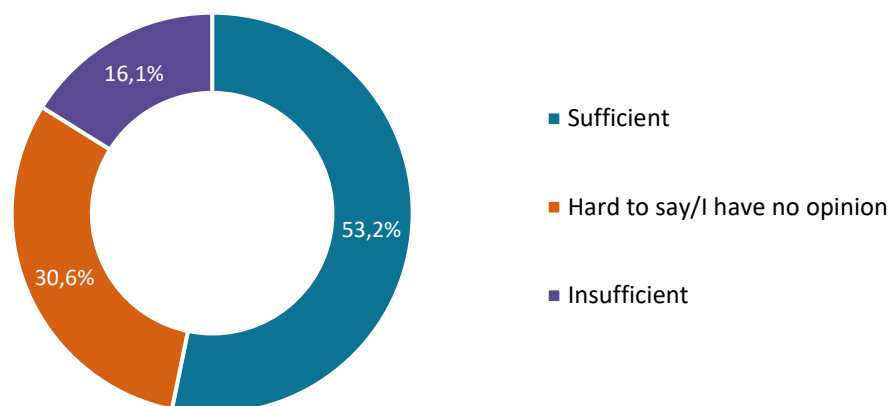
Source: research of cluster members (N=642).

Analysis of partial indicators for sub-areas

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

Indicator	Comment
Employment in all cluster members	Average: 18.0 thousand people, median: 13.2 thousand people, benchmark: 105.8 thousand people[65]. Only for two clusters the total employment did not exceed 1,000 people. In turn, a cluster with a total employment of nearly 106,000 people appeared in the ranking. In terms of this indicator, significant differences can be observed as to the critical mass of the cluster (measured by the size of employment).
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 5 clusters with employment not exceeding 1,000 people among enterprises. This means 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 of 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 12 clusters this number did not exceed 5 people.
Number of employees of the cluster coordinator team	Average: 6.1 people, median: 4.0 people, benchmark: 18.0 people. 5 clusters are operated by 1 and 2 people. This may indicate an increased activity of cluster coordinators (in the previous edition of the study, employment by 1-2 persons concerned nearly half of the clusters). For 9 clusters, the number of people coordinating activities was greater than or equal to 10 people (but for none of the clusters it exceeded 20 people).

Source: own elaboration based on a survey of cluster coordinators (N=41).

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[65]There are a number of indicators in the study where the benchmark (maximum recorded value) is an extreme value. The presence of extreme values significantly overestimates the average value and leads to a significant concentration of unitary variables within the lower values of 0 - 0.1. This results in a significant dominance of one or a small group of clusters, while reducing the differences within the remaining cluster groups (poor, average, good). Since most distributions of variables are skewed towards the lower value, the extreme values were cut off using the values of the Q1 and Q3 quartiles and the value of the range between the quartiles (IQR). In this method, the maximum value (upper cutoff) is Q3 + 1.5 IQR. The value of 1.5 IQR can be treated as conventional, but at the same time it is widely used in the statistical and econometric literature.

5.1.2. Infrastructure resources

In the case of infrastructural resources, very low values of the median index should be noted for most of the analysis sections (comparable situation to the previous edition of benchmarking). This means that in the case of infrastructural resources there was quite a large group of clusters with a very low level of development in this area. In terms of the median, the group of clusters located in the north-western (0.34) and southern (0.26) macroregions performed favorably in relation to the total value (0.14). Also clusters established before 2009 (0.26) and having the status of KKK (0.26) received relatively high scores. Very low values (close to zero) were obtained by clusters without a written strategy. For a change in relation to human resources, the highest median level was obtained by construction (0.28) and metal (0.34) clusters.

Graph 24. Median and benchmark for the infrastructural resources sub-area
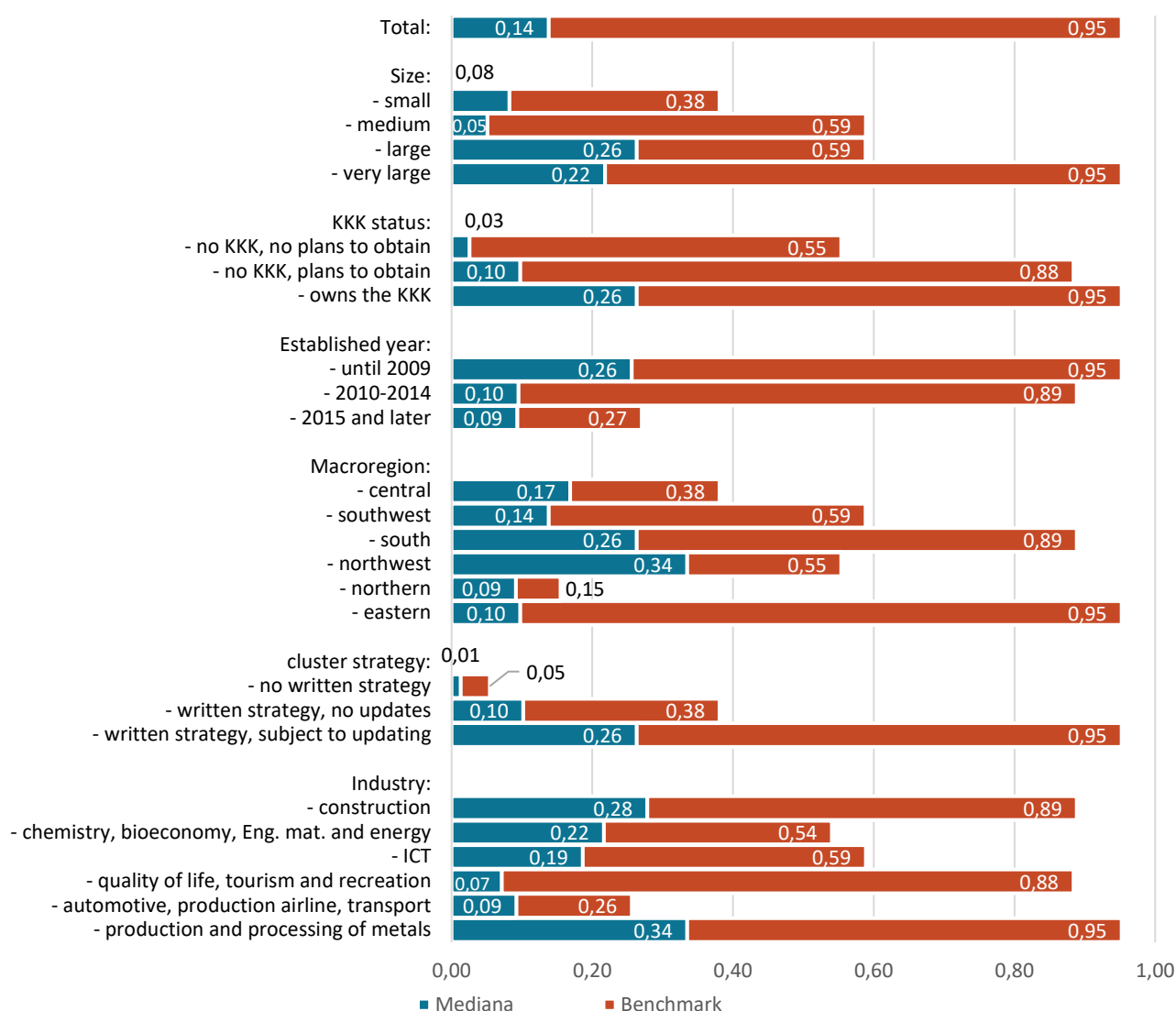
Source: own elaboration based on a survey of cluster coordinators (N=41).

In the case of the benchmark analysis, the best scores were obtained by a very large cluster (over 120 members), with the status of KKK, established before 2010.

As a supplement to the surveys of coordinators, surveys of opinions of cluster members were conducted. The assessment of the availability of resources was possible on the basis of the response scale: low, average and high. These ratings were given numerical values (1 for a low rating and 5 for a high rating) and then averages were calculated for each type of infrastructural resource. As far as the availability of resources in the cluster is concerned, the respondents gave the highest rating to the accessibility of the premises of the communication platform (score 4.2 - the majority of high scores) and research infrastructure (4.0). In turn, the availability of financial instruments was rated the lowest (3.5). This may be an indication for coordinators to increase activity in this area (e.g. establishing cooperation with industry-dedicated funds).

Graph 25. Evaluation of the availability of resources in the cluster according to the surveyed organizations
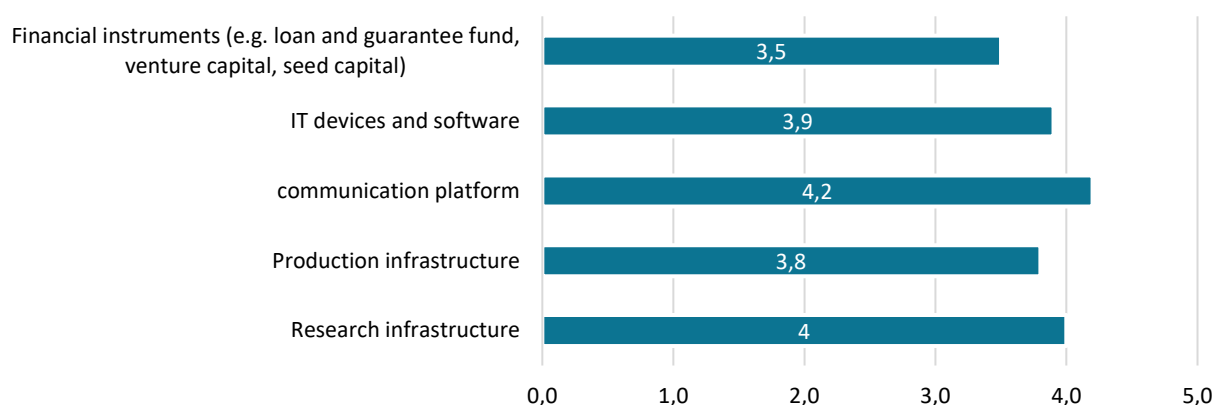
Source: research of cluster members (N=642).

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
Area of research infrastructure at the disposal of the cluster, owned or made available on the basis of contracts	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 area available does not exceed 1,000 m2. The average value is significantly increased by two clusters declaring over 20 thousand. m2 of available space. In turn, the low value of the median is related to the situation in which 19 clusters did not declare any available research infrastructure.

Indicator	Comment
The value of investments in research infrastructure at the cluster's disposal, owned or made available on the basis of contracts[66]	Average: 11,094.1 thousand PLN, median: PLN 0.0 thousand PLN, benchmark: PLN 120.0 million PLN. Most of the clusters (16) declaring that they have research infrastructure at their disposal, invest funds in its development at the same time. The amounts vary dramatically (from several thousand zlotys to over one hundred million zlotys).
Area of production infrastructure at the disposal of the cluster, owned or made available on the basis of agreements for cluster members	Average: 1,651 m2, median: 0 m2, benchmark: 38,000 m2. The median at the level of 0 m2 means that more than half of the clusters do not provide production infrastructure. Of the 16 clusters providing production infrastructure, the majority were production clusters. The exceptions are two clusters in the area of quality of life and one in the area of ICT, which also declared making production infrastructure available to their members.
The value of investments in production infrastructure at the disposal of the cluster, owned or made available on the basis of contracts	Average: 3,990.5 thousand PLN, median: PLN 0.0 thousand PLN, benchmark: 40.0 million PLN. Only 9 clusters declared investments in production infrastructure. It is worth noting that for 5 clusters the value of investments exceeded PLN 10 million.
The number of IT platform features available in the cluster	Average: 2.7, median: 3.0, benchmark: 7.0. From the list of 5 functions, the following were most often indicated: communication (83%), knowledge repositories (51%) and cooperation management (41%). Further positions were taken by: educational functions, e.g. e-learning (32%) and a group ordering platform (29%). The benchmark value was higher than the number of platform functions, as some clusters indicated additional functions. These include, among others: innovation exchange, job exchange, room rental, sales platform, spare production capacity management or project management.
The value of investment in the cluster's IT infrastructure	Average: 1,812.6 thousand PLN, median: PLN 650.0 thousand PLN, benchmark: 50.0 million PLN. 22 clusters recorded expenditures on IT infrastructure. The declared amounts are very diverse (from several hundred zlotys - e.g. small office equipment with computer equipment, to the amount of up to PLN 50 million).

Source: own elaboration based on a survey of cluster coordinators (N=41).

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[66] Unless otherwise indicated in the question / comment, the questions regarding the report on the value of a given indicator in the cluster (as in the case of investments in research infrastructure) consist in summing up the value of the indicator for the analyzed period of 2020 and 2021.

5.1.3. Financial resources

Moving on to financial resources, it is worth noting the very low value of the median in total (0.13) and for most cluster categories. A low value of this measure means that among the examined clusters there was a significant group (at least half) that presented itself poorly against the background of the top dozen or so clusters. In terms of financial resources, very large clusters stood out (median at the level of 0.68), KKK (0.56), operating from min. 2009. As before, clusters rated well in this area have a written strategy subject to updating (0.29).

Graph 26. Median and benchmark for the financial resources sub-area
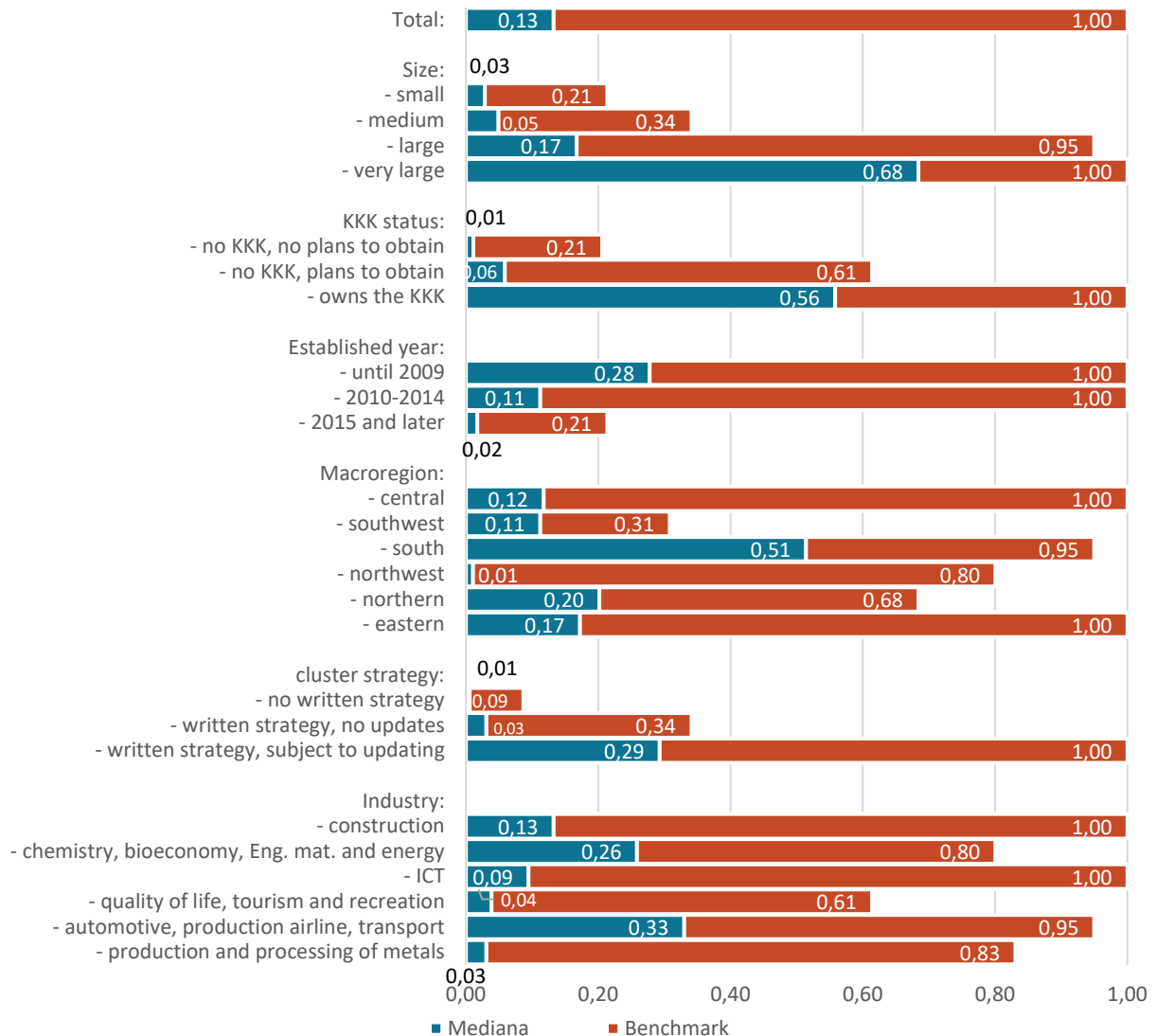
Source: own elaboration based on a survey of cluster coordinators (N=41).

In the studied group of clusters, there were two that obtained maximum scores (benchmark at the level of 1.00). Both are in the very large category.

Analysis of partial indicators for sub-areas

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

Indicator	Comment
Cluster budget (at the coordinator's disposal) (divided into individual years)	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 exceeded PLN 1 million. On the other hand, for 11 clusters the budget did not exceed PLN 100,000. zloty.
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 means 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. From a few thousand zlotys to amounts equal to or higher than PLN 20 million (three clusters).
Financial instruments available to cluster members through the cluster (option request)	Average: 0.7, median: 0.0, benchmark: 4.0. From the list of 4 instruments, the following were most often indicated: loan fund (19%) and venture capital (19%). Further positions were taken by: guarantee fund (10%) and seed capital (10%). This is an area worth considering by cluster coordinators as a development area.

Source: own elaboration based on a survey of cluster coordinators (N=41).

Area summary

- Within the area of cluster resources, human, infrastructural and financial resources were analyzed. The situation in the area of human resources was assessed relatively favorably, and the situation in the area of financial resources was rated the worst.

- The human resources assessment included: number of employees of the coordinator's team, including persons permanently delegated to service the cluster. A significant part of the clusters was serviced by 1-10 people. Cluster members assessed this aspect rather well. Only 16% of them believed that the number of people involved in cluster management is insufficient.

- Over 90% of the clusters declared the involvement of research workers. This can be considered a very positive sign of the activity of these structures. Clusters can play an important role in establishing R&D cooperation between enterprises and representatives of the science sector.

- Cluster members assessed the availability of infrastructural resources relatively well, especially in terms of the communication platform and research infrastructure (although this was assessed mainly by cluster members that actually have such infrastructure).

- In each of the researched sub-areas, very large clusters (with at least 120 members), having the status of KKK and operating at least since 2009, gained the advantage. In the case of financial resources, the disproportions between these clusters and the remaining group were relatively the largest (similarly to the previous edition of the study).

- Cluster coordinators were very active in ensuring access to additional external sources of financing (e.g. financial instruments).

- In the opinion of the members, participation in the work of the cluster brings great benefits (53.6% of respondents). Negative votes (no benefits) accounted for only 2.8%. At the same time, the majority of surveyed cluster members (51.0%) believe that the premium paid is adequate to the benefits of participation in the cluster. Only 10.7% of respondents are willing to pay higher fees for additional services provided by the coordinator.

5.2.   Cluster processes

The area of "Processes in clusters" concerned both internal and external activities carried out within the cluster. In this area, the following were investigated:

- **Management processes** – having strategic and operational documents, having specialized management bodies, researching the needs and satisfaction of cluster members and quality standards implemented in cluster enterprises.
- **Cluster communication** – direct contacts in clusters (meetings) and communication tools.
- **Market activity** – cooperation within the value chain (including joint procurement and distribution), revenues generated by cluster members and the value of online sales.
- **Marketing activity** - presence in the media, joint promotional and marketing activities, including joint fair and exhibition activities.
- **Innovative activity** – availability and use of pro-innovation services in clusters, presence of institutions supporting technology transfer, purchase of knowledge and technology for cluster needs and diagnosis of technological potential of cluster companies.
- **Cluster digitization** - degree of digitization of cluster members (use of IT systems and Industry 4.0 technological solutions).

Processes in the cluster were examined using a set of 24 indicators.

Due to changes in the list of indicators and other cluster lists, a precise dynamic analysis is not possible. It is worth noting, however, that an increase in the median value was observed in five areas compared to the previous edition of the study: management processes (from 0.61 to 0.68), market activity (0.25 to 0.33), marketing activity (0.17 to 0.34), innovative activity (0.18 to 0.24) and digitization of the cluster (0.38 to 0.71). Currently, the best rated sub-area is digitization of the cluster (0.71). In the case of the benchmark, it is worth noting very high values equal to 1 (digitization of the cluster, management processes) or close to 1 (innovative activity, communication in the cluster). This means that there were several clusters in the surveyed population that obtained maximum or almost maximum scores for the indicators included in a given sub-area. At the same time, comparing the situation to that of the 2020 edition, an increase can be seen in each of the sub-areas.

Graph 27. Values of subsynthetic indicators in the area of processes in the cluster for the 2020 and 2022 editions of research[67]
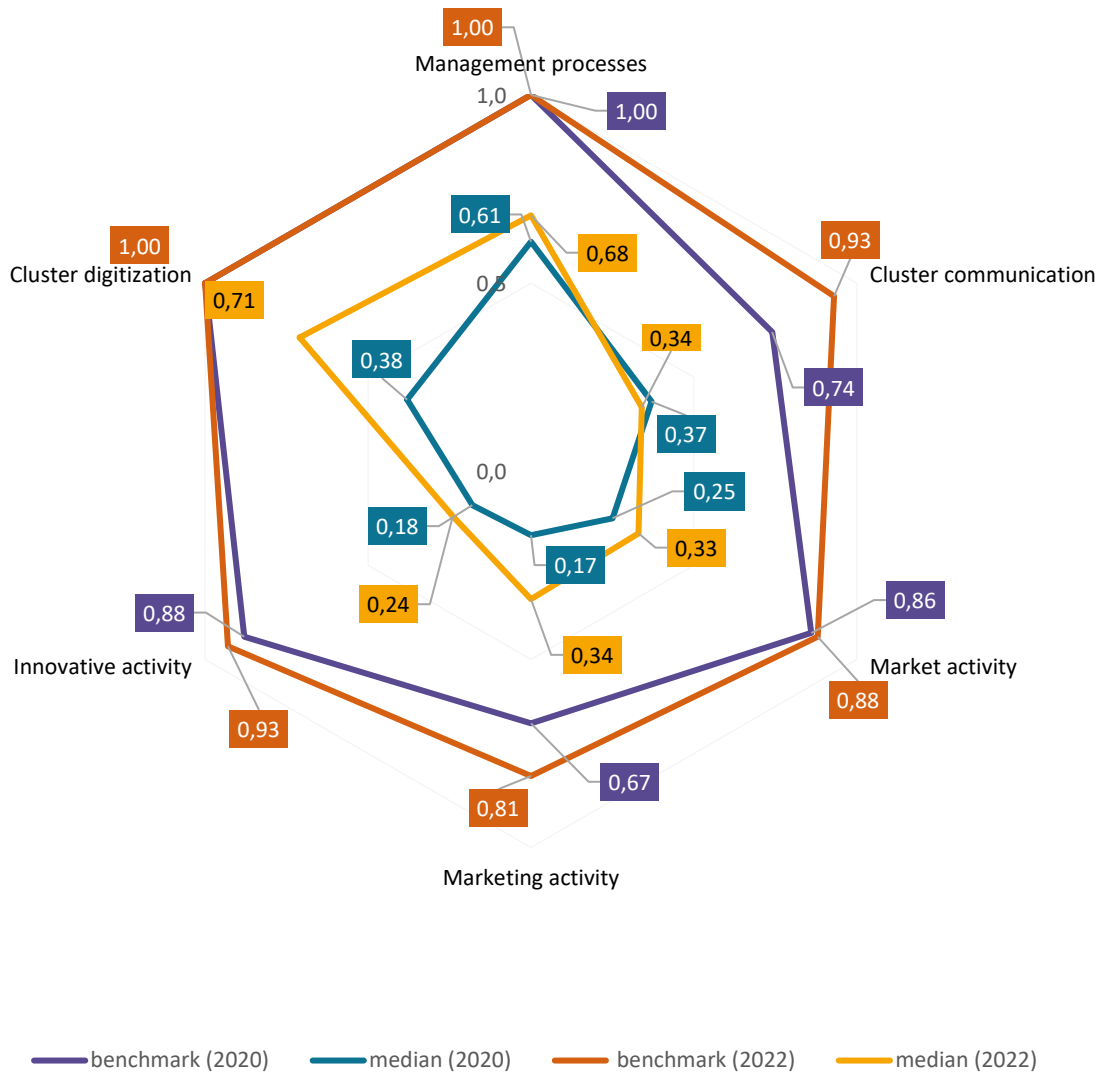
Source: own elaboration based on a survey of cluster coordinators (N=41).

The cluster digitization sub-area was characterized by a very high median value (0.71) with the maximum benchmark value (1.00). This means that among the surveyed clusters their level of digitization was very high. In the digitization sub-area, there were practically no clusters that could be considered very weak (i.e. not undertaking any activity).

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[67] 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

For the management processes sub-area, the median index in total and broken down into particular types of clusters assumed relatively high values. This means that there was not so much difference between the best and the other clusters in this case. Clusters with the status of KKK (0.86), having a written strategy, subject to updating (0.79), operating min. 10 years (median 0.75) and with at least 121 members (0.74). In the case of the benchmark analysis, the best scores were obtained by a very large cluster (over 121 members), with the status of a KKK, established before 2010 and having a written strategy that is subject to updating.

Graph 28. Median and benchmark for the management processes sub-area
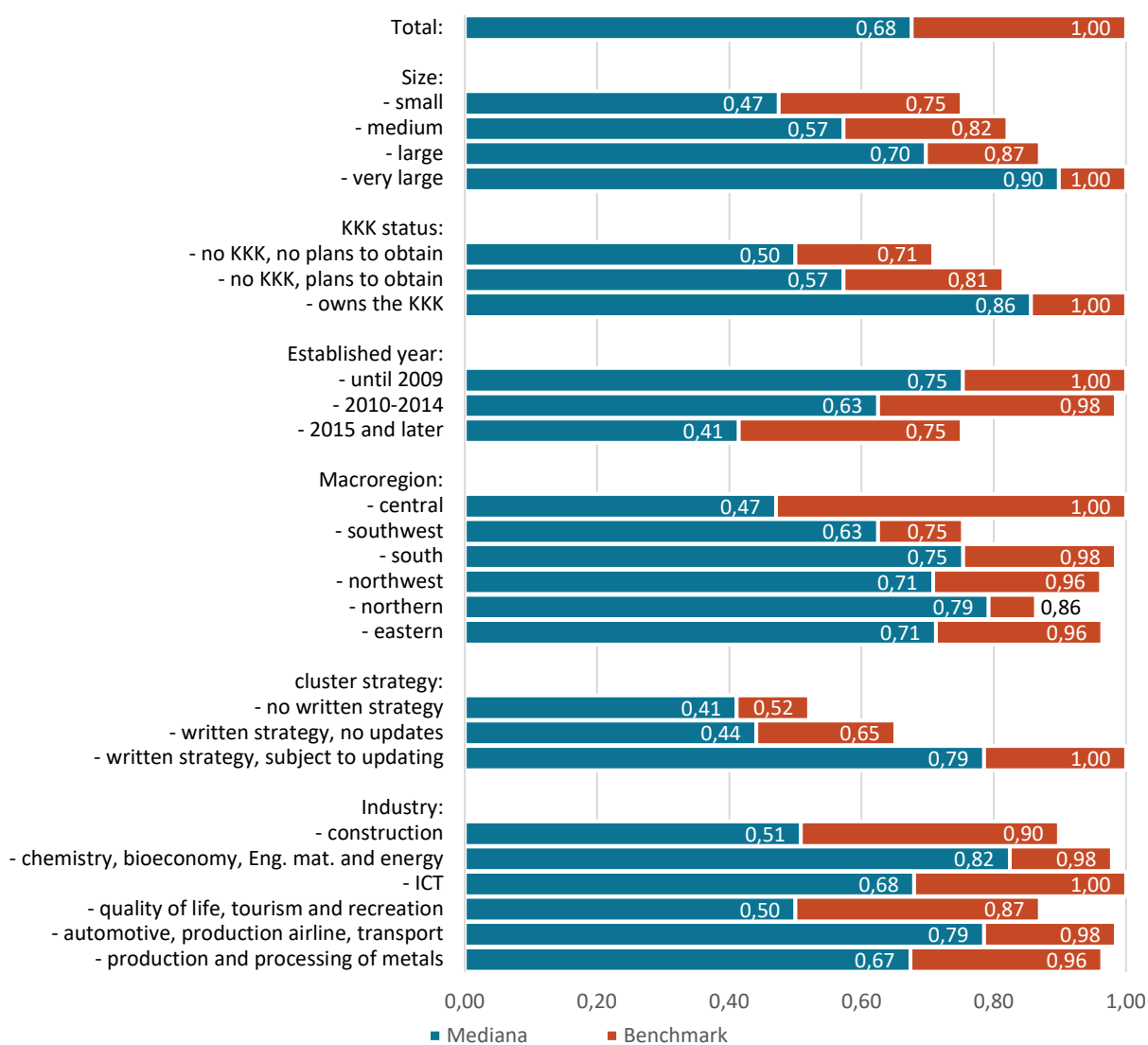
Source: own elaboration based on a survey of cluster coordinators (N=41).

Management processes were also assessed by cluster members. Representatives of this group rated the highest achievement of goals in such areas as: building a network of relations with cluster enterprises (positive ratings: 66%) and development of cooperation between cluster members (positive ratings: 65%). The lowest scores were given to the implementation of objectives in the area of: creating local supply chains (30% positive assessments, negative 14%, which is the highest negative value), improving the quality of products and services or reducing the costs of doing business (30% positive assessments and 12% negative assessments).) and impact on public authorities and other institutions (31% positive and 10% negative).

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

Goal	Achieved	Averagely achieved	Unachieved
Joint marketing activities with partners from the cluster and greater possibilities of product distribution	49,0%	19,2%	9,0%
Creating local supply chains - faster access to production materials and the ability to choose a supplier, lower transport costs	30,1%	23,7%	13,8%
Development of cooperation between cluster members	64,9%	20,7%	4,1%
Impact on public authorities and other institutions (e.g. educational)	30,7%	31,0%	10,2%
Increasing the quality of products and services and/or reducing the cost of running a business.	40,9%	19,6%	11,7%
Gaining access to tangible and intangible resources	47,7%	22,8%	9,3%
Building a network of relations with cluster enterprises	66,1%	18,1%	3,7%

■ Achieved　■ Averagely achieved　■ Unachieved

Source: research of cluster members (N=642).

For the majority of respondents (70%), participation in the cluster was associated with great benefits. It is worth noting that half of the respondents (50%) thought so in the previous edition of the survey. The percentage of respondents who were of the opposite opinion, for whom these benefits were small, also decreased (26% in the current edition of the survey, in the 2020 edition - 41%).

Graph 30. Scale of benefits from participation in the cluster

3,7%
26,6%
69,8%

- Big benefits
- Small benefits
- None
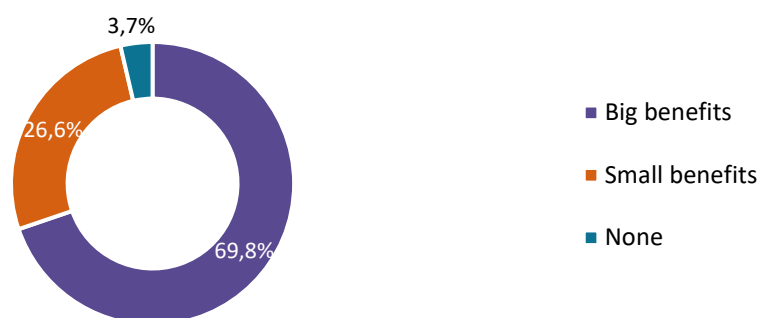
Source: research of cluster members (N=642).

In the opinion of more than half (51%) of cluster members, the amount of the contribution was adequate to the benefits obtained by a given entity due to participation in the cluster. 8% of respondents were of the opposite opinion. It is interesting to note that for a relatively high percentage (21%) of respondents, the benefits obtained from membership in the cluster were perceived as higher than the premium paid. This result is also much higher than in the previous edition (8%).

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

20,3%
20,6%
8,2%
51,0%

- We get more than we expected with this amount of premium
- What we get is adequate to the amount of the premium
- We get less than we expected with this amount of premium
- Not applicable (we do not pay a cluster membership fee)
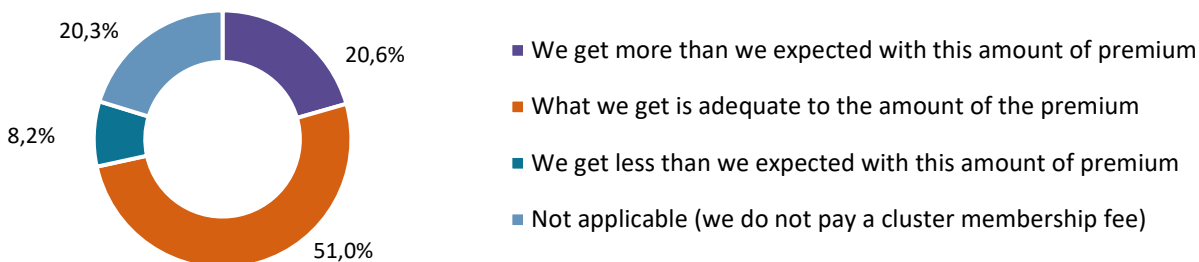
Source: research of cluster members (N=642).

It is worth mentioning that only 10.7% of members representing 22 clusters declared their readiness to pay higher fees in exchange for additional coordinator services. The average value of the amount that members would be willing to pay is PLN 10.5 thousand. PLN per year. The following services were most often indicated as additional services: promotion, marketing, internationalization activities, training (including specialized training), networking within the cluster and with external entities.

Opinions of cluster members provide objective information on the level of cluster service provided by the coordinator. 2/3 of the coordinators of the surveyed clusters conduct needs or satisfaction surveys among members. Among the surveyed cluster members, 34% declared that surveys of the needs or satisfaction of cluster members were regularly conducted in their cluster over the last two years. 35% of the surveyed clusters conducted them *ad hoc.* This result remained at a similar level as in the 2020 edition.

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

30,8%

34,6%

34,6%

■ Yes, they were conducted regularly (i.e. at regular intervals)

■ Yes, they were conducted ad hoc (on an ad hoc basis)

■ No, they weren't conducted
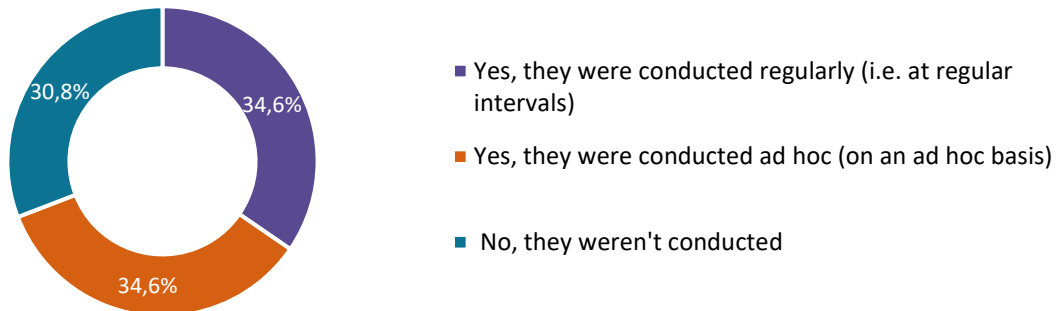
Source: research of cluster members (N=642).

Over 29% of the respondents indicated that they did not know or found it difficult to say whether, as a result of the research, on the basis of the obtained results, improvement actions were implemented (aimed at better meeting the needs and increasing the satisfaction of cluster participants), while 57% declared that the implemented there were many activities. Only 1% of members believe that coordinators do not implement improvement actions.

Graph 33. Implementation of improvement actions
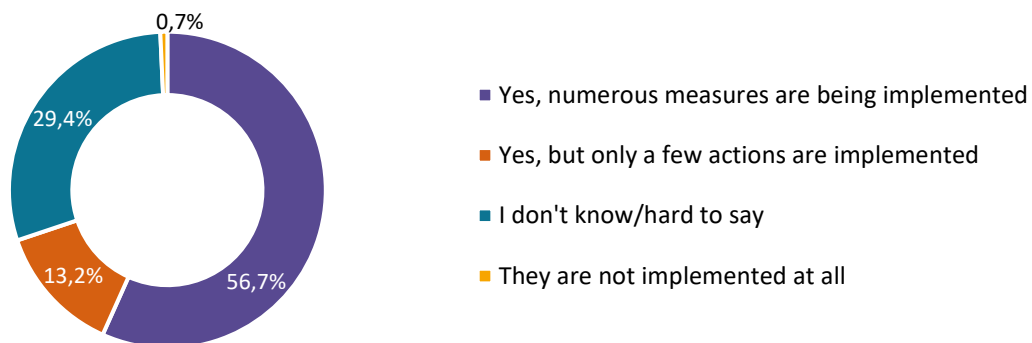
0,7%

29,4%

13,2%

56,7%

■ Yes, numerous measures are being implemented

■ Yes, but only a few actions are implemented

■ I don't know/hard to say

■ They are not implemented at all

Source: research 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

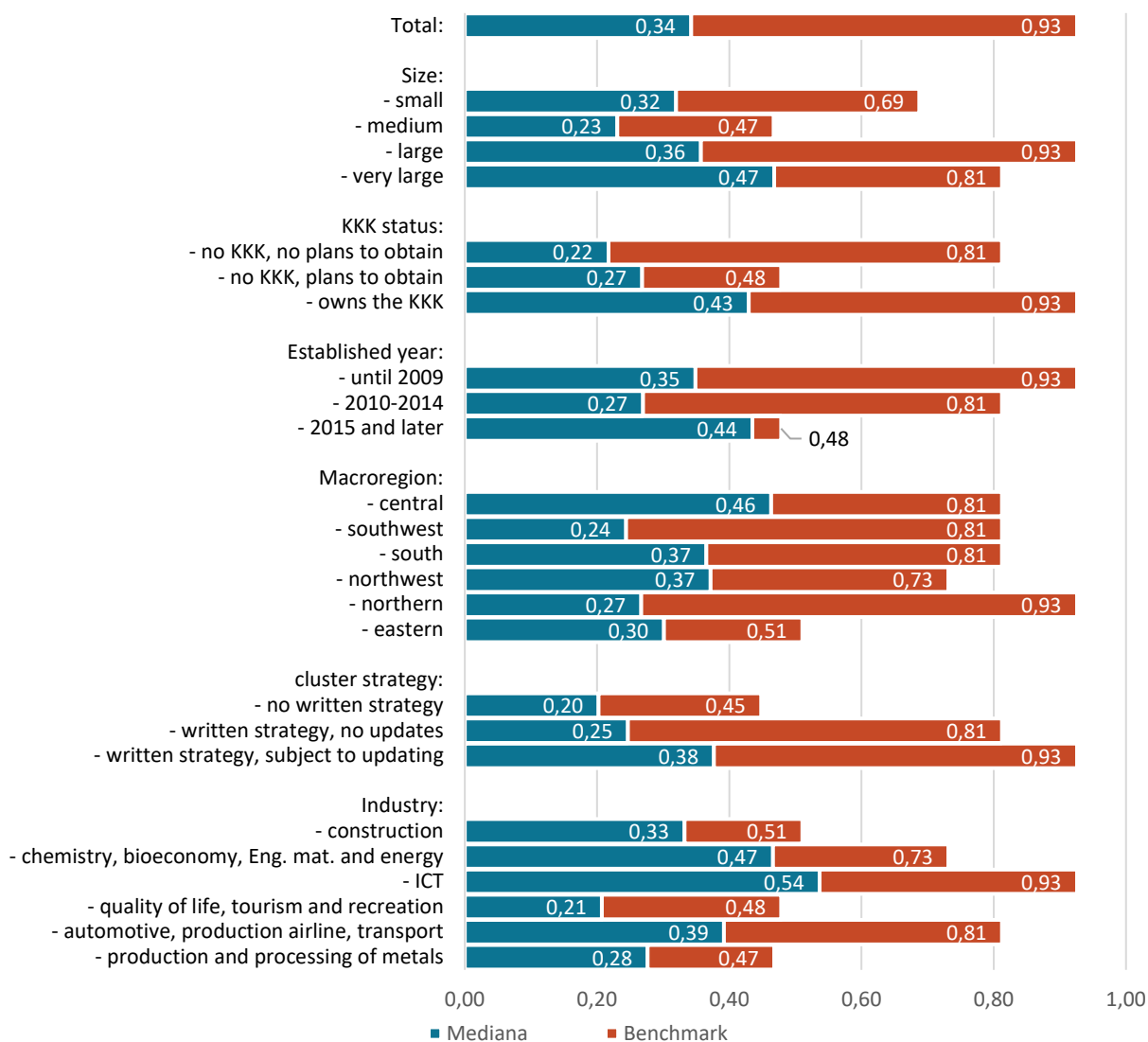| Indicator	Comment
Formulating and updating the cluster strategy	63% of clusters have a written strategy subject to updating. Another 22% of clusters have a written strategy but do not update it. 15% of clusters do not have a written strategy. In addition to general provisions, the strategy may also refer to various specific areas of cluster operation. In this respect, the provisions of the strategy most often additionally 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 case of the previous edition of the survey, participation in shaping the cluster's strategy was confirmed by nearly 54% of the members participating in the survey. This means that over 46% of cluster members do not actively participate in shaping the strategy.
Possession of operational documents (action plan for a specific period of time)	56% of clusters have detailed documents; another 41% of clusters with a high level of generality; only 1 cluster does not have 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 mostly have complex management structures; 68% of clusters have 3 or more specialized bodies; another 22% have 1 or 2 authorities, 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). At the same time, the participation of cluster members in the work of these bodies is relatively low. Only 26.5% of the surveyed members declared delegating employees to activities within at least one cluster body.
Cyclic nature of research on the needs/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 implemented ISO standards	Average: 42.8%, median: 43.6%, benchmark 92.6%. Due to significant differences in the number of cluster members, data in the form of the share of enterprises implementing ISO in the entire population were presented. On the 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 takes place in one of the smaller clusters participating in the study and amounts to nearly 93%.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.2.2. Cluster communication

Taking into account the communication in the cluster, the median in total and for individual types of clusters was quite high. There were some differences between different categories of clusters. Nevertheless, clusters with at least 121 members (median 0.47), having the status of KKK (0.43) and having a written strategy subject to updating (0.38) were still the most advantageous. The benchmark at the level of 0.93 was obtained by a cluster registered before 2010, having the status of KKK, with over 121 members and having a written strategy that is subject to updating.

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

	Mediana	Benchmark
Total:	0,34	0,93
Size:		
- small	0,32	0,69
- medium	0,23	0,47
- large	0,36	0,93
- very large	0,47	0,81
KKK status:		
- no KKK, no plans to obtain	0,22	0,81
- no KKK, plans to obtain	0,27	0,48
- owns the KKK	0,43	0,93
Established year:		
- until 2009	0,35	0,93
- 2010-2014	0,27	0,81
- 2015 and later	0,44	0,48
Macroregion:		
- central	0,46	0,81
- southwest	0,24	0,81
- south	0,37	0,81
- northwest	0,37	0,73
- northern	0,27	0,93
- eastern	0,30	0,51
cluster strategy:		
- no written strategy	0,20	0,45
- written strategy, no updates	0,25	0,81
- written strategy, subject to updating	0,38	0,93
Industry:		
- construction	0,33	0,51
- chemistry, bioeconomy, Eng. mat. and energy	0,47	0,73
- ICT	0,54	0,93
- quality of life, tourism and recreation	0,21	0,48
- automotive, production airline, transport	0,39	0,81
- production and processing of metals	0,28	0,47

Source: own elaboration based on a survey of 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 a number of restrictions on face-to-face meetings (due to the COVID-19 pandemic). For this reason, a number of meetings were held online. In 2021, the number of organized meetings in all clusters was approx. 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 5 tools, the following were most often indicated: a website (90%), social networking sites (85%) and newsletters / newsletters (73%). The cafeteria of possible answers included five items, additionally 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%). It is followed by Twitter (26.8%) and Instagram (17.1%). Some of the clusters indicated additional tools, such as online meetings, dedicated communication software created for the needs of the cluster, a project management platform or messengers).

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.2.3. Market activity

In the case of market activity, a fairly clear difference was noticed between the value of the median and the benchmark, with the median still reaching a relatively high level of 0.33 overall. The highest level was achieved by clusters established before 2010 (0.33), having the status of KKK (0.50) and a written strategy subject to updating (0.44) and having at least 121 members (0.45). A clearly higher level was achieved by clusters located in the southern macroregion. In the case of the benchmark analysis, the best scores were also obtained by a very large cluster (over 121 members), with the status of KKK, founded before 2010, with a written strategy, subject to updating. Contrary to the median, the highest benchmark value was achieved by clusters located in the eastern and central macroregions.

Graph 35. Median and benchmark for the market activity sub-area
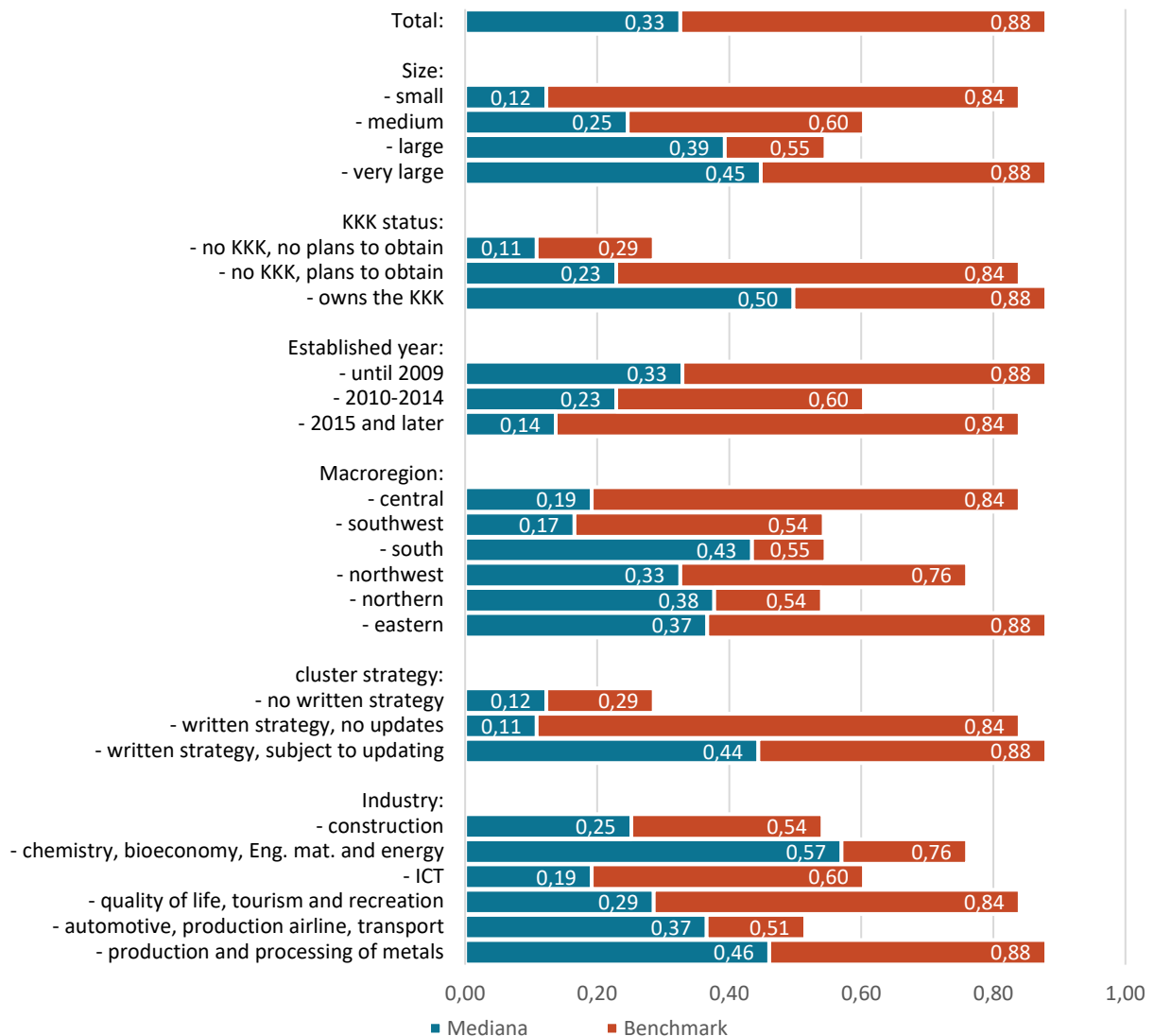
Source: own elaboration based on a survey of cluster coordinators (N=41).

Analyzing the results of the opinions of cluster members, participation in clusters translated primarily into an increase in their activity on regional markets (an affirmative answer from half of the respondents), as well as on national markets (47.5%). Activity in foreign markets was slightly weaker, but the indicator was still quite high (35.4%). These indicators are 3-5 percentage points (pp) higher than in the previous edition of the benchmarking.

Graph 36. Improvement of the organization's activity on the market in the context of its participation in the cluster
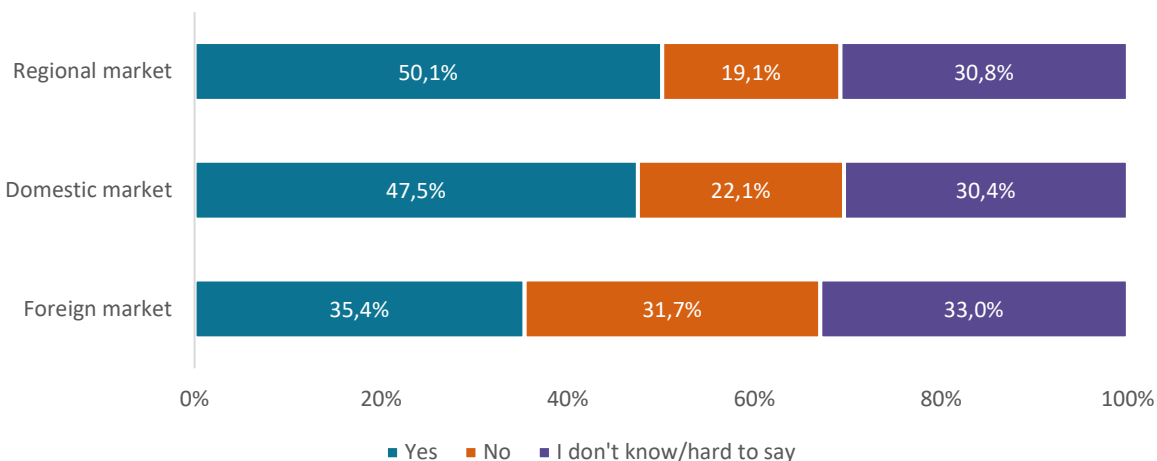
Source: research of cluster members (N=642).

Over 48% of respondents declared that thanks to their participation in the cluster, their organization established business relations with foreign partners. This is quite a significant increase compared to the previous edition of the survey (then the percentage was 33%).

Graph 37. Participation in a cluster and establishing business relations with foreign partners
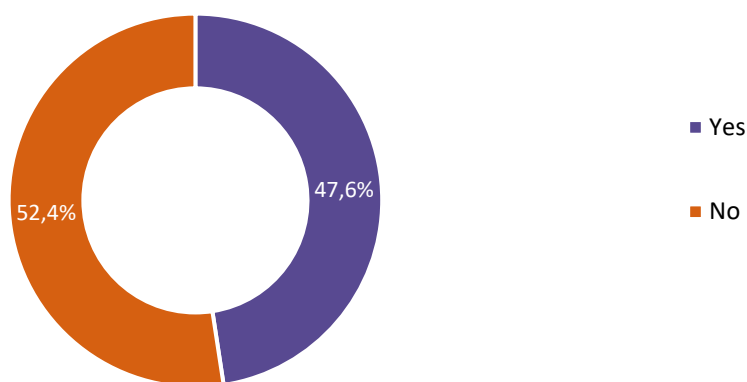
Source: research of cluster members (N=642).

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 you to identify the sources of costs, profits and potential competitive advantages[68].*

The value chain can be broken down into elements that form a sequence of activities starting with from procurement, then production and/or service delivery, marketing and sales, distribution, export activities and after-sales service. In addition, you can talk about an element of a horizontal nature, i.e. activities in the field of product planning and development and/or services. Importantly, each of these elements can be the subject of cooperation within the functioning of a given cluster. It is worth noting that only two cluster coordinators had no knowledge of any jointly implemented stage of the value chain. This is a significant improvement compared to the 2020 benchmarking (12 cluster coordinators) and 2018 (19 cluster coordinators). Cooperation was most often concentrated within 1, 2, 3 or all 7 stages of the value chain (7 clusters each). It is worth noting that in the previous edition of the study only one cluster declared the implementation of 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 a survey of cluster coordinators (N=41).

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

The most frequently indicated common market activities in clusters, in which cluster members participated, were "Marketing and sales" (39%), "Development and planning of products and/or services" (37%) and "Production and/or provision of services" (30%) and "Export activities" (29%), and the least popular "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
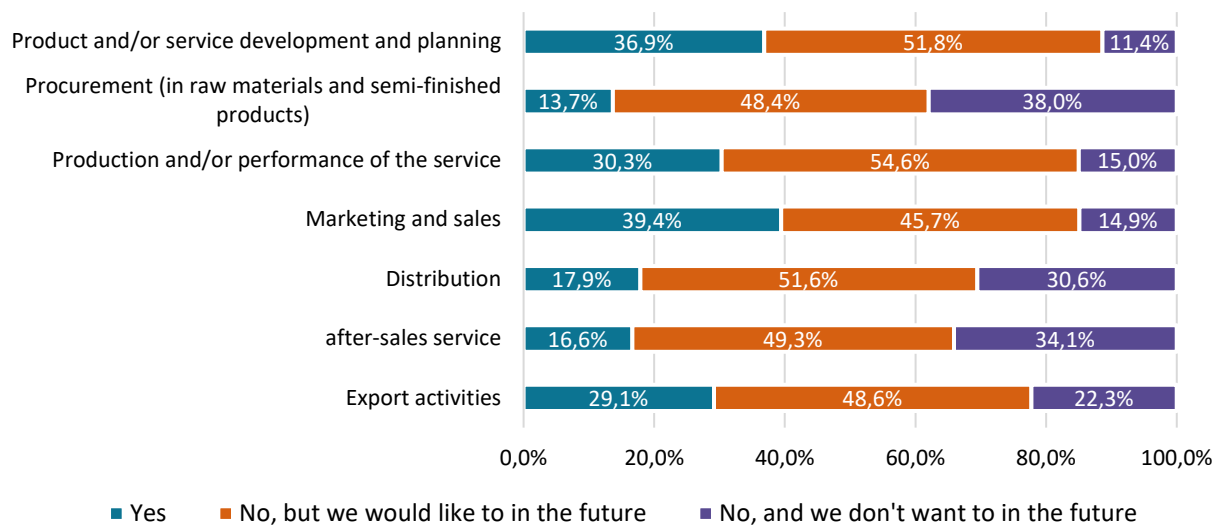
Source: research of cluster members (N=642).

As far as the assessment of cluster coordinators' activities is concerned, the vast majority of respondents are satisfied with their activities. Each of the areas was highly rated by the surveyed cluster members. Integration and development of relations in the cluster were rated the most favorable (84.7% of high scores), development of competencies in the cluster (75.5%) and development of cooperation in the cluster (75.3%). The obtained results do not differ significantly from the previous edition of the study.

<p style="text-align:center;color:red;">Graph 40. Evaluation of activities of cluster coordinators in selected areas</p>
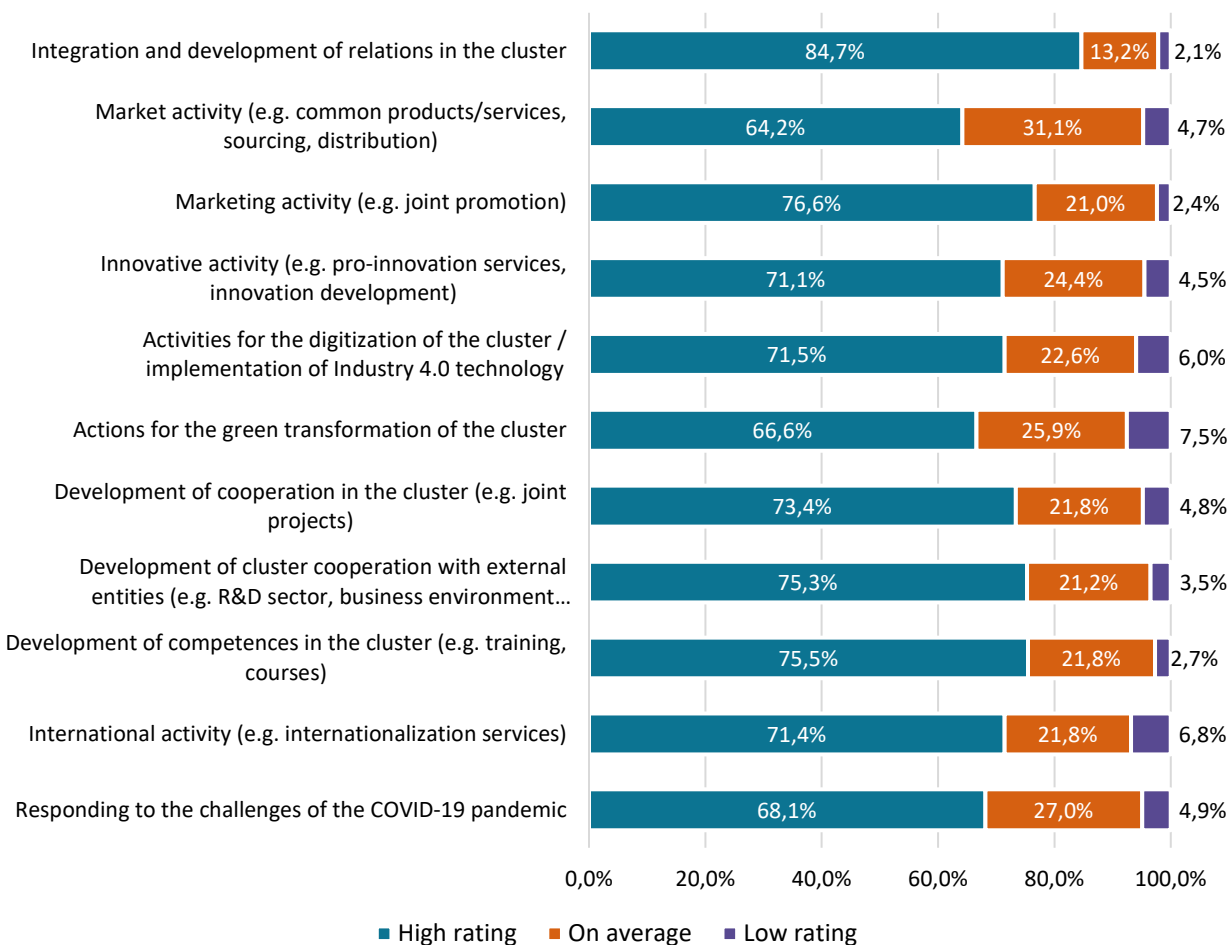
Source: research of cluster members (N=642).

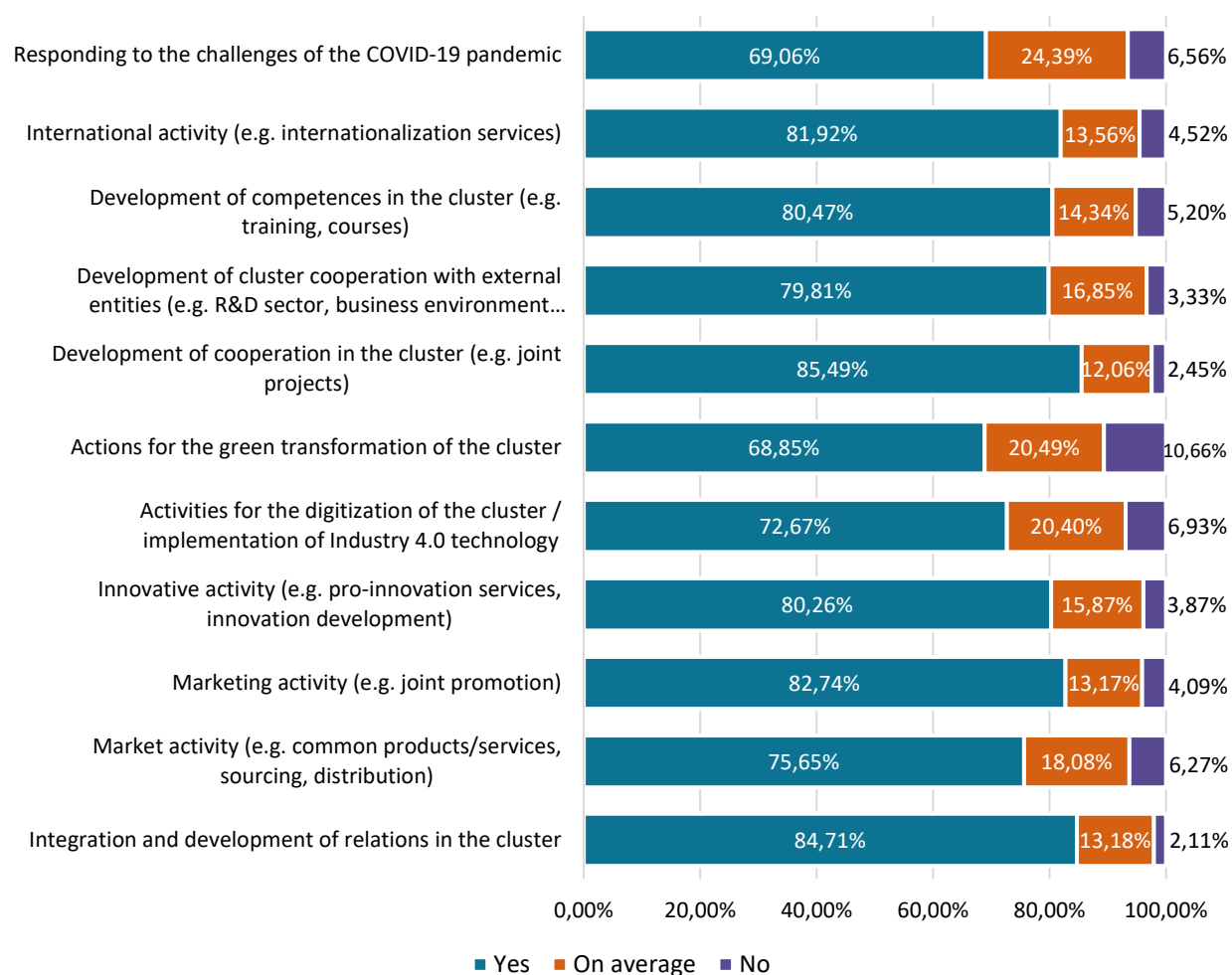In the next two years, from the point of view of cluster members, the most important areas will be the development of cooperation in the cluster (85.5%), integration and development of relations in the cluster (84.7%), marketing activity (82.7%) and international activity (81.9%). These results can be interpreted as high expectations of cluster members as to the role and activity of coordinators. The analysis omitted the answers "I don't know"/ "It's hard to say" because they did not bring any particular added value (for each category they were at the level of approx. 10%). It is worth mentioning that for most categories the significance of indications is higher by 3-8 pp. compared to the previous edition of the survey.

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

Area	Yes	On average	No
Responding to the challenges of the COVID-19 pandemic	69,06%	24,39%	6,56%
International activity (e.g. internationalization services)	81,92%	13,56%	4,52%
Development of competences in the cluster (e.g. training, courses)	80,47%	14,34%	5,20%
Development of cluster cooperation with external entities (e.g. R&D sector, business environment…)	79,81%	16,85%	3,33%
Development of cooperation in the cluster (e.g. joint projects)	85,49%	12,06%	2,45%
Actions for the green transformation of the cluster	68,85%	20,49%	10,66%
Activities for the digitization of the cluster / implementation of Industry 4.0 technology	72,67%	20,40%	6,93%
Innovative activity (e.g. pro-innovation services, innovation development)	80,26%	15,87%	3,87%
Marketing activity (e.g. joint promotion)	82,74%	13,17%	4,09%
Market activity (e.g. common products/services, sourcing, distribution)	75,65%	18,08%	6,27%
Integration and development of relations in the cluster	84,71%	13,18%	2,11%

■ Yes   ■ On average   ■ No

Source: research of cluster members (N=642).

In the opinion of the respondents, in the surveyed entities, participation in the cluster improved the functioning of such areas as: acquiring new customers/markets (48.5%), contractors (46%) and increasing technological advancement (41.1%). On the other hand, the indicator concerning the amount of exports (25.1%) and the green transformation (28.4%) fared quite poorly. It is worth noting that in the case of the latter, the principles related to the so-called European *Green Deal*[69]*,* including in the use of the circular economy concept, possession and implementation of environmental certificates, implementation of solutions resulting from the energy efficiency audit, R&D works in the field of low-carbon technologies or technological innovations in the field of green economy, production and distribution of energy from renewable sources and implementation of low-carbon economy projects conducted by the coordinator or cluster members. It is worth noting that nearly 31% of cluster members, thanks to their participation in the cluster, better met the challenges related to the COVID-19 pandemic.

Graph 42. Improvement of the functioning of the organization in selected areas
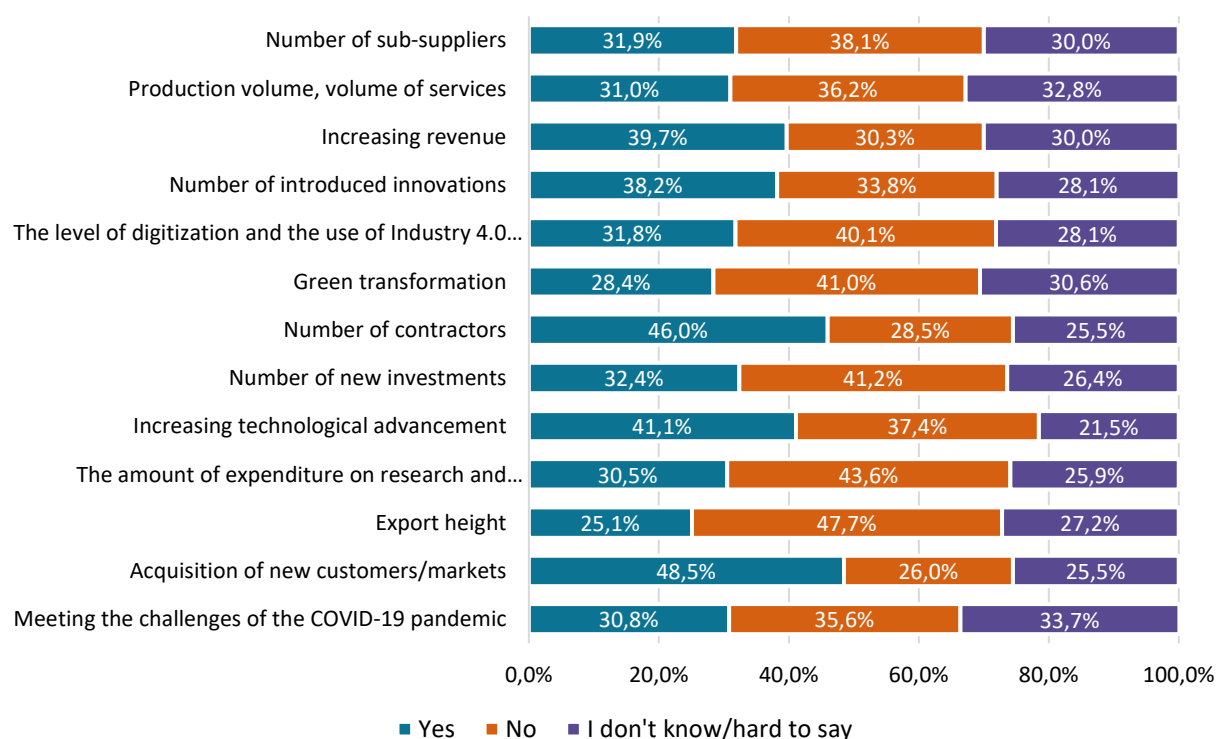
Source: research of cluster members (N=642).

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[69] The European Green Deal is a plan of action and policy initiatives of the European Union, the main goal of which is to transform the EU into a modern, resource-efficient and competitive economy, and to achieve climate neutrality by 2050. The European Green Deal also aims to improve the quality of life of European Union citizens through a cleaner environment, more accessible energy sources and new jobs. Investments in the renewable energy sector and improvement of energy efficiency are also planned as 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 of the value chain jointly implemented in the cluster declared by the coordinator[70]	Average: 3.5, median: 3.0, benchmark: 7.0. Out of the 7 possible stages of the value chain, the following were most often 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 declared cooperation within 5 or more stages of the value chain. On the other hand, only two clusters did not declare any jointly implemented stage of the value chain.
The number of categories of products and/or services acquired in the cluster as part of joint group purchases	Average: 1.4, median: 1.0, benchmark 5.0. From the list of 4 categories of products and/or services obtained in the cluster as part of joint group purchases, expert, consulting and training services were most often indicated (61%). Other categories were not so important: raw materials and production components (27%), consumables (20%) and energy (15%). The clusters had the option of indicating additional categories of products and/or services, hence the benchmark value is higher than the number of predefined categories. Additionally, it was indicated insurance services, organization of trips to fairs, courier services and hotel services.
The number of common distribution channels in the cluster	Average: 1.7, median: 1.0, benchmark: 5.0. From the list of 7 distribution channels, the following were most often indicated: joint stands, e.g. at fairs (73%) and joint offers in tenders (24%). Less popular were: jointly hiring an agent, exporter on 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 sales (7%).

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[70] 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 value of total sales revenues of enterprises in the cluster (change in the value of revenues 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 is consistent with the behavior of the entire economy, when, according to the Central Statistical Office data, the revenues of enterprises from total activity and revenues from the sale of products increased by approx. 23%. There are significant differences between the sectors in terms of changes in total sales revenue, which has been presented in more detail in Chapter 8. In the opinion of the coordinators, in 33% of cluster enterprises there was an increase in revenues as a result of the COVID-19 pandemic, and a decrease in 32% (in the remaining ones, no change). The assessment of this situation by cluster members is slightly more favourable: an increase in revenues was declared by 39.7% of members and a decrease by 30.3%.
Value of sales of products and services of cluster enterprises via electronic commerce (e-commerce)	Average: 89.7 million PLN, median: 0.0 million PLN, benchmark: 3,240.3 million PLN. Only 12 cluster coordinators declared the value of revenues from sales with the use of e-commerce by cluster enterprises.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.2.4. Marketing activity

In the sub-area of marketing activity, the median again reached a relatively high level (0.34). KKK, very large clusters and those with a written strategy subject to updating presented themselves the most favorably against the rest. The highest median level was obtained by clusters operating in the chemical, bioeconomy, material and energy engineering and construction sectors. Interestingly, clusters from the eastern macroregion had a certain advantage in this area. The benchmark was also relatively high (0.81). The results, in principle, were similar as in the case of the analysis of the median value. The best ratings were obtained by a large cluster (over 121 members), with the status of KKK, established before 2010 and having a written strategy that is subject to updating.

Graph 43. Median and benchmark for the marketing activity sub-area
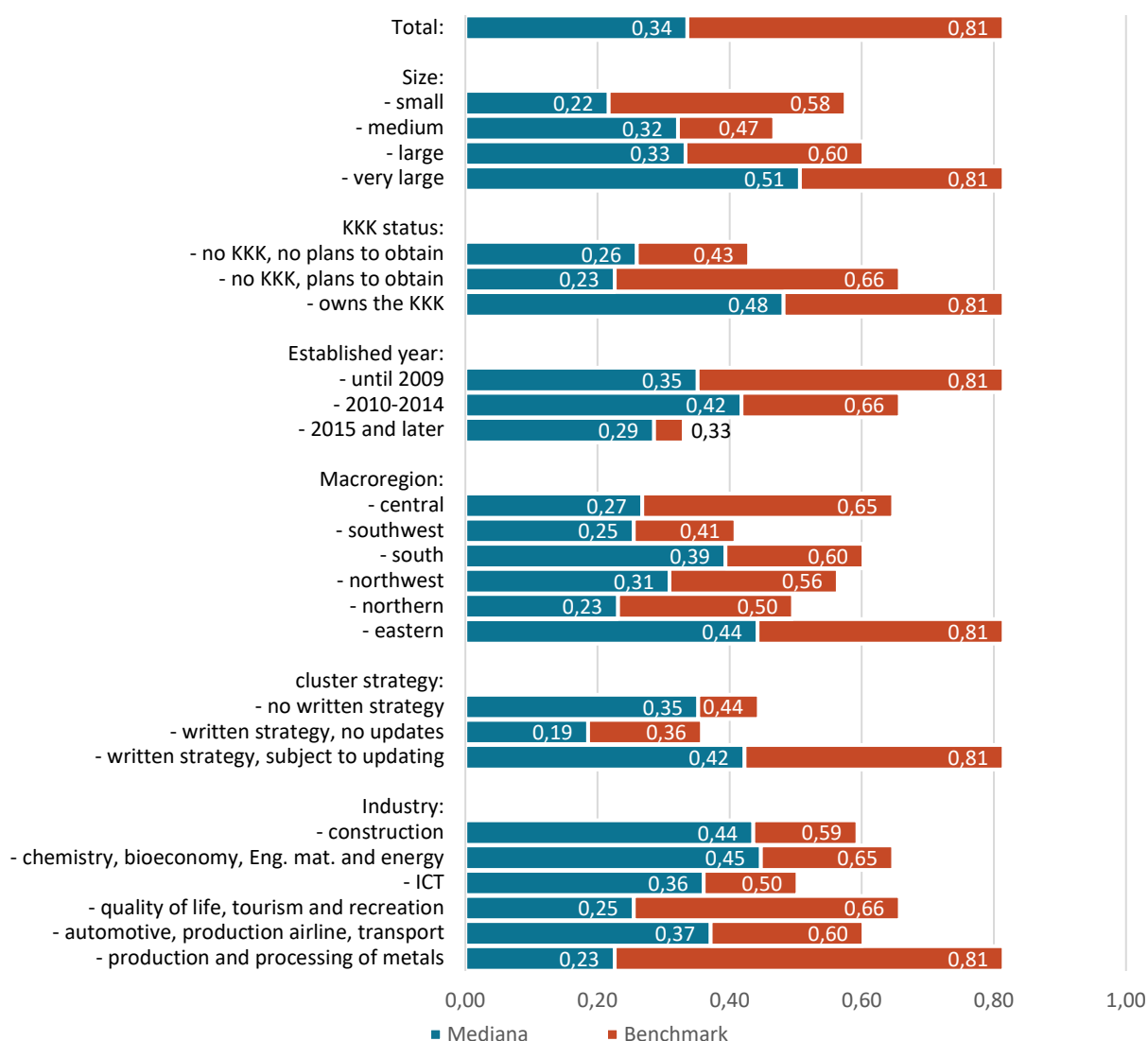
Source: own elaboration based on a survey of cluster coordinators (N=41).

One of the questions regarding the marketing activity of the clusters was conducting joint activities in the field of promoting the cluster and its members. The most frequently used activities include: creating a common cluster brand and logo (33 surveyed clusters), advertising activities (30) and public relations activities (29). In this respect, the sequence of actions is the same as in the previous edition of the survey. Sales activities were used less frequently.

Graph 44. Number of clusters with joint activities in the field of cluster promotion and its members
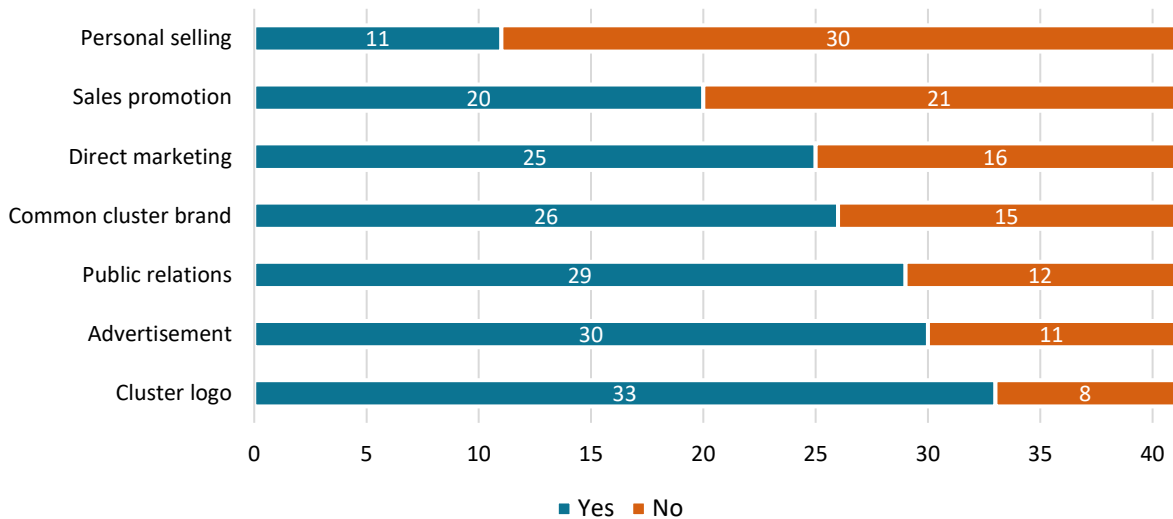
Source: own elaboration based on a survey of cluster coordinators (N=41).

About 3/4 of the clusters declared active participation in national fairs and exhibitions and organization of joint domestic trips (eg study trips, trade missions). The total number of exhibitions and fairs attended by the cluster was 153 (4.9 on average per active cluster in this area) and 277 other joint domestic trips (8.9 on average).

Graph 45. Joint activities to promote the cluster and its members
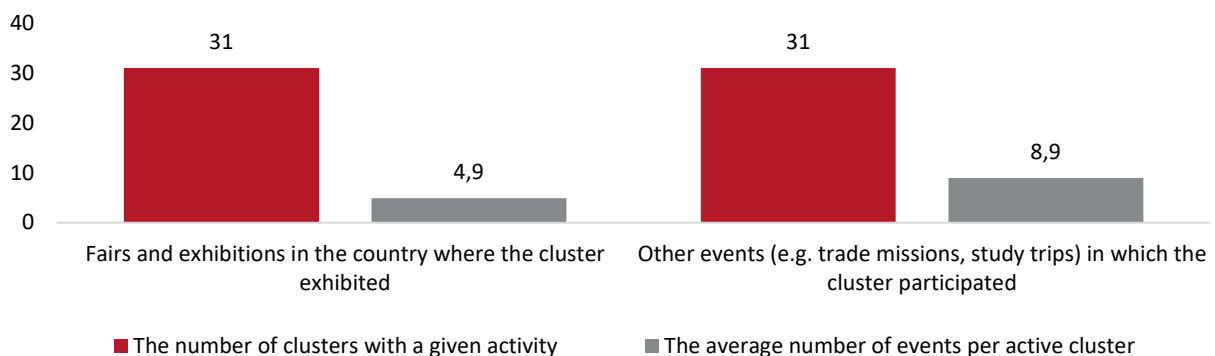
Source: own elaboration based on a survey of cluster coordinators (N=41).

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/Yahoo) generated in many cases inflated results. The best results were achieved by clusters with a relatively simple and short name.
Number of visits to the cluster's website	Average: 79.8 thousand, median: 8.6 thousand, benchmark: 1,143.3 thousand. Only some clusters (approx. 60%) were able to provide the number of visits to the website (some do not keep statistics in this regard).
Number of joint activities in the field of promotion of the cluster and its members	Average: 4.4, median: 5.0, benchmark: 6.0. From the list of 6 activities (with an option to indicate others) in the field of promotion, the following were most often 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 every fourth cluster (27%) used personal selling (in this case understood as a direct form of communication between the cluster coordinator and the external environment for the purpose of promoting the cluster and its members - e.g. sending information materials on the product offer of the cluster and its cluster members to potential contractors). Clusters could additionally indicate other actions taken. In this respect, items such as participation of the cluster in educational and similar events or conducting open webinars have appeared.
Number of fairs and exhibitions in the country where the cluster exhibited	Average: 3.7, median: 2.0, benchmark 28.0. Only 9 clusters did not record any activity in this area. 3 clusters presented themselves at more than 10 fairs and exhibitions.
Number of other events (e.g. trade missions, study trips) in which the cluster participated	Average: 6.8, median: 2.0, benchmark: 56.0. In this case, 10 clusters with no activity in this area were recorded. At the same time, 7 clusters declared to organize more than 10 events.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.2.5. Innovative activity

In terms of innovation activity, there is a high difference between the median (0.24) and the benchmark (0.93). This means a significant diversity in the population of the studied clusters in this sub-area. In terms of the median, KKK again gained a significant advantage (0.65) over the other clusters (0.20). It is interesting that clusters from the southern macroregion were more favorable in this comparison. The benchmark was set at a very high level, which means that a leader can be identified among the examined clusters, i.e. a very large cluster established before 2010, with the status of the KKK and a written strategy that is subject to updating.

Graph 46. Median and benchmark for the sub-area of innovative activity
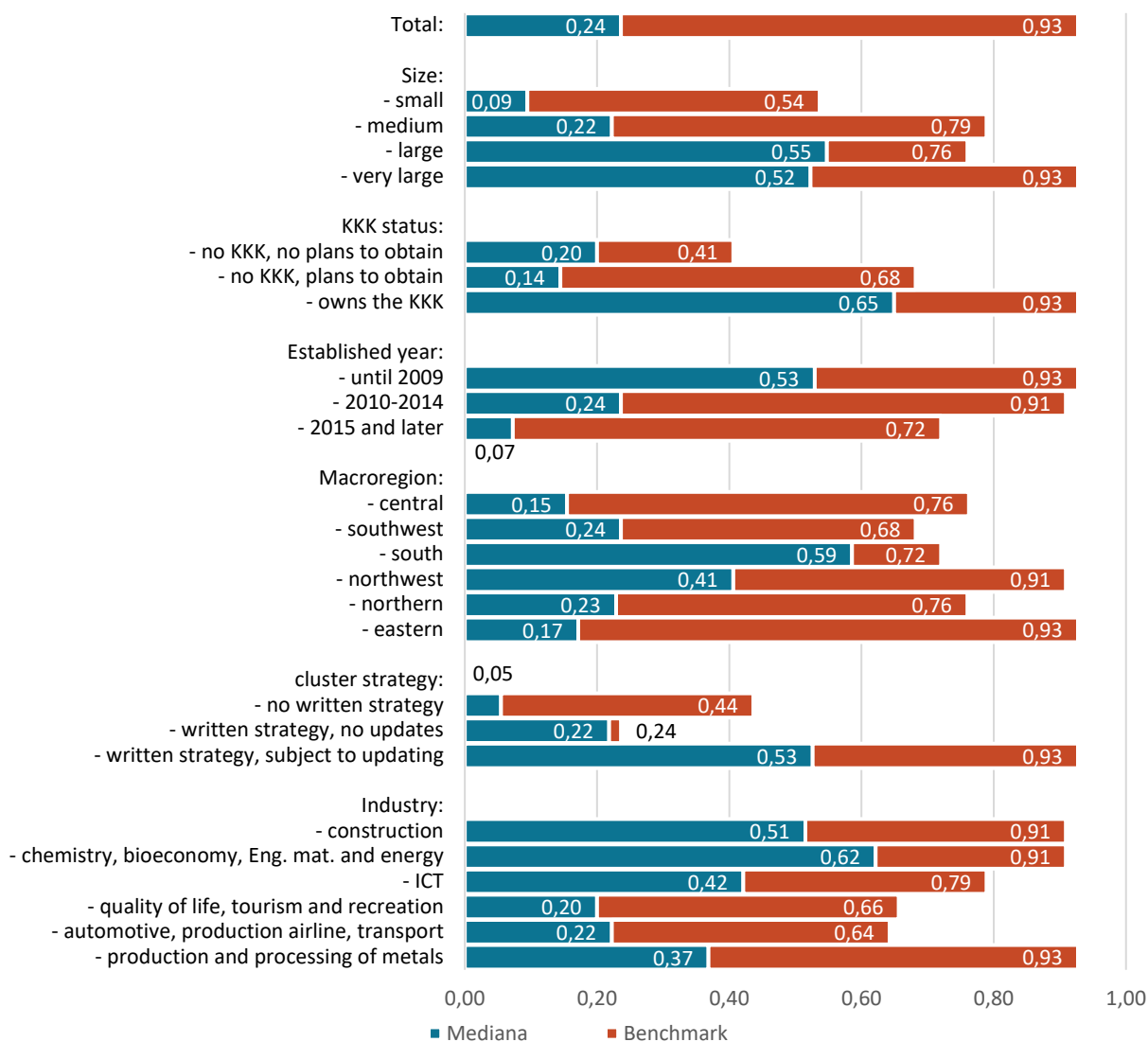
Source: own elaboration based on a survey of cluster coordinators (N=41).

The surveyed clusters undertook a number of activities to ensure access to pro-innovation services in the cluster. The way these services were offered differed significantly between clusters. They were provided directly by the cluster coordinator, by selected cluster members (e.g. business environment institutions) or they were commissioned to external entities. The most frequently offered services were specialized training (30 clusters), innovative consulting (28) and monitoring of technological trends (24). In the case of the last category of services, a significant increase was recorded compared to the previous edition of the benchmarking (by 6 out of 18).

Graph 47. Ensured access to pro-innovation services in the cluster
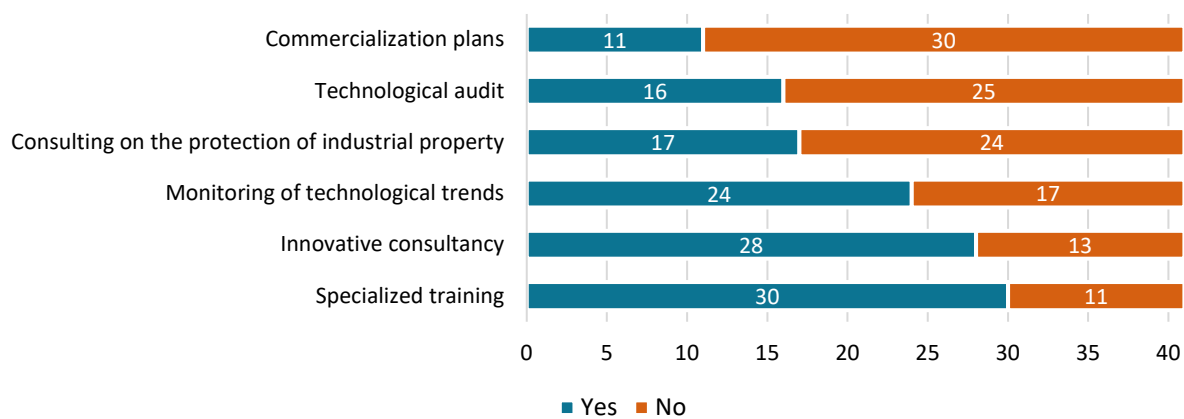
Source: own elaboration based on a survey of cluster coordinators (N=41).

In 2020–2021, the largest percentage of surveyed cluster members used pro-innovation services provided in the cluster by or through the cluster in the following areas: specialized training (47.2% of members used the services offered) and monitoring of technological trends (38.3%).

Graph 48. Using pro-innovation services provided in the cluster or through the cluster
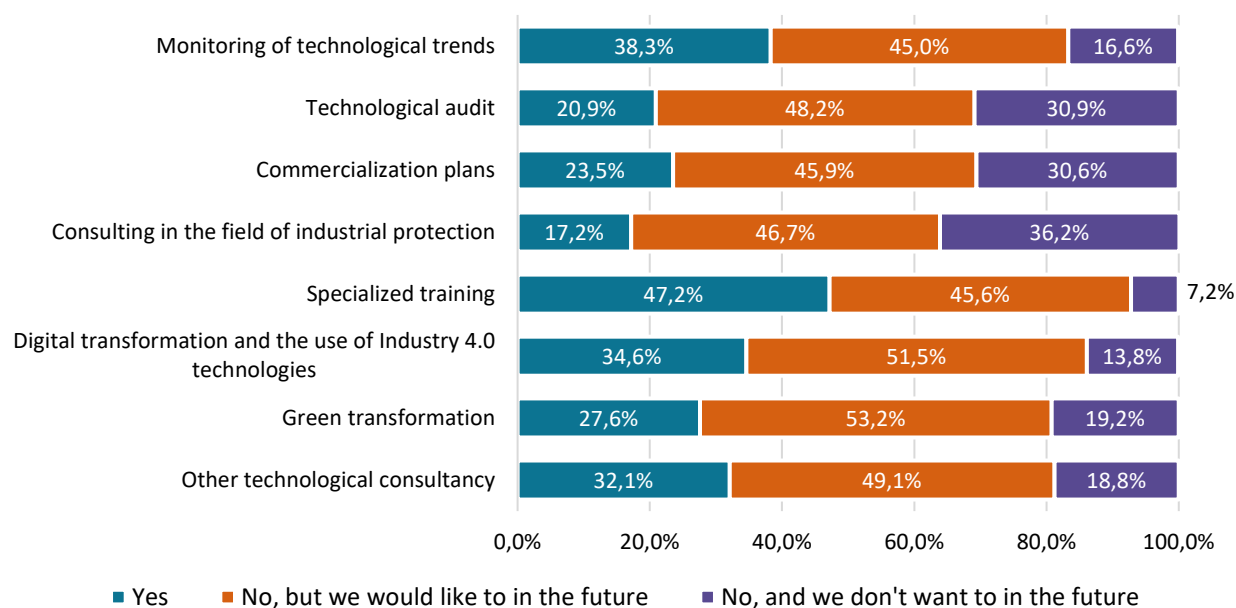
Source: research of cluster members (N=642).

The surveyed coordinators could also indicate other categories of pro-innovative services provided in the cluster. In the six clusters covered by the study, the following can be additionally indicated:

- Industry 4.0 demonstration services;
- incubation of projects at an early stage of development;
- specialized services within the European Digital Innovation Hub; technological scope includes i.a. AI/ML, IoT, VR/AR, Industry 4.0, Intralogistics, KDM, Big Data, Cloud;
- advice on building business models;
- networking services in the area of innovation creation and development;
- knowledge 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). From the list of 6 pro-innovation services, the following were most often indicated: specialized training (73%), innovative consulting (68%) and monitoring of technological trends (59%). A significant number of services (80) was declared by the cluster whose coordinator operates in the European Digital Innovation Hub cooperation network. More: graph no. 43 and commentary.
Functioning of an institution supporting 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 supporting technology transfer.
Purchase of knowledge and technology for the needs of the cluster (licences, know-how)	Knowledge and technology are purchased in 34% of clusters.
Number of cluster members who used pro-innovation services available in the cluster or through the cluster	Average: 13.4, median: 3.0, benchmark 80.0. Pro-innovation services were used by members of 63% of clusters, which means that in 26 clusters there is no access to such services. Only in the case of 8 clusters, more than 20 members benefited from pro-innovation services.
Number of technological audits carried out in cluster entities via the cluster	Average: 5.5, median: 0.0, benchmark 78.0. In the case of 59% of clusters, technological audits are not carried out (hence the zero median). In turn, only 4 clusters declared more than 10 audits.

Source: own elaboration based on a survey of cluster coordinators (N=41).
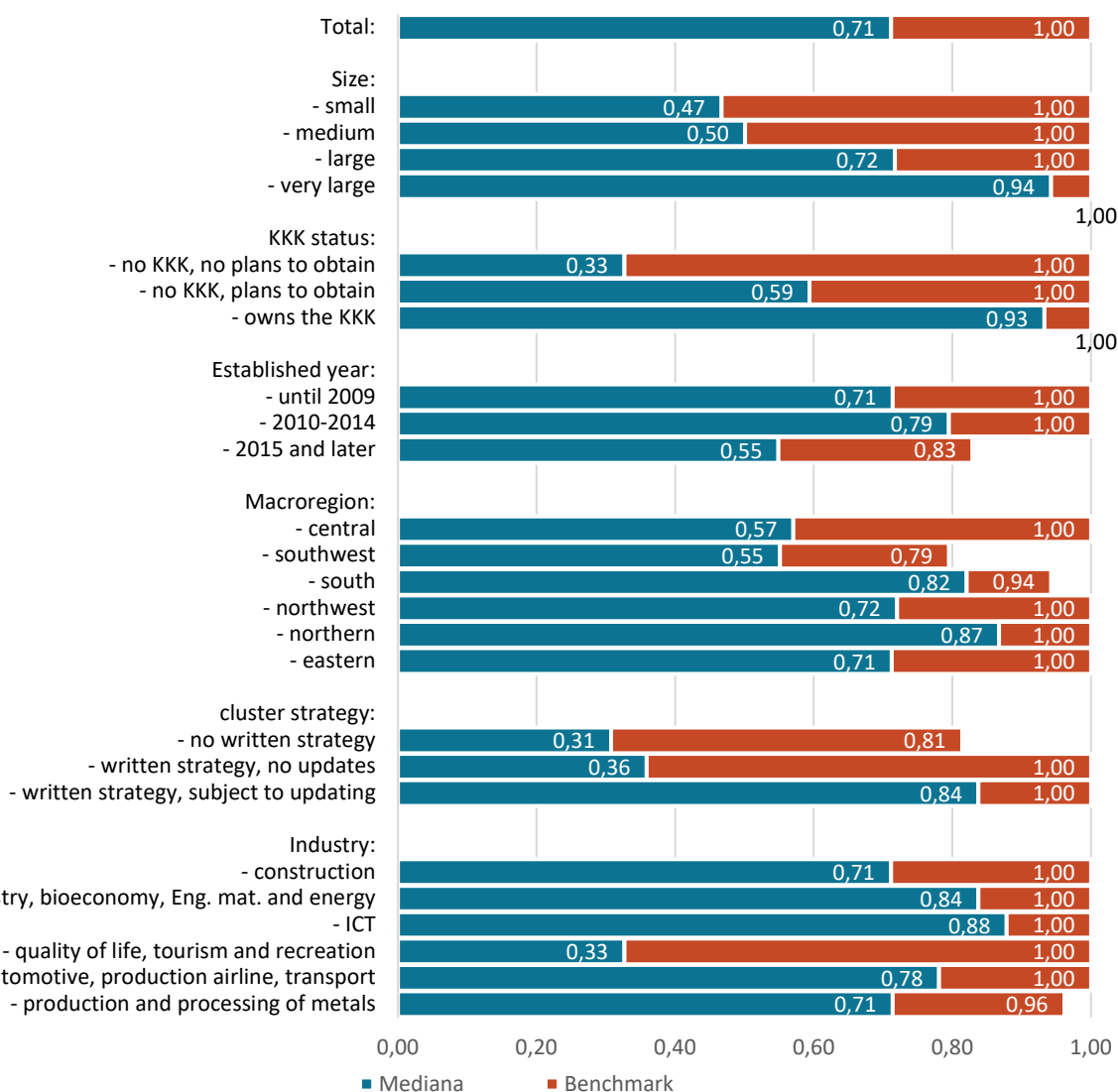
5.2.6. Cluster digitization

Only two indicators with a predefined cafeteria of answers were used to measure the digitization of clusters (use of IT systems at various stages of development and Industry 4.0 technology). Nowadays, the so-called digitization of the economy, which can be identified with the increasing penetration of IT systems among enterprises, public institutions or non-governmental organizations, as well as among employees, consumers and citizens[71]. The digitization of the economy is closely related to the so-called the fourth industrial revolution, also known as Industry 4.0. One of the paradigms of Industry 4.0 is e.g. adjusting the manufactured products to the customer's expectations, while maintaining low costs, high quality and efficiency. This is done using technologies such as digital platforms, block chains, Internet of Things, artificial intelligence, big data processing or machine learning. Penetration of IT systems and the aforementioned technologies in clusters was the subject of analysis within this area.

Due to the use of two indicators, the results are slightly differentiated (7 clusters obtained the maximum score of 1.00, which is also a benchmark). The best results in terms of the median were achieved by clusters operating for a long time, with the status of KKK, very large and having a written strategy that is subject to updating. Taking into account the geographical area of operation of the clusters, the best scores were obtained by the northern macroregion (median 0.87), which may be due to the industry characteristics of the clusters located in this area. Also in the southern region, very high scores were recorded (0.82), which in turn results from the presence of large and very large clusters with a high general level of development. From the industry side, it is not surprising that clusters from the ICT industry received the highest score (0.88).

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[71] 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

Category	Mediana	Benchmark
Total:	0,71	1,00
Size:		
- small	0,47	1,00
- medium	0,50	1,00
- large	0,72	1,00
- very large	0,94	1,00
KKK status:		
- no KKK, no plans to obtain	0,33	1,00
- no KKK, plans to obtain	0,59	1,00
- owns the KKK	0,93	1,00
Established year:		
- until 2009	0,71	1,00
- 2010-2014	0,79	1,00
- 2015 and later	0,55	0,83
Macroregion:		
- central	0,57	1,00
- southwest	0,55	0,79
- south	0,82	0,94
- northwest	0,72	1,00
- northern	0,87	1,00
- eastern	0,71	1,00
cluster strategy:		
- no written strategy	0,31	0,81
- written strategy, no updates	0,36	1,00
- written strategy, subject to updating	0,84	1,00
Industry:		
- construction	0,71	1,00
- chemistry, bioeconomy, Eng. mat. and energy	0,84	1,00
- ICT	0,88	1,00
- quality of life, tourism and recreation	0,33	1,00
- automotive, production airline, transport	0,78	1,00
- production and processing of metals	0,71	0,96

■ Mediana ■ Benchmark

Source: own elaboration based on a survey of cluster coordinators (N=41).

The digitization of clusters has been, at least partially, associated with the concept of Industry 4.0 for several years[72]. Industry 4.0 technology providers are largely ICT, high tech companies and R&D sector entities. They can become key partners in the supply of Industry 4.0 solutions for other cluster members. In addition, clusters with a dominant group of entities from the ICT area can create an offer addressed to both individual enterprises and other clusters. Clusters of this type can contribute to the permanent stimulation of technological changes, greater integration of the customer with the producer, efficient use of artificial intelligence, the emergence of new business fields and new professions on the labor market, and thus to

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[72] 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.

strengthening the innovation and competitiveness of the regional, national and European economy[73].

Analysis of partial indicators for sub-areas

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

Indicator	Comment
Number of IT systems used at particular stages of value chains in the cluster	Average: 5.7, median: 7.0, benchmark 9.0. From the list of 9 systems, the following were most often 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 (63%), systems for production resource management (59%), supply chain management and warehouse management (56% each) and business analytics (also 56%). As in the previous edition of the study, high positions were recorded by IT clusters. In addition, a number of clusters in the area of industrial processing (e.g. automotive, metalworking) or services (e.g. medical) also recorded 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 was indicated on a scale from 1 to 3, where 1 meant no use, 2 the start of digital initiatives and 3 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 following were most often indicated: IT systems (80%), cybersecurity (73%), 3D production (71%) and cloud computing (68%). At a moderate level, the following are used: big data analytics (61%), digital platforms (59%), Internet of Things (56%), autonomous robots (54%) and Industrial Internet of Things (51%). Less than half of the clusters use the following technologies: simulation (49%), artificial intelligence (41%), blockchain (37%) and artificial intelligence of things (29%). In the current year, a significant increase in the use of technologies based on artificial intelligence can be forecast, e.g. in connection with current achievements, including OpenAI (chat GPT) and others, which have gained wide interest from both business and individual Internet users.

Source: own elaboration based on a survey of cluster coordinators (N=41).

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

Area summary

- Within the area of cluster resources, management processes, communication in the cluster, market, marketing and innovation activity as well as digitization of the cluster were analysed.

- As in the previous edition of the study, relatively high median values were recorded for individual sub-areas. This proves the relatively good situation of clusters in this area (this concerned in particular the digitization of the cluster and management processes). High benchmark values (equal to or close to 1.00) for all sub-areas prove that clusters that obtained maximum or almost maximum scores in individual partial indicators participated in the study. The best clusters in this area gained a significant advantage over the others.

- Taking into account the opinions of cluster members, there is potential for improvement in the area of creating supply chains, joint actions to increase the quality of products and services / reduce the costs of doing business and influencing public authorities and other institutions. In these cases, the highest percentage of members declaring failure to achieve the objectives was recorded.

- There was a significant improvement compared to the previous edition of benchmarking in terms of jointly implemented stages of the value chain. Currently, 32% of the surveyed coordinators declared the implementation of 5 or more joint stages (including 17% of coordinators - all 7 stages). At the same time, it is worth noting that the coordinator's declarations are not always fully covered by the answers of cluster members (which is especially visible in reports dedicated to particular clusters). Members often indicate joint participation in more stages. This can be interpreted as a situation where part of the cooperation between members takes place without the direct involvement of the coordinator (which can be considered a positive aspect).

- In the current edition of the study, a significant percentage of cluster members declaring great benefits from cluster membership was noted (70%). This represents an increase of 20 percentage points. compared to the previous edition of the survey (when opinions were much more polarized).

- In the case of marketing and innovation activity, most of the results are similar to the previous edition of the survey (at least in terms of the order in which individual activities are declared). In most of these areas, slight positive changes were noted (where percentage ratios were used, it was usually an increase of 3-5 pp.).

5.3. Cluster results

Another of the researched areas, "Cluster results", concerned the assessment of cluster development in 2020-2021
in such sub-areas as:

- **Development of cooperation in the cluster** - incubation of new business activities (start-up, spin -off / spin -out companies) and their cooperation with large entrepreneurs, joint implementation of projects, building a joint market offer, joint sale, obtaining joint orders, strengthening public- public partnership private.
- **Development of innovation in a cluster** - joint R&D&I activity, including the implementation of product innovations and business processes, knowledge transfers in clusters, protection of industrial property.
- **Development of competences in the cluster** - number of initiatives increasing the competences of representatives of cluster members and the coordinator's staff.

In the area of results obtained by the cluster, the results of the current edition of benchmarking in terms of median and benchmark are more favorable than the 2020 edition. Despite this, the situation of clusters should be assessed quite poorly, especially in the area of innovation development. The median value in this criterion reached 0.13, which means that half of the clusters in the surveyed population showed negligible activity in this area.

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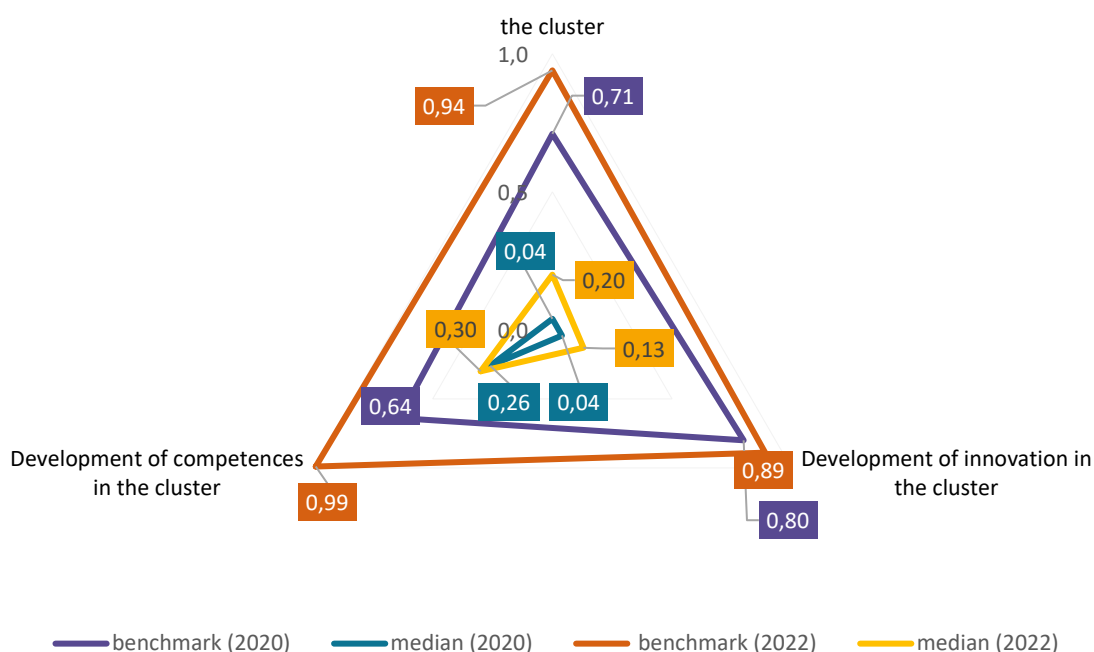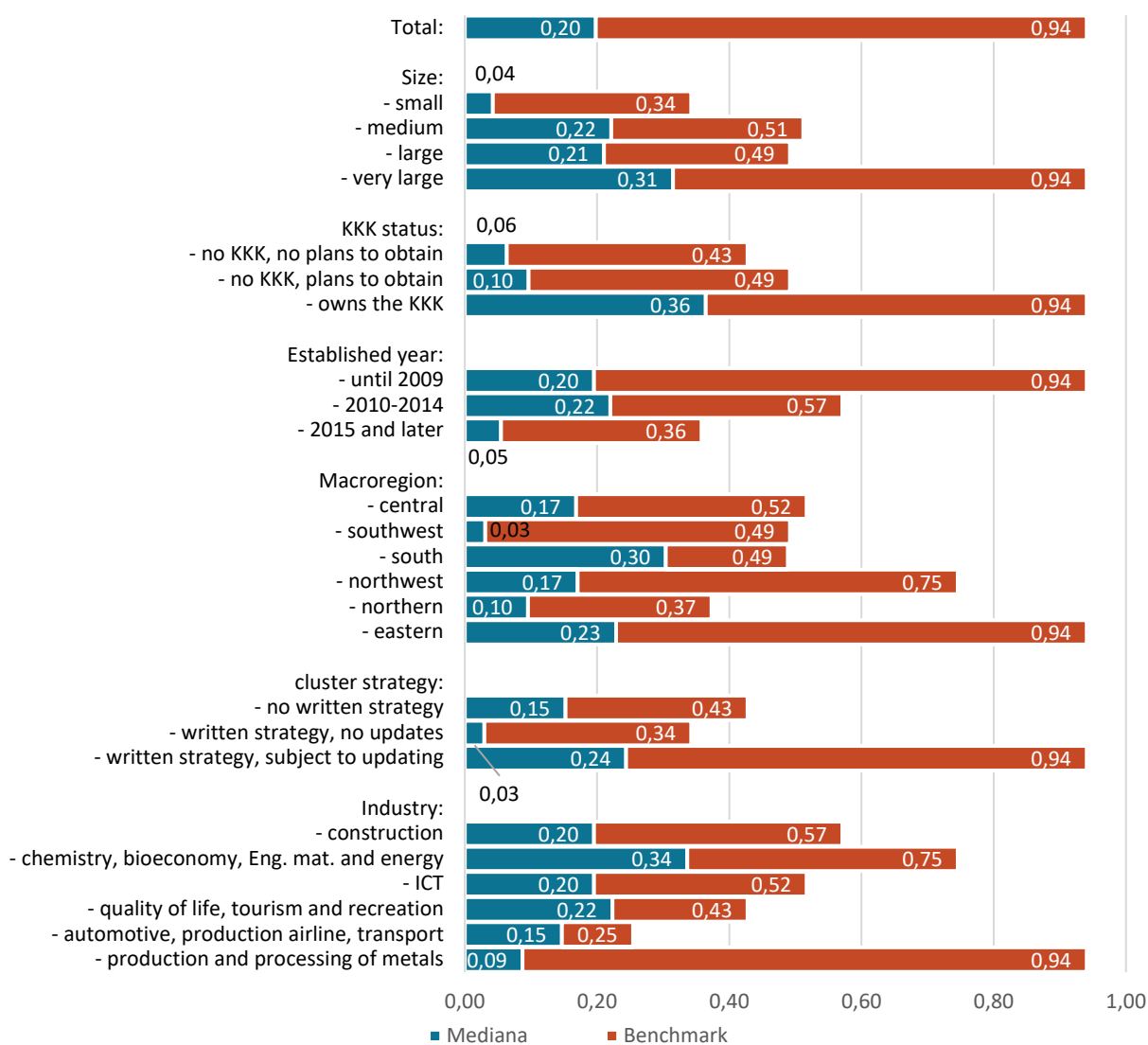

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.3.1. Development of cooperation in the cluster

The median value for the development of cooperation in the cluster reached a low level in relation to the benchmark value. This means that quite a significant group of clusters showed insignificant activity in the sub-area in comparison to the group of several best clusters. Again, the status of the cluster was important (in the case of KKK, the median value was much higher). The number of members was of the greatest importance. In very large clusters the median was 0.31, while in the smallest it was 0.04. The benchmark value illustrates a situation in which a very large cluster established before 2010 and having the status of a KKK and a written strategy subject to updating was rated the best.

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

Source: own elaboration based on a survey of cluster coordinators (N=41).

One of the manifestations of the development of cooperation in the cluster is the joint implementation of cluster projects. Such activity was declared by over 43.5% of the surveyed cluster members. This represents a slight decrease of 1.5 pp. compared to the previous edition of the study (which is within the statistical error). The meaning of projects in this case was broad, ie it concerned both projects co-financed from EU funds and others.

Graph 52. Joint implementation of cluster projects

Source: research 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 start- ups, spin -offs/ spin -outs and special purpose vehicles established in the cluster	Average: 1.9, median: 0.0, benchmark 14.0. In the case of 19 clusters, this type of activity was recorded. Only in two clusters the number of established enterprises and special purpose vehicles exceeded 10.
Documented cooperation of technological start- ups with large enterprises within cluster structures	Average: 2.0, median: 0.0, benchmark: 21.0. In the case of 20 clusters, this type of activity was recorded. In most cases, however, these were single occurrences.
Number of jointly implemented projects in the cluster co-financed from public funds	Average: 3.4, median: 2.0, benchmark 20.0. 32 clusters declared the implementation of joint projects co-financed from public funds. Only in the case of 3 clusters the number of projects was greater than or equal to 10.
Number of cluster members who participated in joint projects co-financed from public funds in the cluster	Average: 18.4, median: 10.0, benchmark 160.0. About 17.5% of members of all clusters participating in the study participated in joint projects. Only in the case of 11 clusters the number of members exceeded 20.

Indicator	All clusters
The value of jointly implemented projects in the cluster 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 9 clusters did not indicate the value of jointly implemented projects co-financed from public funds. On the other hand, a very large diversification of the value of these projects can be noted (the lowest ones amounted to PLN 10-20 thousand).
The number of common cluster products and services introduced to the offer	Average: 3.5, median: 1.0, benchmark: 16.0. 24 clusters declared introducing joint products and services to their offer. In most cases, the number of products and services did not exceed 10.
Number of cluster members who undertook joint production/implementation of joint services	Average: 7.0, median: 3.0, benchmark: 40.0. In the case of 25 clusters, the implementation of joint production/joint services by cluster members was indicated.
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 declared the value of sales of common products or services in the cluster (taking into account the previous indicator, probably more cases could be recorded, but they are very difficult to calculate from the coordinator's perspective).
Number of orders acquired by the coordinator or cluster members for joint implementation	Average: 6.2, median: 0.0, benchmark 100.0. Nearly half of the clusters (19) indicated obtaining orders for joint implementation. In the case of 7 clusters, it was 10 or more orders.
Number of PPP initiatives undertaken through the cluster	Average: 0.7, median: 0.0, benchmark 7.0. Only 7 clusters recorded PPP initiatives in this regard. Interestingly, one of the highest scores was obtained by a relatively poorly assessed cluster in the study. This is an example when each of the clusters is able to find an area in which it will obtain good results (cluster specialization).

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.3.2.   Development of innovation in the cluster

The median for the development of innovation in the cluster reached a very low level of 0.13. This means
that at least half of the surveyed clusters showed insignificant results in this sub-area compared to a few/over a dozen of the best organizations. In the case of this criterion, clusters with the KKK status (median 0.43) and clusters with a minimum of 121 members (0.49) and having a written strategy subject to updating (0.34) performed better. The best cluster reached the benchmark of 0.89, which means that it obtained maximum values in almost all criteria. It was a cluster founded before 2010, with the status of KKK, with over 121 members, with a written strategy that is subject to updating.

Graph 53. Median and benchmark for the innovation development sub-area
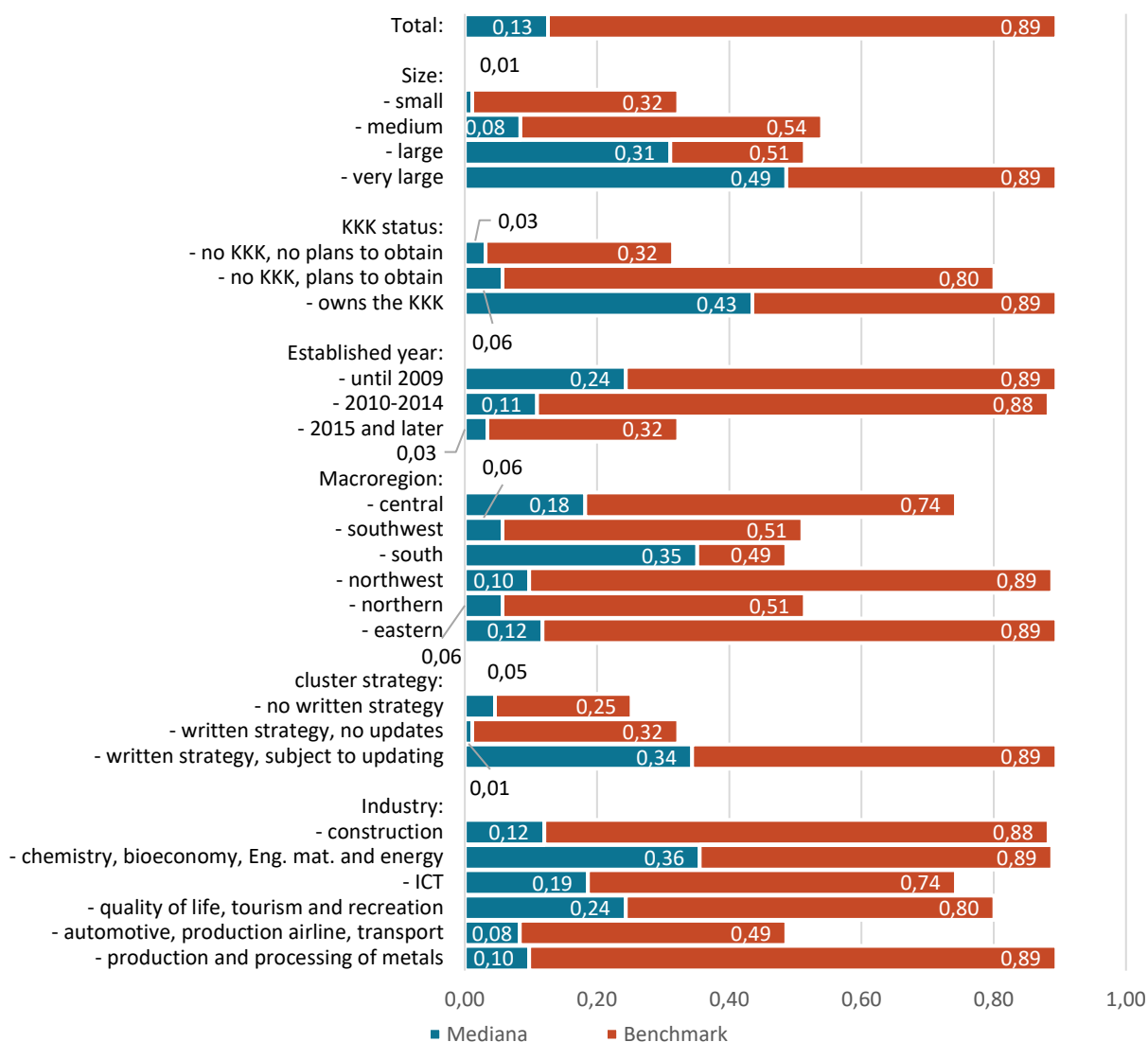
Source: own elaboration based on a survey of cluster coordinators (N=41).

Clusters have been perceived as an important element of innovation systems and innovation stimulators for many years. Such a role has already been noticed and described in detail in the OECD publication of 1999[74]. The European Commission perceives clusters as an important actor for increasing innovation and competitiveness of regional economies[75]. This was reflected in the Communication of the Commission of 22/01/2014[76], in which it is emphasized that the innovation-friendly potential of clusters should be better used as a way to support the development of innovative enterprises. In numerous presentations of the European Commission, the main axes of the European cluster policy are cited, the first of which treats clusters as accelerators of innovation and industrial change.

The development of innovation is one of the six goals set for the Eurocluster initiative (as of September 1, 2022, there were 171 partnerships from 23 countries in the Eurocluster network). Euroclusters participate in the redistribution of funds under various competition programs, most of which directly or indirectly support the development of innovation. The European Commission also notes the legitimacy of including clusters as participants in Digital Innovation Hubs in the area of providing innovative services and training[77]. On the domestic level, it is worth looking at the provisions of the document of the Ministry of Development, entitled Directions for the development of cluster policy in Poland after 2020, according to which in the coming years clusters should play an important role as centers of innovation, supporting their members, especially enterprises in the implementation of innovations.

One of the key indicators concerning the activity of coordinators in this area was the number of jointly implemented innovative and R&D projects in the cluster. 1/3 of the surveyed clusters did not show any activity in this regard. In the case of 59% of clusters, the number of implemented projects did not exceed 5. Only one cluster declared the implementation of 11 or more projects (this is a significant decrease compared to the previous edition of the survey, when it was 5 clusters).

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[74] Boosting Innovation. The Cluster Approach, OECD, 1999.
[75] www.interregeurope.eu/policylearning/news/8772/clusters-an-established-innovation-policy-for-regional-specialisation (accessed April 19, 2023).
[76] Actions for the renaissance of European industry, Brussels 2014.
[77] European Digital Innovation Hubs in Digital Europe Programme, European Commission, Brussels 2020.
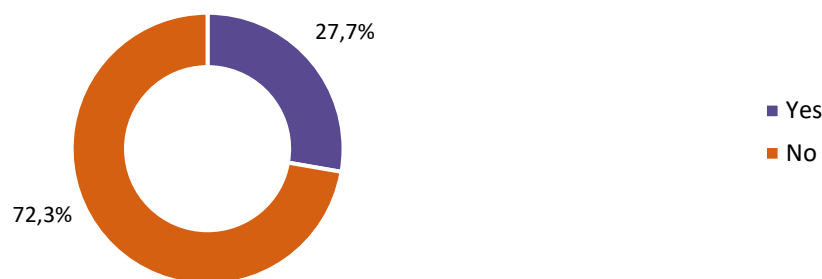
Graph 54. Number of implemented innovative and R&D projects in the cluster

Legend:
- 0 — 34%
- 1-5 — 59%
- 6-10 — 5%
- 11 and more — 2%
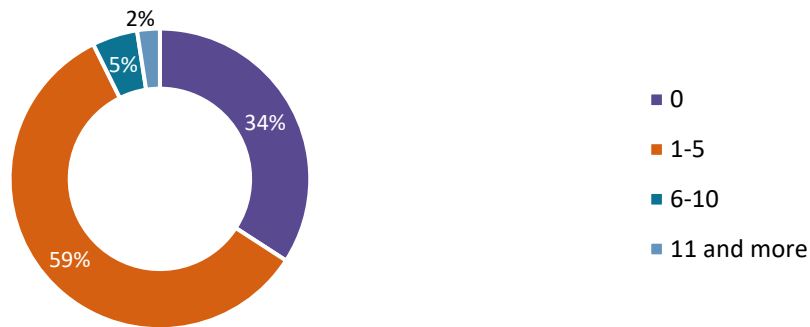
Source: own elaboration based on a survey of cluster coordinators (N=41).

Only 27.7% of cluster members participated in innovative and/or R&D projects in a cluster should be moderately assessed.

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

Legend:
- Yes — 27,7%
- No — 72,3%

Source: research of cluster members (N=642).

The direct effects of the implemented innovative and R&D projects in the cluster were the implementation of innovations, knowledge transfers and activity in the field of intellectual property protection. 24 clusters implemented product innovations, and a slightly smaller number, i.e. 20, implemented business process innovations. This is a significant increase (by nearly 50% compared to the previous edition of the survey). The number of implemented innovations per active cluster is also significant (on average 26.6 and 18.7 for the indicated types of innovation). In total, 638 product innovations and 373 business process innovations were implemented. Also a significant number of clusters (22) were involved in technology transfers. 153 transfers were declared (on average 7 per active cluster).

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

■ The number of clusters with a given activity   ■ Average number per active cluster
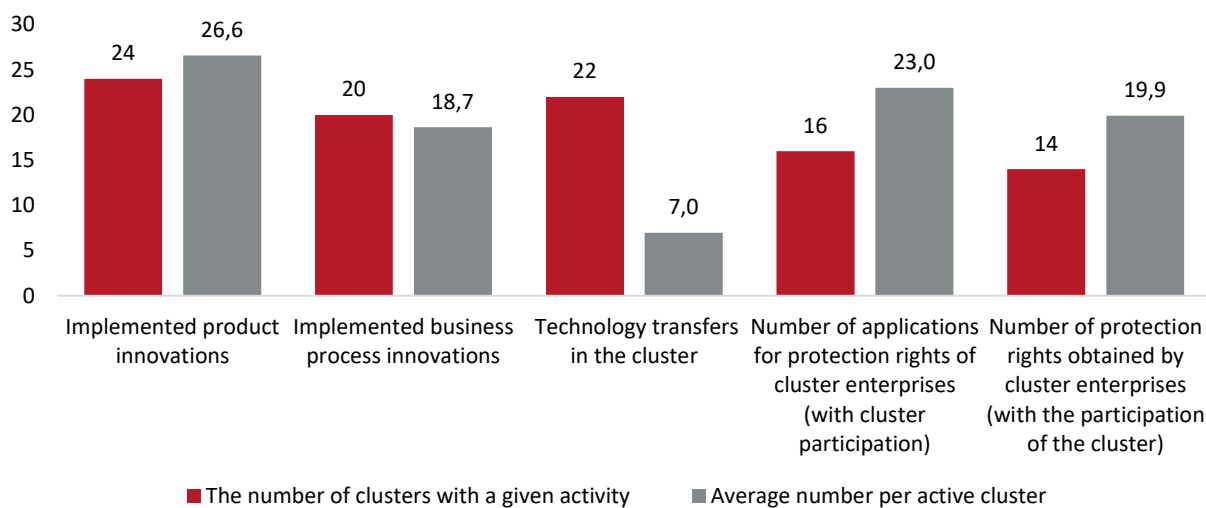
Source: own elaboration based on a survey of cluster coordinators (N=41).

An important manifestation of the development of innovation is activity in the field of intellectual property protection. In this area, the number of patents, patent applications, utility model protection rights and industrial design registration rights applied for and obtained by cluster enterprises with the participation of the cluster was examined. Such activity was declared by 16 clusters (applications) and 14 clusters (obtained rights). These values are very similar to the previous edition of the survey. The total number of registered protection rights amounted to 368, and obtained - 279.

It will be justified to look at the development of innovation also from the perspective of cluster members. Thanks to participation in the cluster, 37.1% of cluster members introduced product innovations and 32.4% introduced business process innovations. On the other hand, 50.9% of entities did not introduce any innovations as a result of being a cluster member. Introducing innovations often takes place with the participation of universities and entities of the science system, while models of cooperation in this area may vary significantly: from simple models in the form of non-institutional cooperation (individual contacts with researchers), commissioning R&D work and/or implementation innovation, to the creation of partnerships and the joint implementation of projects[78]. It is worth noting that about 50% of cluster members participating in the study positively assessed the role of the cluster in establishing cooperation in this area.

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[78] Poznańska K., Cooperation of enterprises with scientific entities in the field of innovation, Warsaw School of Economics, Warsaw 2017.

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

- Yes
- I don't know/hard to say
- No
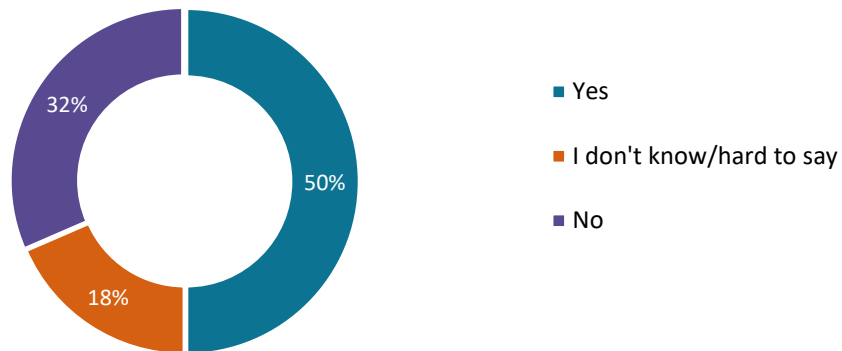
Source: research of cluster members (N=642).

It is worth mentioning that within this sub-area, less than half of the surveyed cluster members (41%) positively assessed the impact of participation in the cluster on the level of technological advancement in the activities of their enterprises. This illustrates an important aspect of clusters' activity in terms of popularizing technological solutions among their members. At the same time, it is a decrease of 9 pp. compared to the previous edition of the survey.

Graph 57. Impact of participation in a cluster on the level of technological advancement
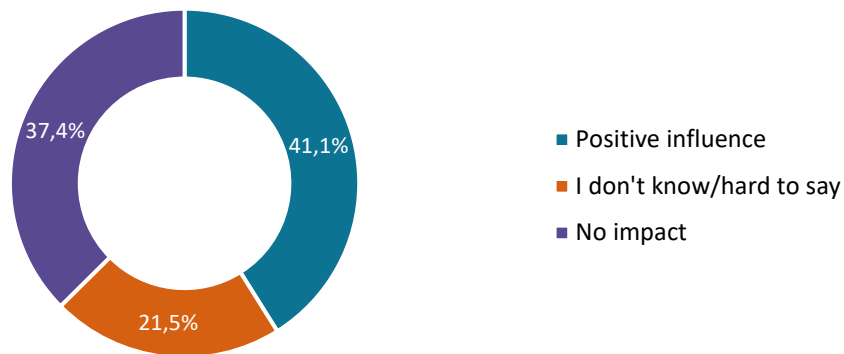
- Positive influence
- I don't know/hard to say
- No impact

Source: research 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
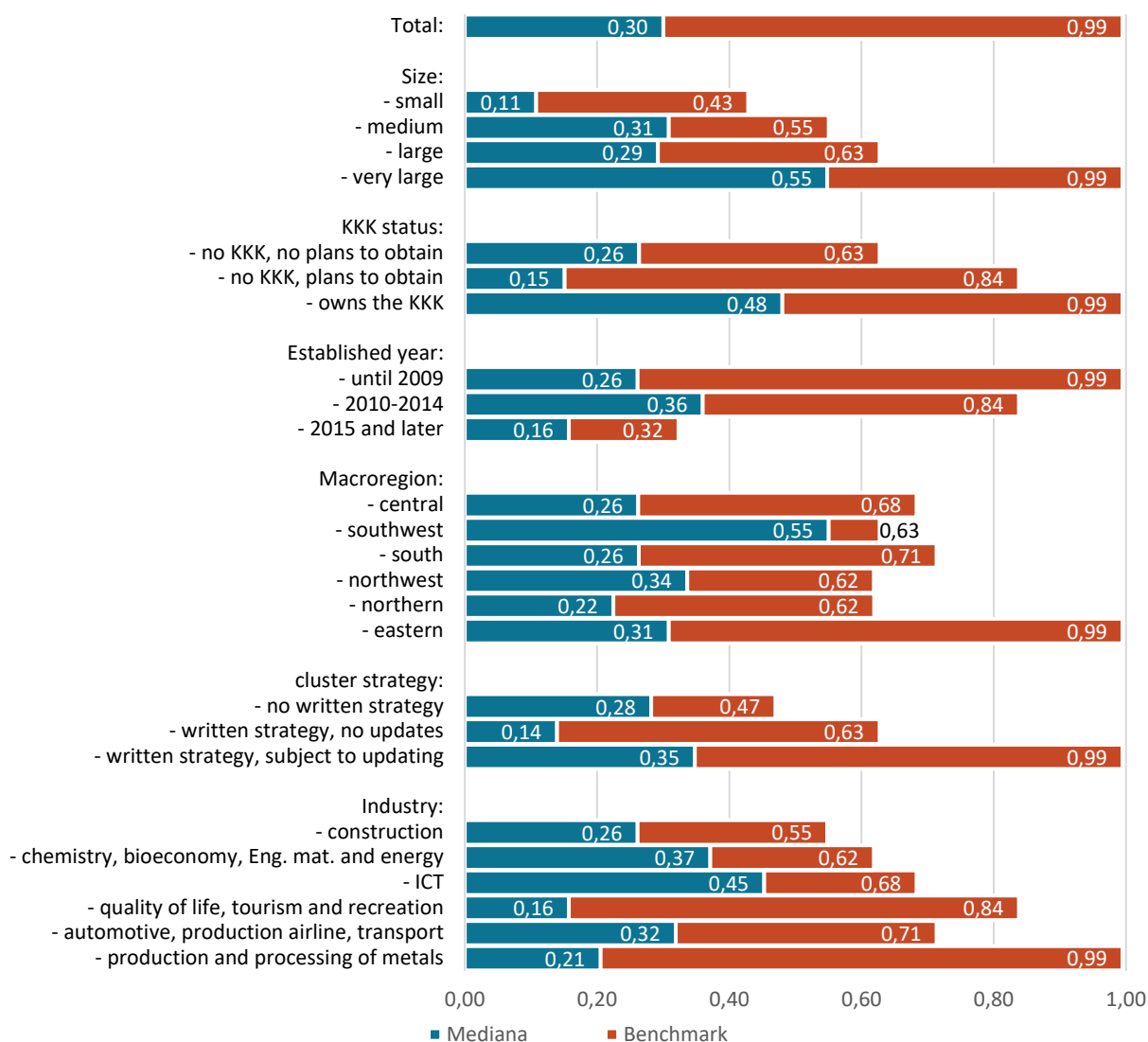
Indicator	All clusters
Number of jointly implemented innovative projects and R&D projects which result in/will be innovative products or technologies in the cluster	Average: 4.0, median: 2.0, benchmark: 73.0. 27 clusters declared the implementation of joint innovative projects. In most cases, the number of these projects did not exceed 5, and only in two cases it was greater than or equal to 10.
Number of cluster members who participated in joint innovation projects and R&D projects in the cluster	Average: 9.4, median: 4.0, benchmark: 96.0. In the case of most clusters, the percentage of members participating in projects was very low (approx. 9.2%, taking into account all clusters and their members).
The value of jointly implemented innovative projects and R&D projects in the cluster	Average: PLN 18.1 million, median: PLN 1.1 million, benchmark: PLN 206.6 million.
Number implemented innovation 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 cases, the number of implemented innovations did not exceed 5.
Number of implemented business process innovations	Average: 9.1, median: 0.0, benchmark: 123.0. In the case of 20 clusters, the implementation of innovations in business processes was recorded. Only in 7 cases the number of innovations exceeded 10.
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) declared the implementation of technology transfers within the cluster. In the case of 6 clusters, this number was greater than or equal to 10.
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. Less than half of the clusters (16) recorded participation in the notification of protection rights, and 14 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 not possible to directly calculate the success rate.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.3.3. Development of competences in the cluster

In the case of competence development in a cluster, the median reached a fairly high level of 0.30, which confirms the relatively even involvement of clusters. The advantage was achieved by clusters founded in 2010-2014 (median 0.36), having the status of KKK (0.48) and a written strategy subject to updating (0.35) and at least 121 members (0.55). The benchmark value illustrates a situation in which a very large cluster established before 2010, with the status of KKK and a written strategy subject to updating was rated the best.

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

| Category	Mediana	Benchmark
Total:	0,30	0,99
Size:		
- small	0,11	0,43
- medium	0,31	0,55
- large	0,29	0,63
- very large	0,55	0,99
KKK status:		
- no KKK, no plans to obtain	0,26	0,63
- no KKK, plans to obtain	0,15	0,84
- owns the KKK	0,48	0,99
Established year:		
- until 2009	0,26	0,99
- 2010-2014	0,36	0,84
- 2015 and later	0,16	0,32
Macroregion:		
- central	0,26	0,68
- southwest	0,55	0,63
- south	0,26	0,71
- northwest	0,34	0,62
- northern	0,22	0,62
- eastern	0,31	0,99
cluster strategy:		
- no written strategy	0,28	0,47
- written strategy, no updates	0,14	0,63
- written strategy, subject to updating	0,35	0,99
Industry:		
- construction	0,26	0,55
- chemistry, bioeconomy, Eng. mat. and energy	0,37	0,62
- ICT	0,45	0,68
- quality of life, tourism and recreation	0,16	0,84
- automotive, production airline, transport	0,32	0,71
- production and processing of metals	0,21	0,99

■ Mediana   ■ Benchmark

Source: own elaboration based on a survey of cluster coordinators (N=41).

The survey of cluster members shows that over 61% of them participated in joint forms of improving competences initiated by the cluster (increase by 2 percentage points compared to the previous edition of the survey).
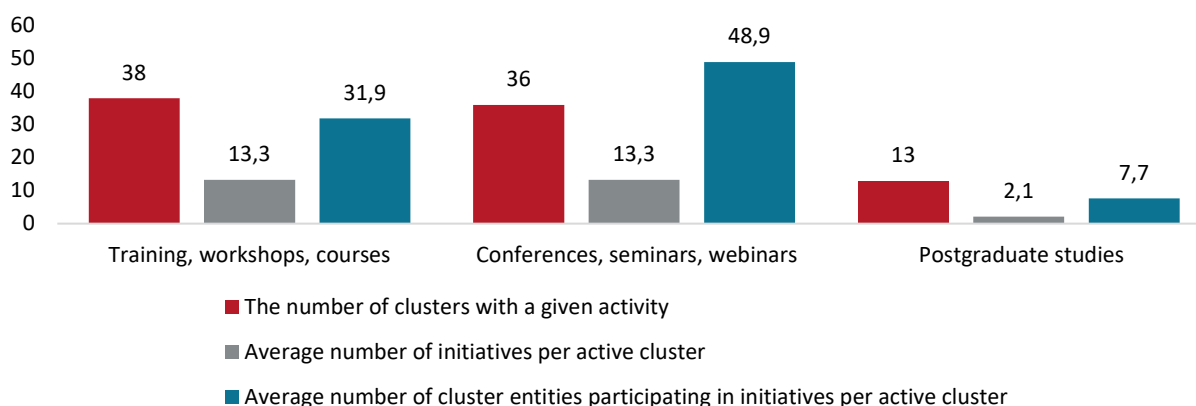
Graph 59. Percentage of cluster entities that participated in common forms of improving competences initiated by the cluster

39,3%

60,7%

■ Yes
■ No
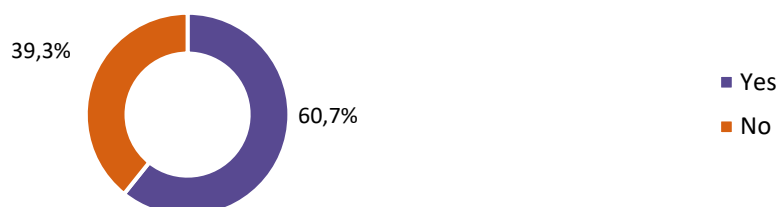
Source: research of cluster members (N=642).

The most frequently used form of improving competences in clusters were trainings, workshops, courses (38 clusters with this form of activity) as well as conferences, seminars and webinars (36 clusters). It is worth noting a fairly high number of cluster members participating in these areas of activity (on average 32 and 49 for these activity groups). Less than 1/3 of the clusters (13) declared running initiatives in the area of post-graduate studies for their members. In the case of the aforementioned forms of activity, their topics were very diverse. It covered both general and non-specialist areas, such as: employee issues (remote work, employee capital plans), marketing and promotion, competition law, quality systems, EU funds, competences of the future, resource management, export or digital transformation. Numerous trainings were also of a very specialized nature, e.g. Industry 4.0 technologies, cybersecurity or strictly related to the cluster industry (e.g. 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

	Training, workshops, courses	Conferences, seminars, webinars	Postgraduate studies
The number of clusters with a given activity	38	36	13
Average number of initiatives per active cluster	13,3	13,3	2,1
Average number of cluster entities participating in initiatives per active cluster	31,9	48,9	7,7

■ The number of clusters with a given activity
■ Average number of initiatives per active cluster
■ Average number of cluster entities participating in initiatives per active cluster

Source: own elaboration based on a survey of 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 2 clusters did not declare activity in terms of improving the competences of cluster members. In most cases (26) there were 10 or more initiatives per cluster. In addition to the forms of improving competences discussed on the previous page, the coordinators also indicated implementation doctorates.
Number of cluster entities that participated in common forms of improving competences initiated by the cluster (broken down by forms of improving competences)	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 indicated. It should be noted, however, that the indications regarding this indicator allow 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 8 clusters it was greater than or equal to 100. Taking into account the method of constructing the indicator, the highest activity was recorded in large and very large clusters, especially in the area of ICT.
Number of trainings improving competences attended by employees of the cluster coordinator (delegated to service the cluster)	Average: 5.8, median: 4.0, benchmark: 20.0. Only 6 clusters did not record any activity in the area of training for the coordinator's employees.

Source: own elaboration based on a survey of cluster coordinators (N=41).

Area summary

- Within the area of cluster results, the development of cooperation, innovation and competence in the cluster was analyzed. Quite low values of the median in terms of the development of cooperation and innovation mean that about half of the clusters fared very poorly compared to the others (i.e. they do not take up more activity in these areas). For these areas, it is also possible to indicate leaders who clearly outperformed most of the clusters. These were mostly very large or large clusters with a fairly diverse industry profile (including ICT, construction, metal industry, chemistry and bioeconomy).

- Involvement in the implementation of joint cluster projects was declared by 43.5% of cluster members, which is only a slightly lower percentage than in the previous edition of the study.

- The development of innovation in the cluster understood as the implementation of joint innovation projects and R&D projects should be assessed at a moderate level. 1/3 of clusters are not active in this respect. At the same time, the intensity of these activities decreased compared to the previous edition of the study (e.g. a significant decrease in the number of clusters implementing more than 10 projects, i.e. five clusters in the previous edition of the study compared to one cluster in the current one). The percentage of cluster members participating in these projects is quite low (27%).

- Despite a moderate level of participation in innovative and R&D projects, the activity of clusters in the field of innovation implementation should be assessed quite well. There was a fairly significant increase in the result compared to the last edition of the survey. Currently, 24 clusters declared the implementation of product innovations, and 20 – business process innovations.

- Cluster coordinators were very active in undertaking activities aimed at improving competencies in the cluster (e.g. training, workshops). The subject matter of the training was very diverse. It is worth noting that in the majority of clusters the trainings conducted were of a specialist and sectoral nature.

5.4.   Impact on the environment

Within the examined area, the following sub-areas were assessed:

- **Cooperation with the environment** - cooperation of the cluster with external entities such as: public authorities, business environment institutions, the R&D and education sector and other associations of enterprises, including other clusters.
- **Influence on shaping the conditions of the environment** - participation in consultative bodies at the national and regional level, activities influencing the society and of a lobbying nature.
- **Impact on the natural environment** – number of initiatives aimed at improving the condition of the natural environment.
- **Specialization and advanced technologies** – the number of enterprises conducting business activity in the area of the National Smart Specialization and Regional Smart Specialization dominant for the cluster, and the number of enterprises operating in the area of technologies conditioning the future economic development of the EU (so-called KET – key technologies).

Both in the previous and the current edition of the study, very high benchmark values can be observed for three out of four sub-areas in terms of impact on the environment (impact on the environment, impact on the natural environment, specialization and technological advancement). This means the presence of one or a group of clusters obtaining very high scores in these areas. In the previous edition of the study, there was a very large group of clusters with very poor results in terms of impact on the environment (median 0.11) and impact on the natural environment (median 0.01). It is worth noting that in the current edition, the results for these areas have significantly improved (median at the level of 0.44 and 0.43, respectively). On the other hand, there was also a slight decrease in the value of the median in the area of specialization and advanced technologies. With the growing number of cluster members, this may mean their greater sectoral diversification (moving away from narrow specialization in favor of interdisciplinarity in undertaken activities).

Graph 61. Values of subsynthetic indicators in the area of impact on the environment for the 2020 and 2022 editions of the study.
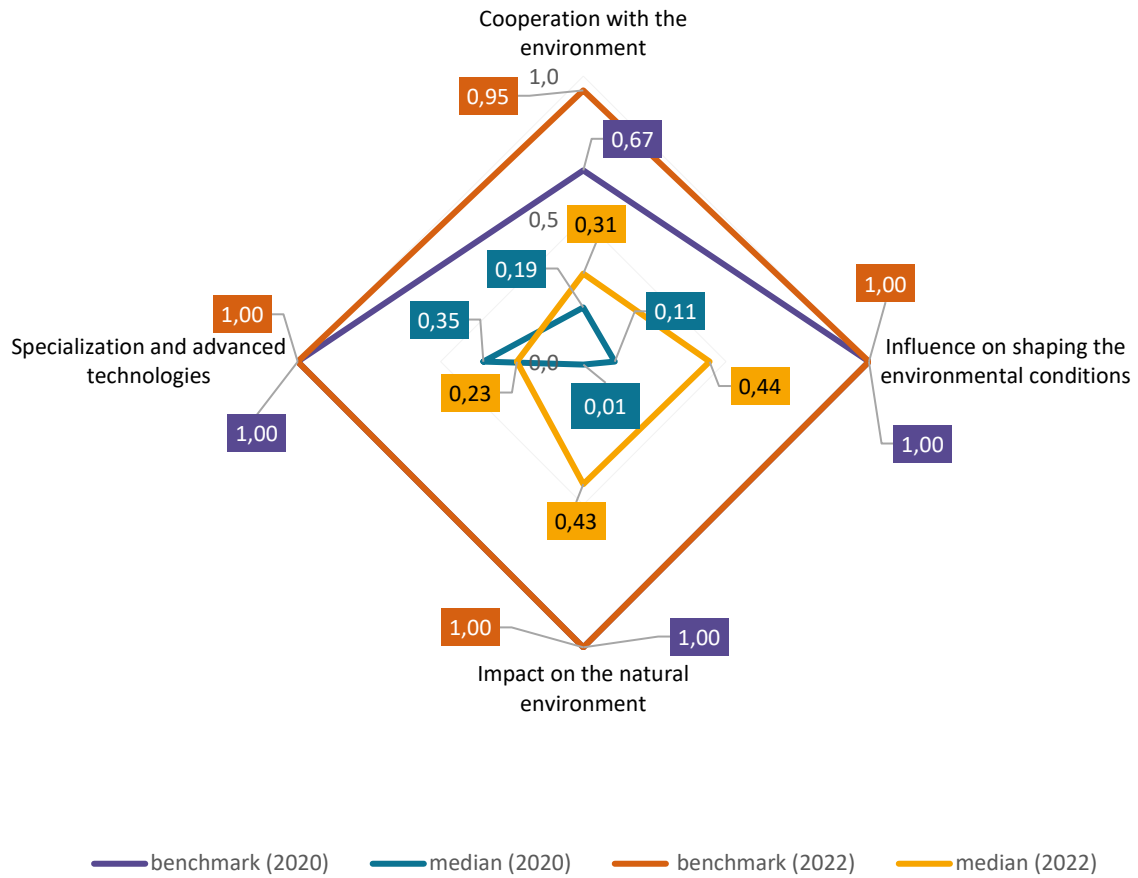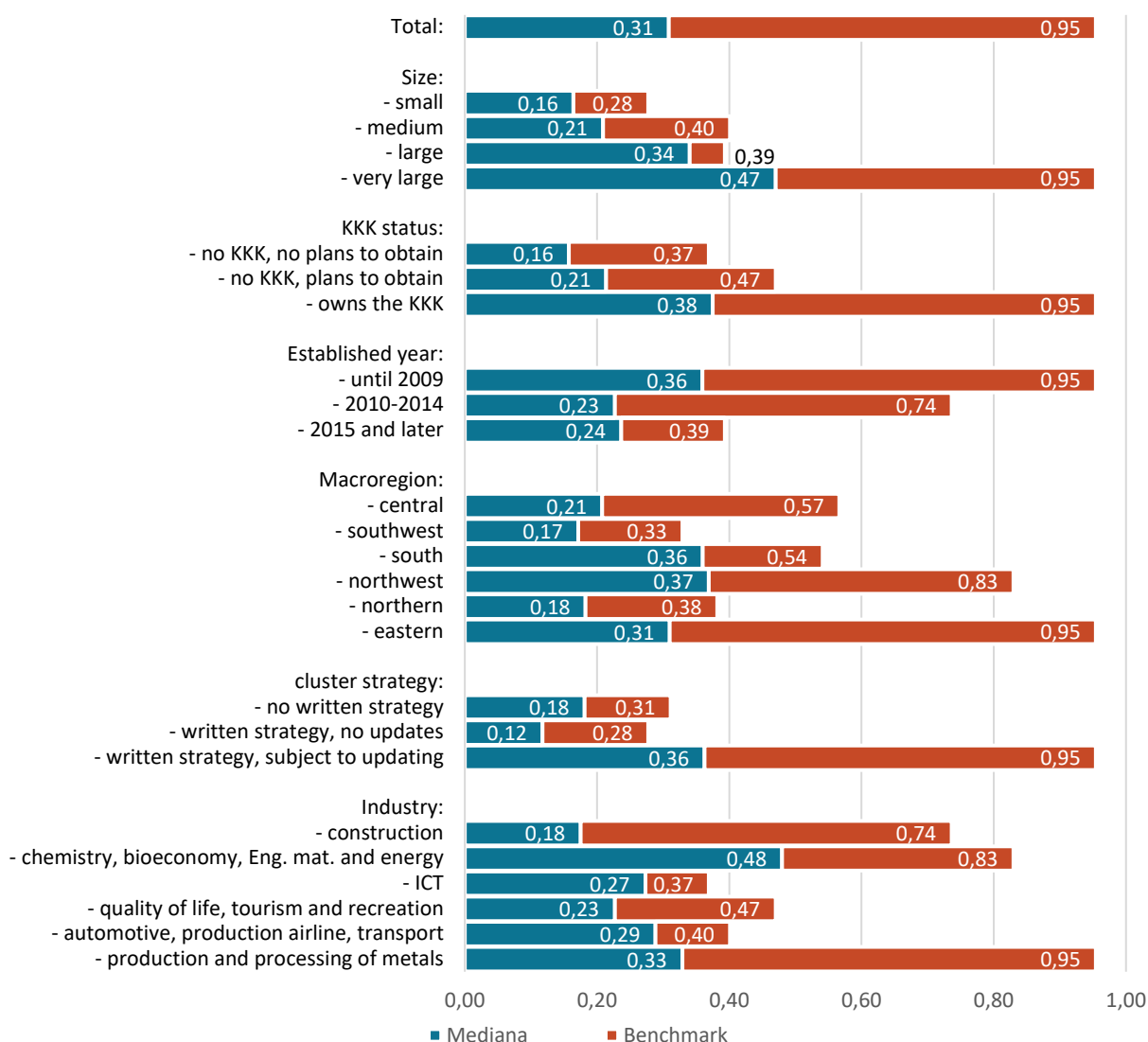

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.4.1. Cooperation with the environment

In terms of cooperation with the environment, a high difference can be noticed between the median (0.29) and the benchmark (0.95). This means a significant diversity in the population of the studied clusters in this sub-area. In terms of the median, KKK again gained a significant advantage (0.41) over the remaining clusters (0.21 and 0.26). The benchmark was set at a very high level, which means that a leader can be identified among the examined clusters, i.e. a very large cluster established before 2010, having the status of the KKK and a written strategy that is subject to updating.

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

Category	Mediana	Benchmark
Total:	0,31	0,95
Size:		
- small	0,16	0,28
- medium	0,21	0,40
- large	0,34	0,39
- very large	0,47	0,95
KKK status:		
- no KKK, no plans to obtain	0,16	0,37
- no KKK, plans to obtain	0,21	0,47
- owns the KKK	0,38	0,95
Established year:		
- until 2009	0,36	0,95
- 2010-2014	0,23	0,74
- 2015 and later	0,24	0,39
Macroregion:		
- central	0,21	0,57
- southwest	0,17	0,33
- south	0,36	0,54
- northwest	0,37	0,83
- northern	0,18	0,38
- eastern	0,31	0,95
cluster strategy:		
- no written strategy	0,18	0,31
- written strategy, no updates	0,12	0,28
- written strategy, subject to updating	0,36	0,95
Industry:		
- construction	0,18	0,74
- chemistry, bioeconomy, Eng. mat. and energy	0,48	0,83
- ICT	0,27	0,37
- quality of life, tourism and recreation	0,23	0,47
- automotive, production airline, transport	0,29	0,40
- production and processing of metals	0,33	0,95

Source: own elaboration based on a survey of cluster coordinators (N=41).

Analysis of partial indicators for sub-areas

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

Indicator	All clusters
Number of active cluster cooperation agreements with public authorities (local and central government)	Average: 2.4, median: 2.0, benchmark: 20.0. Over 1/3 of clusters (15) do not have any active cooperation agreement with public authorities. It is e.g. the effect of relatively low involvement of public authorities in cluster activity in a more advanced model (only 16 clusters have local government units – LGU as partners, but it does not necessarily have to be the LGU's membership in the cluster, there might be cooperation agreements).
Forms of cluster support from public authorities	Average: 1.85, median: 2.0, benchmark: 7.0. From the list of 5 forms of support, the following were most often indicated: promotion support (51%), financial support (46%) and training and education support (39%). Organizational support (27%) and legal support (10%) were much less important. Clusters could indicate additional forms outside the cafeteria (hence the benchmark is higher than the list of forms of support). The clusters additionally indicated, among others, the CORNET initiative at the National Center for Research and Development, competitions of the Marshal's Offices, economic missions.
Number of active cluster cooperation agreements with business environment institutions (BEI)	Average: 3.3, median: 2.0, benchmark: 16.0. Over 3/4 of clusters (32) have active cooperation with BEI. The quite common presence of business environment institutions in cluster activities has a number of reasons. Often the BEI is the cluster coordinator. Secondly, business environment institutions are often interested in joining the cluster, e.g. striving to expand the potential pool of contractors. At the same time, BEI can provide a number of useful services to the cluster coordinator and members. One of the most important business environment institutions in clusters in the context of the KKK status are e.g. innovation centers certified by the Ministry of Development and Technology. Clusters in the competition for the KKK status need to have 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 4 possible areas of cooperation, the following were most often indicated: cooperation with selected scientists (73%), cooperation in teaching (66%) and joint implementation of projects (61%). Clusters could indicate additional areas of cooperation outside the cafeteria. Among others, initiatives in the field of creating demonstration laboratories, or joint organization of trips to fairs were indicated.
Number of active cluster cooperation agreements with R&D and education sector institutions	Average: 3.9, median: 3.0, benchmark: 16.0. Only 10 clusters do not have an active cooperation agreement with R&D sector institutions. It is worth noting that only in the case of 3 clusters one agreement is 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. 29 clusters were involved in creating new fields of study. Most clusters were involved at the level of higher education (24 clusters, 60 launched majors) and postgraduate studies (17 clusters, 29 majors). On the other hand, quite a few clusters (14) were involved in creating courses at the level of 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 distorts (significantly overstates) the value of the average. If this cluster were to be excluded from the list, then 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. 22 clusters have an active cooperation agreement with another national cluster. Only in two cases this number was higher than 5 and amounted to 8 and 22 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 in the case of domestic cooperation, as evidenced by the almost twice higher average number of contracts. Additionally, more (24) clusters 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 cluster cooperation agreements with other associations of enterprises	Average: 1.8, median: 1.0, benchmark: 19.0. 23 clusters are active in this area (which is evident from the relatively low value of the median). Only 2 clusters have 10 or more signed agreements.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.4.2. Influence on shaping the environmental conditions

The median for the sub-area of impact on environmental conditions reached a relatively high level of 0.44. In this case, the year of the cluster's establishment and its location did not matter much. Clusters operating in the chemistry, bioeconomy, materials and energy engineering industries (median 0.79), having the status of KKK (0.65) and a written strategy, subject to updating (0.57) and having at least 121 members (0.62) gained the advantage). Benchmark at the level of 1.00 means that there was at least one cluster in the ranking which obtained maximum scores in each of the partial indicators. It is a cluster with the status of KKK, established before 2010, with at least 121 members and having a written strategy that is subject to updating.

Graph 63. Median and benchmark for the sub-area impact on shaping the environmental conditions
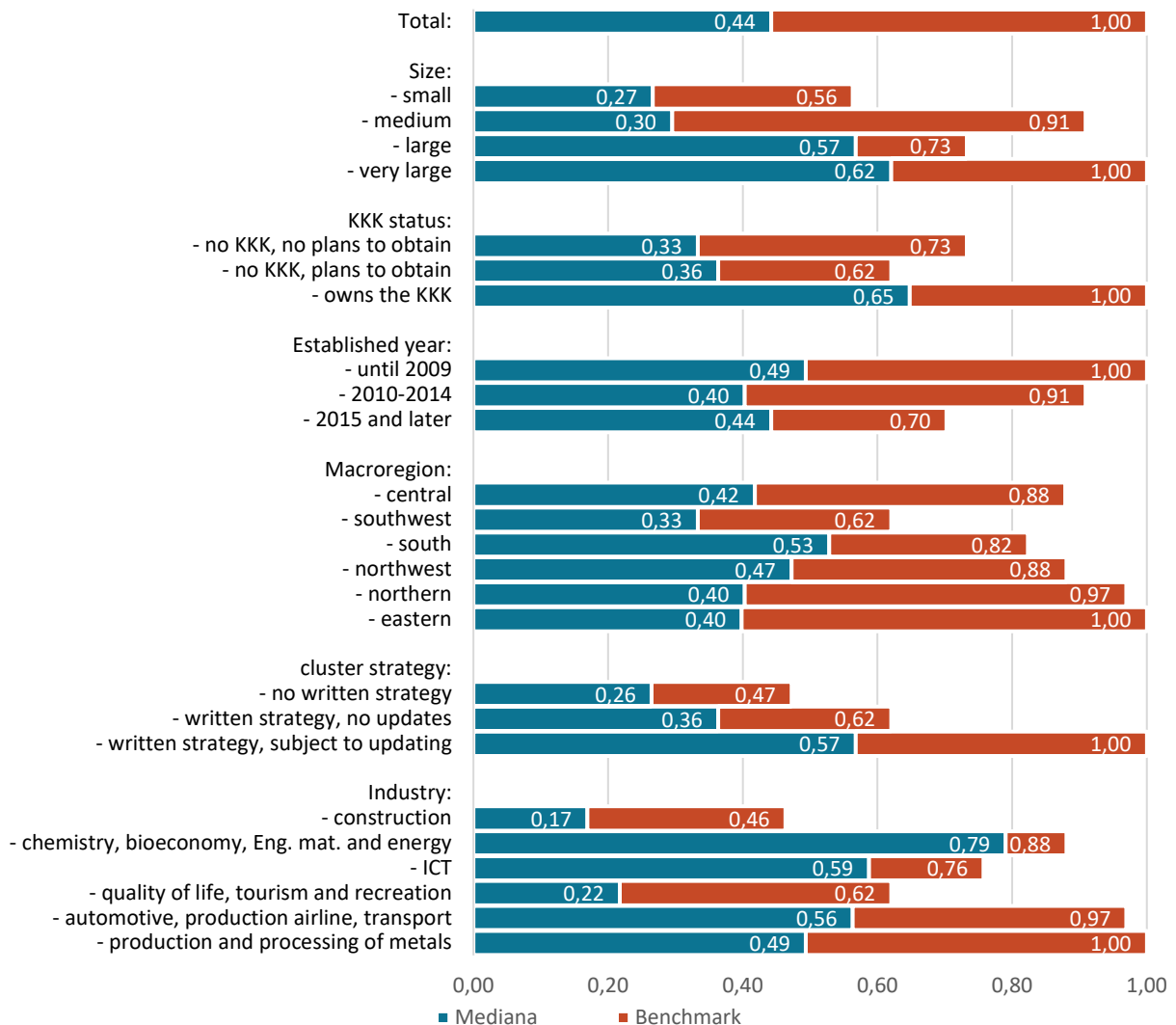
Source: own elaboration based on a survey of cluster coordinators (N=41).

Taking into account the value of the benchmark, the category of clusters that do not have a written strategy and operate in the construction industry fared quite poorly.

An important element of cluster activity, which translates into the external environment, is the representation of cluster structures in various types of consultative bodies. In this respect, cluster members are moderately active (only 10% of members indicated an affirmative answer).

Graph 64. Representation in economic, social and scientific consultative bodies (e.g. NCBR[79], NCN[80])

- Yes
- I don't know
- No

10,2%
10,8%
79,0%
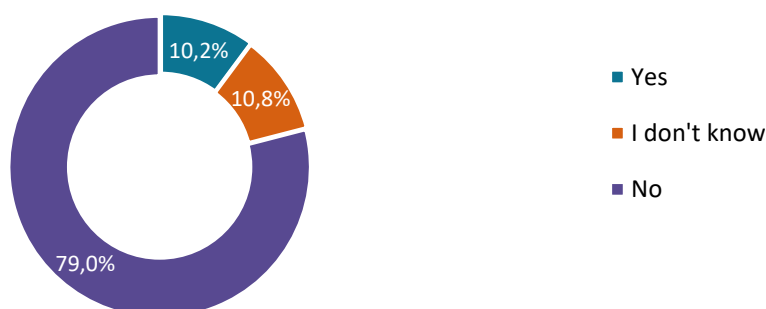
Source: research of cluster members (N=642).

On the other hand, clusters from the institutional point of view can shape the external environment in a very broad and diverse way. These can be both soft activities (e.g. training, information) and investment activities aimed at improving the situation in the clusters' external environment. Some of these activities may be in the area of corporate social responsibility. Interesting activities indicated by clusters include, among others:

- Funding prizes for high school students participating in competitions and Olympiads (e.g. Olympiad of Technical Innovation and Invention, during the elimination of the above-mentioned Olympiad, students can visit factories associated in the cluster).
- Co-organization of sports, medical or cultural events (also support for organizations operating in these areas). Active participation in these events (e.g. participation in competitions under the cluster's brand).
- 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).

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[79] National Centre for Research and Development Poland.
[80] National Science Center Poland.

- Educational, training and information forms, e.g. in the area of 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.
- Free programming workshops for teenagers.
- Free consulting services for enterprises in the ICT area (also for non-members of the cluster).
- Financial / in-kind donations (also dedicated production of materials and articles) for health care facilities during the COVID-19 pandemic.
- Joint actions to help refugees from Ukraine.
- Promotional activities in the area of low-emission drives in coastal shipping (goal - to improve the quality of life of the inhabitants of the Hel Peninsula).
- Providing the infrastructure of machines, tools and materials for the university PWR RACING TEAM (Wrocław University of Science and Technology), which has been creating the university F1 car for over 7 years.
- Innovation audits, organization of a cooperation forum, B2B exchange.
- World cleaning operation.
- Creation of the Pomeranian Digital Innovation Hub.

Analysis of partial indicators for sub-areas

Table 16. Analysis of the values of partial indicators for the sub-area of influence on the development of environmental conditions

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 quite often sit in various types of consultative bodies. Such activity was indicated by 34 clusters. In the case of 3 clusters, it was 10 or more bodies.
Taking actions by the cluster with a positive impact on 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.)	68% of clusters declared taking actions with a positive impact on society.
Number of initiatives aimed at improving the external conditions of running a business for cluster members	Average: 4.6, median: 2.0, benchmark: 55.0. 32 clusters declared to run such lobbying initiatives. Only in the case of 5 clusters the number of initiatives was greater than or equal to 10. The total number of initiatives of all examined clusters was 187.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.4.3. Impact on the natural environment

In the sub-area of impact on the natural environment, the median indicator was quite high (0.43), which confirms that most clusters undertook various types of activities in this area, which is an improvement compared to the previous edition of the study (then at least half of the surveyed clusters did not was more active in this area. Basic information on the ways of influencing the environment, including political initiatives under the European Green Deal, is included in the section on market activity.

Graph 65. Median and benchmark for the sub-area of impact on the natural environment
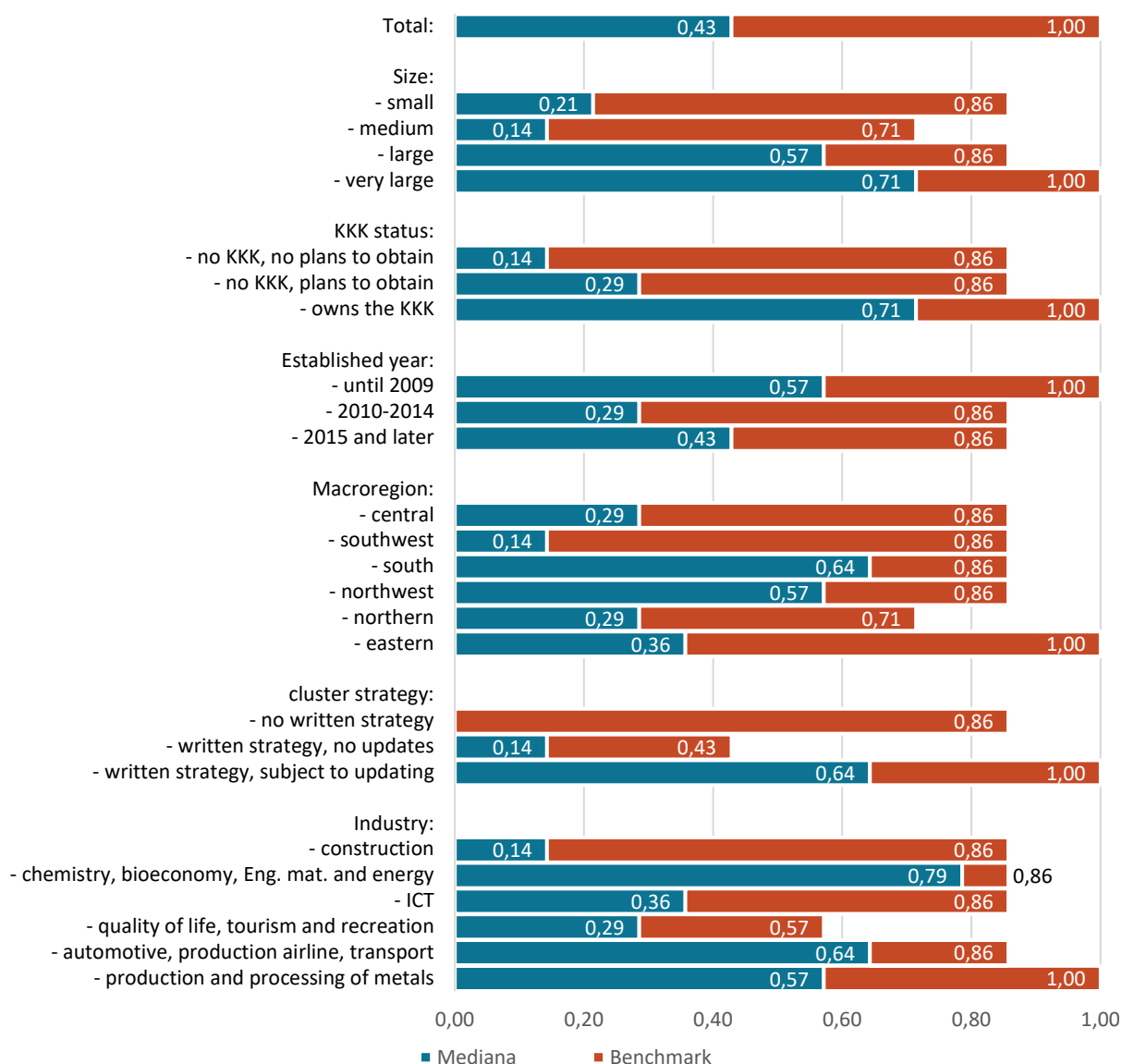
Source: own elaboration based on a survey of cluster coordinators (N=41).

Again, KKK, very large clusters established before 2010 and those with a written strategy that is subject to updating were the most advantageous compared to the others. The highest median level was obtained by clusters operating in the chemical, bioeconomy, materials and energy engineering industries. Interestingly, clusters from the southern and north-western macroregions had a certain advantage in this area. The benchmark was also very high (1.00). The best ratings were obtained by a very large cluster (over 121 members), with the status of KKK, founded before 2010 and having a written strategy that is subject to updating.

One of the questions addressed to cluster members concerned the assessment of the impact of participation in the cluster on taking actions aimed at improving the condition of the natural environment. Only 28% of the surveyed cluster members had a positive impact in this area. This represents a decrease of 10 pp. compared to the previous edition of the survey.

Graph 66. Assessment of the impact of participation in the cluster on activities in the area of green transformation
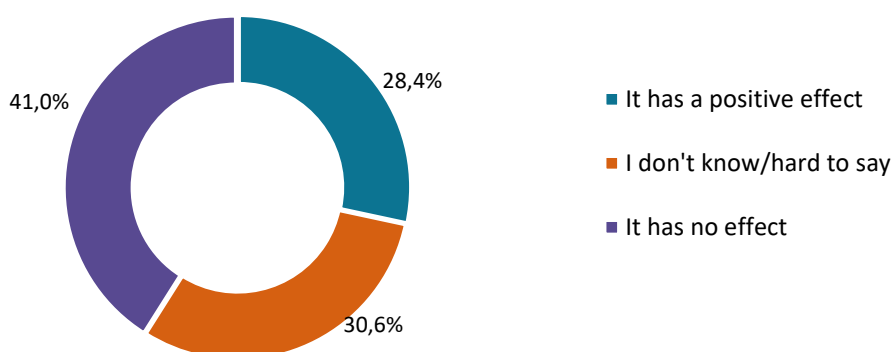
Source: research of cluster members (N=642).

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 type 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 6 types of activities, the following were most often indicated: the use of the circular economy concept (59%), implementation of solutions resulting from the energy audit (59%), R&D works in the field of low-emission technologies (54%) and production and distribution of energy from RES (54%). To a lesser extent, measures such as: implementation of low-emission economy projects (49%) and possession and implementation of environmental certificates for technology (ETV) or products (Ecolabel) or equivalent (34%) were used. Clusters had the option of indicating other activities not included in the list. In this case, it is worth noting conducting trainings, which are supposed to contribute to reducing the negative impact on the environment (e.g. as a result of improving the efficiency of production processes).

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.4.4. Specialization and advanced technologies

The median for the sub-area of specialization and advanced technologies was 0.23, which confirms a fairly even involvement of clusters. In this area, clusters founded before 2010 again prevailed (median 0.35), having the status of KKK (0.46) and a written strategy subject to updating (0.34) and at least 121 members (0.56), located in the southern macroregion and operating in the chemical, bioeconomy, materials and energy engineering industries (0.38).

Graph 67. Median and benchmark for the sub-area of specialization and advanced technologies
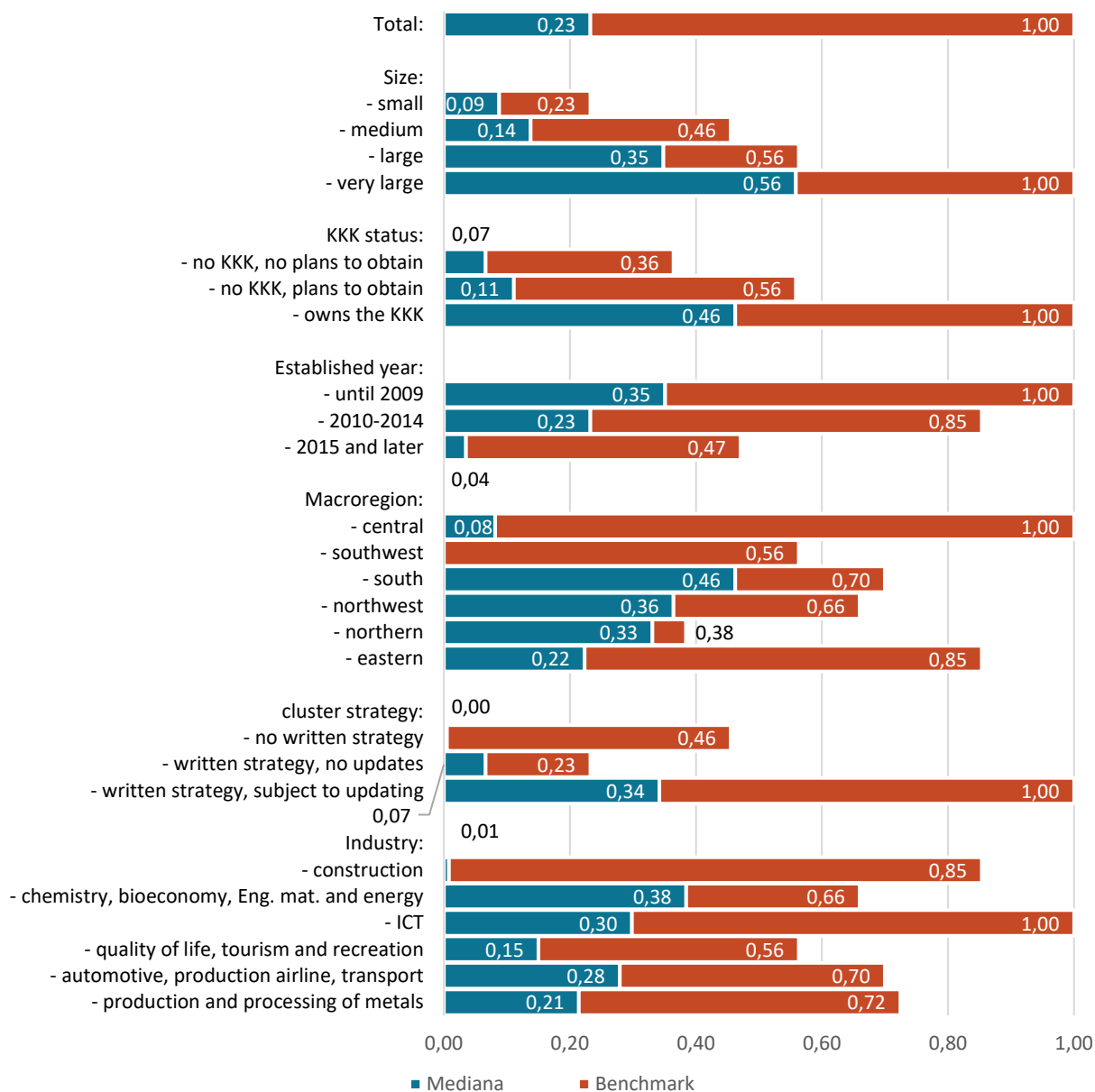
Source: own elaboration based on a survey of cluster coordinators (N=41).

The benchmark at the level of 1.00 indicates a situation in which at least one cluster obtained maximum scores for each of the partial indicators, and a certain group of clusters received very high scores. The best ratings were obtained by a very large cluster, with the status of KKK, founded before 2010, 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 that conduct 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, as added 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 undertake activity in the field of KIS in line with the dominant one for the cluster. Only three clusters indicated 100%.
The number of cluster enterprises that conduct economic activity in the scope of the Regional Smart Specialization dominant for the cluster	Average: 54.4, median: 32.0, benchmark: 250.0. On average, 62% of cluster enterprises undertake activity in the field of RIS, which is dominant for the cluster. In the case of 5 clusters it is 100%.
Number of cluster enterprises that conduct business activity in the dominant industry for the cluster (by NACE divisions)	Average: 49.6, median: 35.0, benchmark: 250.0. On average, 60% of cluster enterprises undertake activity in line with the cluster's industry. Only in the case of 3 clusters it is 100%.
The number of cluster enterprises that conduct business activity using technologies conditioning 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 undertake activity in accordance with the technologies that determine the future economic development of the EU. Only in the case of 1 cluster it is 100%.

Source: own elaboration based on a survey of cluster coordinators (N=41).

Area summary

- Within the area of Impact on the environment, cooperation with the environment, impact on shaping the environmental conditions, impact on the natural environment and the level of specialization and advancement of technology among members were analysed. In the case of the first three sub-areas, an improvement in the value of indicators was noted in relation to the previous edition of the study. On the other hand, in the case of specialization and advancement of technology, a decrease in the median was observed, which may mean that clusters are moving away from narrow industry specialization.

- A novelty in the previous edition of the study was the introduction of the sub-area impact on the natural environment. At that time, very low ratings were recorded in this sub-area. There has been an overall improvement in the current edition, but there are still areas of possible cluster activity. Especially in a situation where some indicators deteriorated. An example is the impact of participation in a cluster for green transformation. A positive answer was declared by only 28% of cluster members (a decrease of 10 percentage points compared to the previous edition).

- Relatively few cluster enterprises (41%) operate in the field of key KET technologies for the future economic development of the EU. It is worth mentioning that some of these technologies can be used horizontally, in various industries (e.g. advanced manufacturing, artificial intelligence, security and connectivity).

- Information and communication technologies as well as geoinformation (no major changes compared to the previous edition of the survey). On average, 67% of cluster enterprises operate within the scope of KIS which is dominant for the cluster.

- More than half (60%) of cluster enterprises fit into at least one of the regional smart specializations (RIS). It is worth mentioning that the compliance of the conducted activity with RIS is a necessary or rewarding condition in the case of applying for co-financing of projects from regional funds.
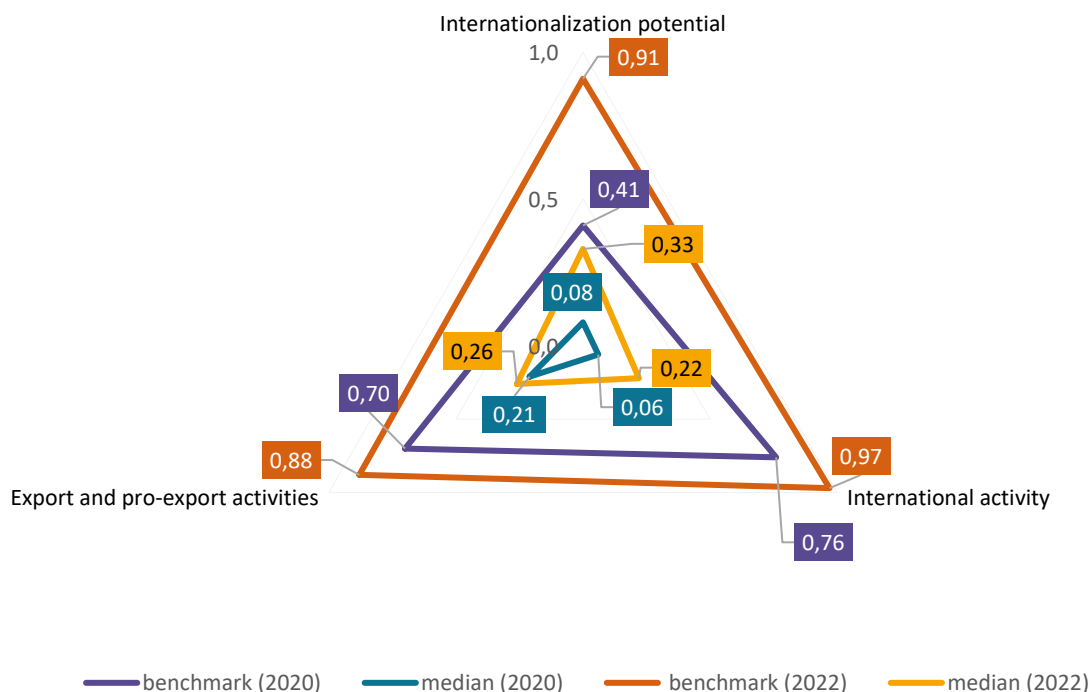
5.5.   Cluster internationalization

Within the examined area, the following sub-areas were assessed:

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

The area of cluster internationalization was one of those that received moderate/low benchmark and median scores in the previous edition of the benchmarking. This is evidenced by low median values, especially for internationalization potential and international activity. In the current edition of the study, an increase in the level of both the median and the benchmark was recorded for each sub-area. This is a positive trend, especially considering the hindered international activity as a result of the COVID-19 pandemic, mainly in 2020. Compared to the previous edition of the study, clear leaders of the ranking have appeared (clusters with very high values of most partial indicators, as evidenced by the high level of benchmarks).

Graph 68. Values of subsynthetic indicators in the area of impact on the environment for the 2020 and 2022 editions of the study.

Source: own elaboration based on a survey of cluster coordinators (N=41).

The internationalization of clusters is perceived as a new stage of clustering development, as evidenced by the intensification of analytical and implementation activities in this area in recent years. In the report entitled "Internationalization of clusters" of 2014[81], the important role of these structures in terms of activity on international markets was noticed, which allows to achieve a number of benefits for the coordinator and cluster members (especially enterprises from the group of micro, small and medium-sized enterprises):

- 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.

Referring to more recent sources at the EU level, one of the chapters of the recommendation report of the European Group of Cluster Experts is devoted to the area of internationalization[82]. The important role of clusters in terms of internationalization was clearly visible in the last decade. This was accompanied by support from the European Commission under the "Clusters Go International" instrument, which aimed to support cluster enterprises in developing and implementing internationalization strategies. Due to the small budget allocated to this activity, the effects were considered moderate. In the last 2-3 years, internationalization strategies have been significantly affected by the COVID-19 pandemic, which has had a significant impact on global markets and value networks. For this reason, clusters should play an important role in rebuilding the position of cluster enterprises on international markets, through e.g. adaptation to new realities, taking into account a strategic and long-term approach.

The role of clusters in this area has been noticed by public authorities. As part of the document "Directions for the development of cluster policy in Poland after 2020" a team of experts appointed by the Ministry of Development and Technology repeatedly refers to the role of clusters in supporting the activity of their members on international markets. One of the proposals was to create an instrument aimed, among others at to strengthen the internationalization of clusters and the export activity of their members.

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[81] Internationalization of clusters, ed. Greenhalgh B., Polish Agency for Enterprise Development, Warsaw 2014.
[82] Recommendation Report, European Expert Group on Clusters, European Commission, Brussels 2021.

resulted in the creation of an instrument supporting the activity of leading clusters (with the status of KKK) on international markets as part of the "Internationalization of National Key Clusters" measure (sub-measure 2.3.3 Smart Growth Operational Programme) in the expiring financing perspective, as well as continuation of support, e.g. internationalization of KKK and supra-regional growth clusters in the next financial perspective (under FENG[83] 2.17).

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[83] Funds for Modern Economy.

5.5.1. Internationalization potential

The total median in the sub-area of internationalization potential was quite high. There were some differences between various categories of clusters. Nevertheless, clusters with at least 121 members (median 0.56), having the status of KKK (0.47) and having a written strategy subject to updating (0.40) were still the most advantageous. The benchmark at the level of 0.91 was obtained by a cluster registered before 2010, having the status of KKK, with over 121 members and having a written strategy that is subject to updating.

Graph 69. Median and benchmark for the sub-area of internationalization potential
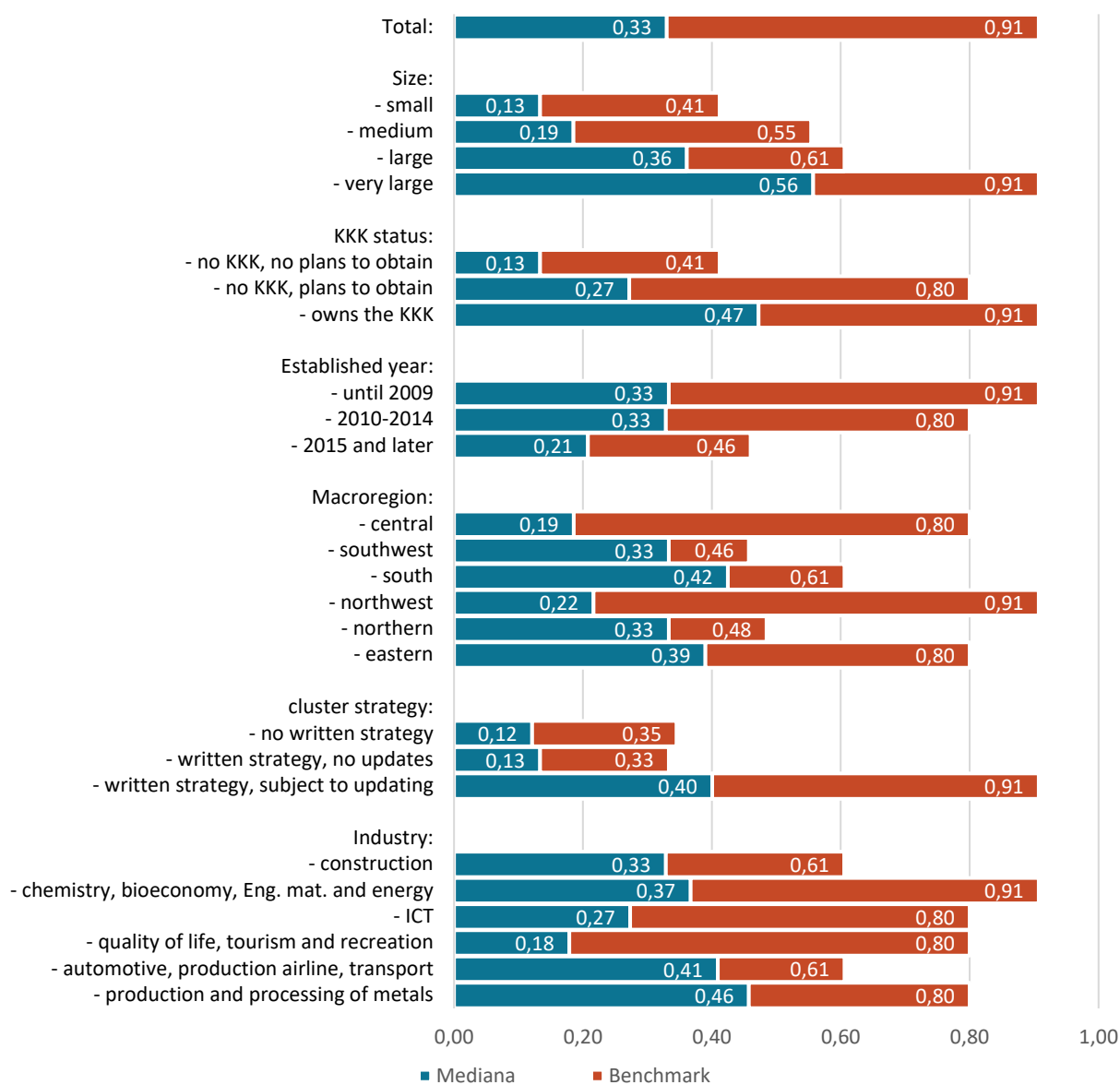
Source: own elaboration based on a survey of cluster coordinators (N=41).

It is worth noting that a significant group of clusters (32) provided services in the field of internationalization of activities for their members. Among the surveyed cluster members, 34% used such services through or through the cluster, and 27% had such an opportunity (received an offer of internationalization services), but decided not to use it. This represents a decrease of 3 and 10 pp, respectively compared to the previous edition of the survey.

Graph 70. Internationalization services

- ■ Yes - we have used internationalization services provided by or through the cluster
- ■ No - we received an offer of services for internationalization, but we did not take it up
- ■ No - we have not received an offer of internationalization services

Source: research 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 cluster for internationalization	Average: 6.4, median: 3.0, benchmark: 60.0. 32 clusters declared an offer of services for internationalization. In the case of 6 clusters, it was 10 or more services. The most frequently indicated services include the organization of trips to fairs and economic missions. Participation in fairs could take various forms (e.g. a joint exhibition of cluster entities at fairs that fit into the cluster's industry or individual organization of a trip to a fair for a given entity or group of entities). In addition, the promotion of brands and products abroad as well as soft support areas (including consulting and training) were also indicated. It is worth mentioning that in the previous financial perspective such services could be co-financed under the Instrument of Internationalization of National Key Clusters (sub-measure 2.3.3 SG OP)[84].

[84] 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
Number of cluster members who have benefited from internationalization services (offered by and/or through the cluster)	Average: 23.0, median: 5.0, benchmark: 227.0. In the case of 15 clusters, the number of cluster members using the services was equal to or exceeded 20. Only in one cluster it was over 100 members. It is worth that due to the interest in this type of services, 9 clusters which do not yet offer such services should consider implementing them in their activities.
Number of language versions (except the Polish language version) of the cluster's website	Average: 1.7, median: 1.0, benchmark: 14. The number of language versions of the website was verified by members of the research team. It is worth noting that 11 clusters do not have a foreign language version of the website. In this edition, the leader of the list with 14 foreign language versions of the website appeared again. In this case, Google's tools for automatic translation of website content were used. Taking into account the increasingly better translation algorithms, this is a solution that may be interesting from the point of view of clusters without any foreign-language version of the site.

Source: own elaboration based on a survey of cluster coordinators (N=41).

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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

For the sub-area of international activity, the median was 0.22, which confirms a fairly even involvement of clusters. In this area, the advantage was achieved by very large clusters (0.51), having the status of KKK (0.48) and a written strategy, subject to updating (0.37), functioning on the market for a relatively short time, i.e. established after 2015. It is worth pointing out that that small clusters (0.11), without KKK status (0.05), performed the worst. The benchmark at the level of 0.97 means that there was a cluster which received very high scores in most criteria. It is a cluster founded before 2010, having the status of KKK and having over 121 members.

Graph 71. Median and benchmark for the international activity sub-area
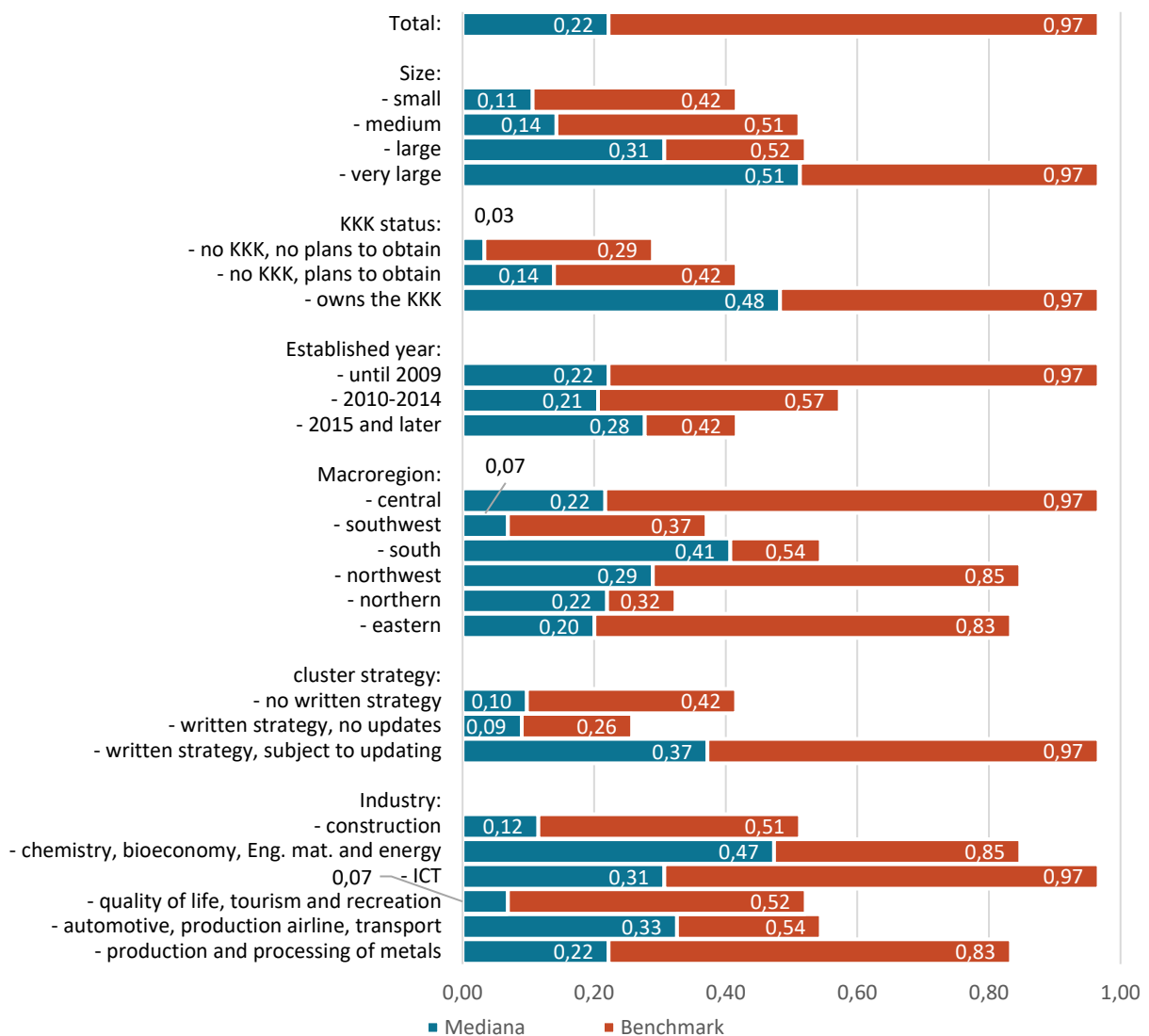
Source: own elaboration based on a survey of cluster coordinators (N=41).

The international activity of clusters was measured with the use of e.g. indicators related to the established foreign cooperation (active contracts), the number of implemented international projects with the participation of foreign partners and the number of international events organized or co-organised. Particularly valuable from the point of view of establishing foreign cooperation and knowledge exchange are international projects, which are most often implemented in consortia consisting of several to even several dozen organizations. This type of activity was demonstrated by 27 clusters, which implemented a total of 64 projects (on average 2.4 per active cluster). An even higher number of clusters were involved in the organization of international events (29) with an average number of events of 17.1 per cluster. In total, 497 events were organized, which is a 4.5-fold increase compared to the previous edition of the survey. 28 clusters had active cooperation agreements with foreign entities.

Graph 72. International activity in clusters
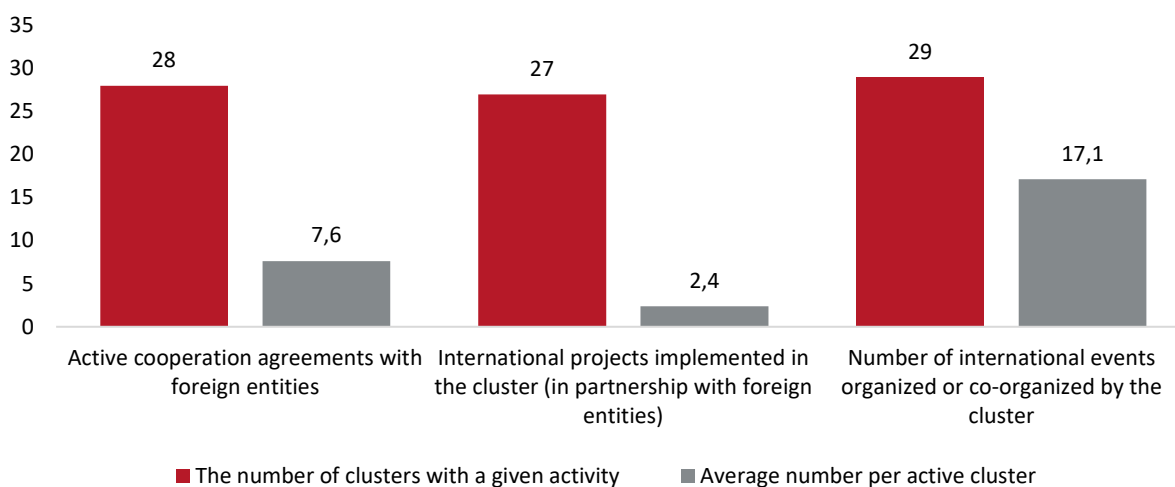
Source: own elaboration based on a survey of cluster coordinators (N=41).

The issue of clusters' international activity was assessed by cluster members. The most frequently indicated activities that a cluster should implement for the internationalization of cluster members include cooperation with foreign entities (92.4% of responses), as well as initiating international projects (89.3%) and participation in foreign fairs (88.9%). The opening of a representative office of a foreign cluster is by far the least popular. Compared to the previous edition of the survey, an increase in interest by approx. 3-10 percentage points was recorded for practically every type of activity.

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

Activity	Yes	On average	No
Cooperation with foreign entities	92,4%	6,9%	0,7%
Initiating international projects	89,3%	9,2%	1,4%
Participation in foreign fairs	88,9%	8,9%	2,1%
Participation in foreign business trips (including economic missions)	86,5%	12,1%	1,4%
Organization of international industry events	86,2%	9,5%	4,4%
Activities stimulating exports	85,0%	11,6%	3,4%
Implementation of services for the internationalization of activities	82,5%	13,6%	3,9%
Opening of a representative office of a foreign cluster	58,0%	17,0%	25,0%

Source: research 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. Over 2/3 of the clusters (28) have signed cooperation agreements with foreign entities. In the case of 4 clusters, it is 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 implemented in the cluster (in partnership with foreign entities)	Average: 10.6 million PLN, median: 0.3 million PLN, benchmark: 245.0 million PLN. 26 clusters indicated the value of international projects. It is worth noting that these types of projects do not necessarily have to have budgets in the millions, which could result from the average value. At least a few clusters can be distinguished in the list, when 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. 29 clusters organized or co-organized international events. The leader of the ranking significantly inflates the average, declaring the organization of 270 events. For most clusters, this number did not exceed 10.
Number of cluster entities with involvement of foreign units in them in the form of shares, branches or other form (foreign direct investment in the cluster (inward))	Average: 8.4, median: 0.0, benchmark: 87.0. 20 clusters declared that among their members there are entities constituting the subject of direct foreign investments. Among them were, above all, clusters from the area of ICT and the automotive industry.
Number of cluster entities that show involvement in entities abroad in the form of shares, branches or other form (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.

Source: own elaboration based on a survey of cluster coordinators (N=41).

5.5.3. Export and pro-export activities

The last analyzed sub-area of the study was export and pro-export activities. In this case, again, much higher values of both the median and benchmarking were obtained by very large clusters (median 0.53), having KKK (0.48) and a written strategy subject to updating (0.35). Taking into account the geographical criterion, the clusters from the southern (0.39) and north-western (0.34) macroregions obtained relatively the best results. From the industry side, the area of chemistry, bioeconomy, material engineering and energy is by far the best (0.48).

Graph 74. Median and benchmark for the export and pro-export activities sub-area
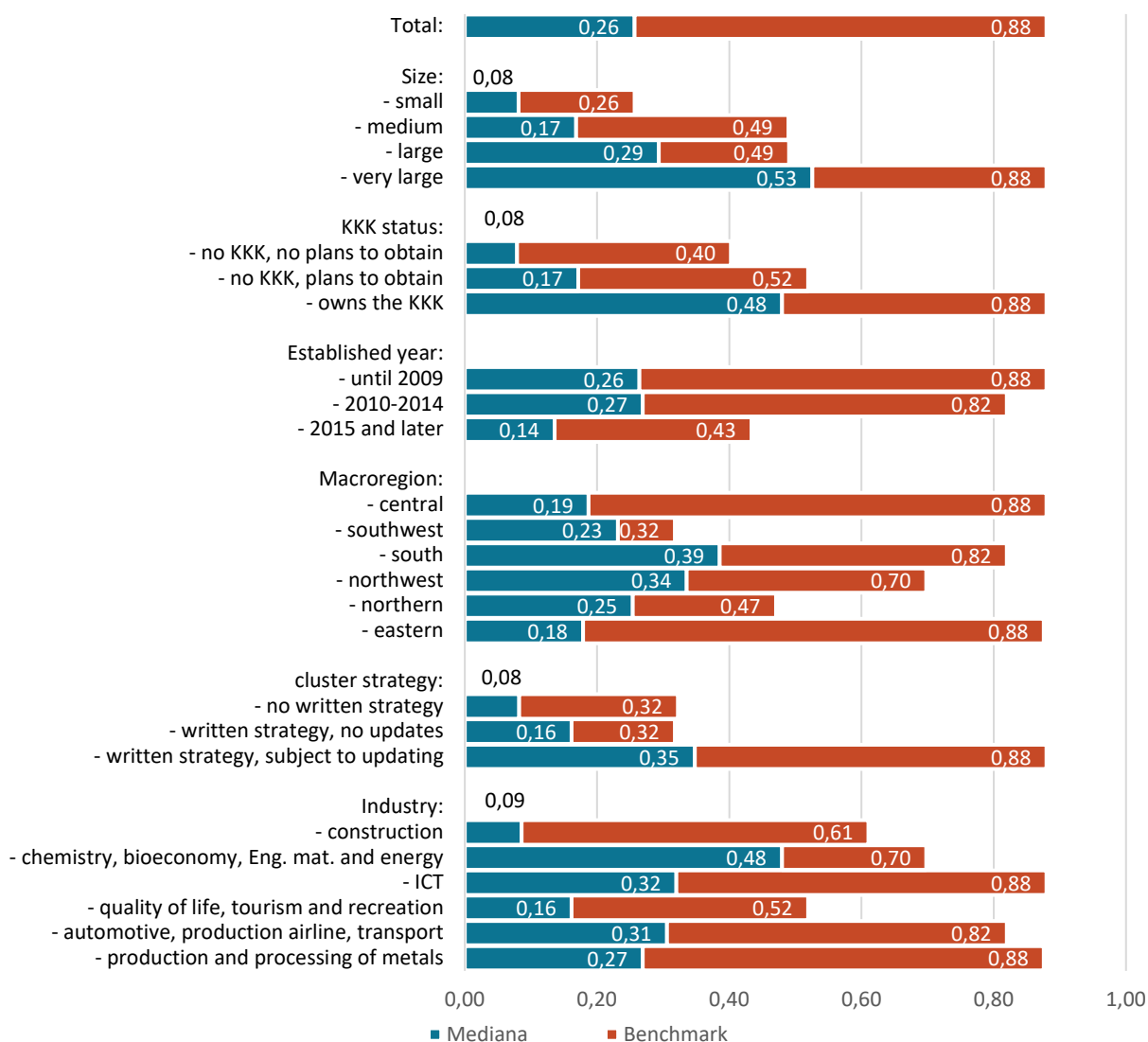
Source: own elaboration based on a survey of cluster coordinators (N=41).

Within the sub-area of exports and pro-export activities, the measurement concerned i.a. the number of foreign events and the number of foreign fairs and exhibitions attended by the cluster. In total, the organization of: 351 trips to foreign fairs and exhibitions attended by 628 cluster members, 522 trips to other foreign events and 131 accepted visits from foreign clusters was declared.

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

■ The number of clusters with a given activity   ■ Average number of initiatives per active cluster
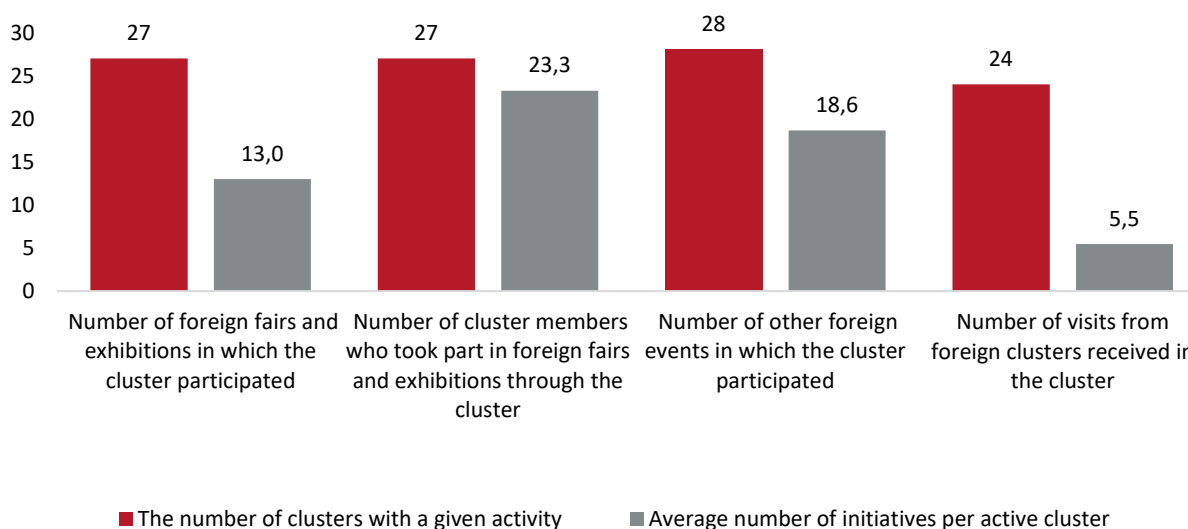
Source: own elaboration based on a survey of cluster coordinators (N=41).

It is worth mentioning that about 1/4 of cluster members (25.1%) reported an improvement in functioning in terms of the value of exports (47.7% indicated a negative answer).

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. 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.
Share of export revenues of enterprises included in the cluster in total sales revenues	Average: 29.2%, median: 26.8%, benchmark: 80.0%.

Indicator	All clusters
of enterprises that earned export revenues in 2021, including the share of electronic commerce (e-commerce)	29 clusters were able to indicate or estimate the share of export revenues of cluster enterprises in total sales. Clusters in the area of ICT stand out in this respect, as well as larger clusters in the area of industrial processing.
Number of foreign markets (countries) where cluster enterprises are present	Average: 31.2, median: 19.0, benchmark: 120.0. Markets with 10 or more indications by coordinators include: Germany (17 clusters), USA (16), France (15), Canada (14), Ukraine (12), Belgium (11), Denmark, Italy, China, Sweden, Lithuania, Spain and the Czech Republic (10 clusters each). Among the more exotic markets reached by cluster enterprises, the following can be indicated: 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. 27 clusters declared participation in foreign fairs and exhibitions. On the other hand, 5 clusters declared participation in 20 or more events.
Number of cluster members who took part in foreign fairs and exhibitions through the cluster	Average: 15.3, median: 6.0, benchmark: 127.0. A total of 628 cluster members participated in the events covered by the previous indicator. Over 20 members participating in trips declared 6 clusters.
Number of other foreign events in which the cluster participated	Average: 12.7, median: 3.0, benchmark: 251.0. 28 clusters indicated participation in other events abroad, and in most cases it was a maximum of 10 events.
Number of visits from foreign clusters received 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 cases was this number greater than or equal to 10.

Source: own elaboration based on a survey of cluster coordinators (N=41).

Area summary

- Within the area of internationalization of the cluster, the internationalization potential, international activity as well as export and pro-export activities were analysed. Of these, the actual internationalization potential was rated the best (median 0.33). For each sub-area, there was an increase in the median value in relation to and benchmarks in relation to the previous edition of the study.

- Compared to the previous edition of the study, a significant increase in the number of international projects and clusters involved in these projects has been observed (currently it is 2/3 of clusters).

- An increase in interest (by approx. 3-10 pp.) of cluster members in internationalization services can be observed. The greatest interest concerns the development of cooperation with foreign entities (92.4% of responses), as well as initiating international projects (89.3%) and participation in foreign fairs (88.9%).

- Support from cluster coordinators was quite popular among members. More than 1/3 of the entities in the cluster used this type of service.
  Most often, these were preparatory activities (e.g. development of an export plan, consulting, training), as well as the organization of missions and trips to fairs.

- In this area, large clusters with the status of KKK and operating on the market for at least 10 years gained a clear advantage, which was probably related to the implementation of projects under sub-measure 2.3.3 SG OP.

6.   Good practices of cluster operation

6.1.   Introduction

One of the elements of the cluster benchmarking study was the identification of good practices - model solutions that allow for outstanding effectiveness and efficiency in the implementation of activities and achieving the cluster's development goals. It was assumed that good practices must be possible to use in other clusters (attribute of imitation, learning), therefore their identification and selection were carried out with a view to their implementation in other cluster structures.

The basic criteria for selecting the best solutions adopted in this study are:

- innovation/novelty of the applied solution;
- efficiency (effectiveness) of the applied solution;
- system character and durability of solutions used in the cluster;
- flexibility and potential for change;
- universality, i.e. the possibility of applying (using) the solution by another cluster, including from another industry;
- efficiency, optimal use of available cluster resources;
- the possible potential of the practice to be applied in a situation of rapid change (e.g. as in the case of the COVID-19 pandemic).

Particular attention was paid to good practices implemented in 7 selected sub-areas, which largely determine the development of cluster structures (as they relate to the organizational maturity of the cluster, development of cooperation and innovation in the cluster and internationalization), i.e.:

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
A 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 of introducing good practice	In numerous industries, including the metal industry, there is a shortage of employees with the competences and skills necessary to work in the rapidly changing and developing industrial sector, which translates into the ability to use its potential. The good practice responds to the problems identified by the cluster in finding appropriately qualified employees. Enterprises from the metal industry report deficiencies in the qualifications of employees, i.e. lack of professional experience, low level of professional knowledge, lack of technical skills. Responding to the needs of its members, cluster is involved in the promotion of technical professions among young people, cooperating in this area with trade schools.
Description of the good practice	The Radom Metal Cluster undertakes a number of activities for the development of vocational education in terms of the needs of its members. The cluster coordinator conducts activities "at the base" aimed at raising awareness among young people and their parents regarding the advantages of choosing education in a technical school and obtaining professions desired by cluster companies. Cluster members take an active part in meetings with parents of students of the last grade of primary schools, during which the educational offer of vocational schools is presented, professional development opportunities are presented, and thus - employment conditions offered by Radom companies operating in the metal industry. In addition, a group of entrepreneurs from the cluster supports students of the first grades of the Complex of Technical Schools and the Complex of Vocational Schools (profile: machine tool operator and

mechanical technical school) by including them in the layette program (metal industry companies finance the purchase of work clothes and books for vocational training), develops materials supporting education, organizes study visits to industry companies and trips to trade fairs.

The next, natural step for the cluster was work on the implementation of the dual education system. The cluster's crowning achievement is the creation and implementation of a pilot dual vocational training course in the profession of "CNC numerically controlled machine tool operator" implemented as part of a first-level trade school. Students take practical classes in a modern technological environment, directly at employers in companies from Radom and the surrounding area, including cluster companies. Thanks to this, the quality and practicality of education is improved, which affects the increase in competences and skills of school graduates entering the labor market.

Activities aimed at dual education at various levels of education are strongly promoted by the coordinator among entrepreneurs who are members of the cluster to encourage them to be even more involved (promotion during local conferences and workshops, meetings at the City Hall or on the occasion of jointly implemented projects). Cluster members active in this area can count on extensive promotion of their companies on the cluster's website and in its social media.

The effect of introducing good practice	The cluster's cooperation with schools and universities is conducive to popularizing vocational education, promoting the production and engineering sector in the region as a source of valuable, long-term employment. The result of these activities is recruiting over 500 students to classes covered by the support program in five years.

Activities undertaken by the coordinator and cluster members allow for better efficiency of the education process and contribute to increasing the competences and skills of the staff entering the labor market, thanks to which cluster members have a better chance of finding the specialists they are looking for. The possibility of verifying knowledge in the realities of production during the production of real products made on behalf of specific recipients automatically extends students' knowledge with further related issues and makes them |

	aware of the functioning of the business environment in the broader context of the supply chain.
	Dual education gives the opportunity to raise the technical competence of the local community and the opportunity to stop educated young people from migrating to other industrial centers, which increases the economic value of the social environment and the quality of life.
	This action also improves the market situation of companies in the cluster, also expanding the scope of the cluster's activities. The cluster aspires to obtain the status of KKK in the future, so such action increases its chances of obtaining this status.
Possibility to use good practice	Coordinators' activities should be aimed at cyclical stimulation of the sense of common responsibility among cluster members for shaping mutually beneficial cooperation with schools, especially where there is a noticeable shortage of employees. Such cooperation should be permanent and may take many different forms. Constant involvement in the promotion of technical education of various levels and activities in the above area, on the one hand, contribute to the provision of properly prepared human resources to the labor market, including cluster members, and, on the other hand, translate into increased recognition of the cluster's brand.
	Thanks to the implementation of education in cooperation with employers, potential future employees gain an easier professional start and entry into the work environment.
	The implemented activities, such as introducing students to work in the profession by educating them in a real environment, also improve the image of industry and technical education, which are becoming more and more attractive.
Przemysław Radomski, plenipotentiary of IPZHR for RKM	*Undoubtedly, the idea of reviving vocational technical education in a completely new formula, adapted to the direct needs of employers, was an action that created a platform for understanding and cooperation for metalworking companies from the region, creating an atmosphere of trust and providing a solid foundation for further cluster cooperation. The companies stopped looking at each other as*

<table>
<tr><td></td><td>potential competitors, and the involvement in a new, proprietary model of teaching allowed to significantly bring the curriculum requirements of the teaching mode to real production challenges. The greatest beneficiaries of this project are students who acquire skills faster and better adapt to the working environment in the future, which significantly increases their competitiveness on the labor market.</td></tr>
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6.2.2. Industry Competence Center for MEDTECH

Cluster name	MedSilesia Silesian Network of Medical Devices
A 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 of introducing good practice	Companies operating in the field of medical devices and their employees face constant changes in legislative solutions, which significantly complicates the development of medical technologies and their certification. In response to this problem, in order to facilitate the members' access to knowledge, the cluster's coordinator decided to create the Industry Competence Center, and within it, the MedSilesia Competence Academy, which offers specially developed training programs for them.
Description of the good practice	As part of the cluster's activities undertaken in recent years in order to exchange knowledge, experience and information, the Industry Competence Center was established. This center is designed to raise the competences of entities from the industry, including both Cluster members and interested external entities. Within its structures, the MedSilesia Competence Academy was established, providing support dedicated to manufacturers of medical devices and enterprises operating in the field of technology for medicine. As part of the

Academy of Competences, two training programs[85] were implemented: the PRRC MASTER Program and the Quality Expert Academy.m The PRRC MASTER program is dedicated to people responsible for regulatory compliance in companies or who want to broaden their knowledge in this area. Within its framework, the issues of verifying the conformity of a medical device, the process of releasing the device, creating and maintaining the technical documentation of the device, post-marketing surveillance of the device are discussed. In addition, participants gain practical knowledge on how to design, obtain approval, register, conduct and report a clinical investigation of a medical device as part of the clinical evaluation required to assess the conformity of the device.

Training at the Quality Expert Academy provided auditors and quality representatives with knowledge as well as practical tips and solutions, such as how to effectively perform the function of the Quality Management System Representative, in accordance with the requirements of ISO 13485, what are the audit principles and tasks and duties of the internal auditor or quality methods and tools in life cycle of a medical device, i.e. the ability to practically apply appropriate tools and techniques for analyses, projects and problems, quickly obtaining invaluable solutions, risk management in the life cycle of a medical device in accordance with the EN-ISO 14971:2019 standard.

As part of the activities of the Industry Competence Center, cluster members have access to information on the possibilities of cooperation with partners from abroad, webinars devoted to legal changes and current trends in the medtech area are organized, services are provided, including: supporting internationalization and commercialization, as well as consulting in of the business model.

The Industry Competence Center is implemented through a proprietary tool created by the cluster coordinator, i.e. the COIN platform (Collaborative Innovation Network), which in addition to access to studies and training materials, provides access to information on the current offer of R&D units and universities in the region for the medical device industry.

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

The effect of introducing good practice	The Industry Competence Center supports the medical industry in developing the necessary skills and provides access to current knowledge, including databases. The introduction of a tool in the form of the COIN platform, as well as a training program dedicated to the industry, enables building better teams and improving the competitive position of cluster members thanks to human resources. All this also creates an appropriate climate for the implementation of innovative projects.
	Using the resources within the COIN platform enabled the cluster's partners to find cooperators for joint ventures, e.g. as part of competitions organized by the Medical Research Agency or the National Center for Research and Development. For units of the R&D sector, it is an opportunity for effective commercialization of knowledge. This sector also uses the COIN platform to present a dedicated offer addressed to the medtech industry.
	An additional added value is the section devoted to internationalization, especially when several dozen members of the cluster are involved in joint MedSilesia Go Global projects.
Possibility to use good practice	Knowledge is a value that has an impact on achieving market advantage. To meet the challenges faced by, among others, In front of cluster members, it is necessary to gather knowledge as well as its creation, transfer and promotion of a culture of information sharing. A response to the competency needs of cluster members and the industry in the form of an organized undertaking such as the Industry Competence Center and the Academy of Competences enable the use of the potential of experts who are cluster members to share practical knowledge and indicate development directions, and also promotes commercialization and technology transfer to the economy. This is an important activity that can bring positive effects in each cluster.
	At the beginning, it is important to identify the gaps well, map the needs of members or the industry, and then prepare good training programs and implement them in practice. This is a service that enjoys interest among members and others, it can be a cluster coordinator service.

MedSilesia Cluster - Silesian Network of Medical Devices	*Cluster coordinators by implementing effective IT tools, which in the case of MedSilesia is the COIN platform, have a chance to better match their offer to the expectations of Cluster members. By creating the Industry Competence Center, IT tools become necessary, and digitization is a process that Cluster coordinators have to face. In the case of limited human resources and increased expectations regarding the professionalization of services provided by the coordinator, this is a good solution to meet these expectations and the accepted standards.*

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

Cluster name	ICT Central Poland Cluster
A 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 of introducing good practice	The IT industry is developing very dynamically throughout the country, including Łódź, and the sector itself is beginning to have a key impact on the economy. As a result, there is a very high demand for programmers and other IT specialists. Companies in this industry, including cluster members, face the challenge of shortages of specialists on the labor market and difficulties in finding appropriate employees. The chronic labor shortage in the IT industry has become one of the most pressing barriers to growth. In turn, the city of Łódź is aware that in order not to lose the pace of development, it needs to actively and effectively, among others, Attract new residents, including talent, by competing both nationally and internationally. It is also in the interest of the city to have as many good employers as possible in its area. The stability of the labor market, the possibility of career development is a factor that strongly attracts new, professionally active residents.

Description of the good practice	The cluster actively works to promote Łódź. The cluster's activity in this area is, for example, the Join IT in Łódź campaign, i.e. 3 editions of the campaign promoting Łódź as an ideal city for learning/studying/work related to the ICT industry (www.joinitinlodz.pl).
	The action included a series of clips featuring employees from companies in the cluster. The leitmotif is joining the Łódź IT industry. The first cycle was devoted to re-industry (2020). Its heroes decided to make changes in their lives - to start working not only in a new company, but in an industry with a completely different specificity. The heroes of the films were employees who adapted well to the new professional reality, despite the fact that they did not have an IT education.
	The second cycle under the slogan "Yesterday a student today an employee" (2021) encouraged secondary school students from the Łódź Voivodeship to tie their professional careers to Łódź. It was a series of 5 different stories about young people who came to Łódź to study and now work in the IT industry.
	In the third edition (2022), the cluster showed the history of people from all over the world who connected their private and professional lives in the IT industry with Łódź. Heroes from Ukraine, Azerbaijan, Canada, Lithuania and Tunisia told their story, how they got to Łódź, what attracted them here and why they want to stay. The cluster was also involved in activities related to the implementation of the "Recommendations of subjects" program as one of the forms of cooperation between companies and universities associated within the ICT Central Poland Cluster cluster. Cluster members inform universities about the demand on the labor market and what they expect from future graduates, and moreover, in consultation and with the consent of the university, they can officially recommend a subject of their choice, directly related to computer science, e.g. programming in Python, which is then is introduced by the Lodz University of Technology, the University of Lodz or the Academy of Social Sciences to the curriculum. This is the first initiative of this type in Poland in the field of promoting specific subjects in study programs as recommended by business in the context of usefulness in the next stages of a career.

The effect of introducing good practice	Building the recognition of Łódź as a city that creates many development opportunities for employees in the IT industry brings three-way benefits. The broad promotion of Łódź is based on the cooperation of the following sectors: the cluster (business), the public sector and universities. It is addressed to potential employees of the IT industry, it is an opportunity for the city to attract new residents, and the developing areas are a guarantee of new jobs and a great opportunity for business, especially cluster companies. Thanks to the cluster's activities aimed at encouraging people to tie their future with Łódź, the cluster provides its members with qualified staff. Students receive practical knowledge, and companies gain potential future practically trained employees, as well as gain image benefits, among others, they become more recognizable thanks to activities such as subject recommendations. The result of the cooperation of universities in Łódź with clusters and their members is the immediate possibility of offering employment to students who graduate from IT majors equipped with practical knowledge. Indicating in the study program that a given subject is recommended by a specific company allows students planning their career with a given employer to focus their interests on a given area.
	The implementation of three editions of the campaign in cooperation with the city authorities allowed, above all, to draw the local government's attention to the problems of the IT industry with finding highly qualified employees, but also shows the local authorities that the cluster is a valuable partner for cooperation. One of the results of this cooperation is discussing the possibilities of cooperation with the city office in the field of joint participation of companies, universities and local government in events related to the labor market in selected voivodships, primarily on the eastern wall. In addition, Join IT in Łódź contributed to greater integration of the IT industry in Łódź, which resulted in, apart from regular meetings among cluster members, regular meetings of all interested IT companies from Łódź with representatives of the City Hall.

Possibility to use good practice	Positive impact of clusters on their surroundings, undertaking activities aimed at encouraging as many people as possible to take up either work or study at the higher education level is in the interest of both clusters, as well as urban centers and universities.
	For this reason, it is important to build partnerships between clusters and local government authorities of Polish cities and universities, in the field of joint efforts for future residents/employees/students.
	Building relationships with the local government should start with collecting as much information as possible about the potential of the industry in a given region. Very often, local governments do not realize what projects of not only local, but very often global scope are implemented in their area and how many employees are involved in these projects.
Adam Owczarek, Manager of the Lodz ICT Cluster	*It is worth implementing similar projects in cooperation with local governments due to potentially much larger reach and the possibility of reaching a larger group of recipients. In total, the Join IT in Łódź campaign generated about 150,000 views over the three years, and the reach of the promotional campaigns exceeded 1,000,000.*
	The biggest obstacle in the implementation of the campaign was the cluster participants' conviction of their employees that their professional history is interesting and worth showing it to the world, and perhaps it will become an inspiration for others. The number of heroes of the campaign, which is growing every year, shows that it was by all means the right decision.

6.2.4. Cluster social responsibility - IT for Ukraine

Cluster name	West Pomeranian ICT Cluster
A 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 of introducing good practice	Russia's attack on Ukraine caused a humanitarian crisis, but also unleashed great solidarity with the Ukrainian people. Polish clusters, including the West Pomeranian ICT Cluster, like the Polish society, have engaged in activities aimed at helping both refugees and Ukrainian citizens who remained in the country, supporting them on many levels. Thanks to good relations within the cluster and the cluster with the environment, members of ICT West Pomerania were active in organizing and providing assistance.
Description of the good practice	Since the beginning of the war, the ICT Western Pomerania cluster has been undertaking a number of activities aimed at helping Ukrainian citizens and soldiers. One of the first activities in this area was the organization of a teleconference by the cluster coordinator with member companies to jointly discuss the possibilities of assistance. As a result of the information obtained about Ukrainian needs and assessing the cluster's resources and capabilities, the coordinator and the members decided to engage in a number of different projects, including, together with other entities, in "Polish IT for Ukraine" (https://www.piit.org.pl/about-us/aktualnosci/polskie-it-dla-ukrainy). The aim of this undertaking is to integrate forces for the effective use of human resources, knowledge and equipment at the disposal of the IT industry. As a result, there were fundraising "Polish TECH and business for fighting Ukraine #CyberBridge". The collected funds were donated to the purchase of equipment for the soldiers. Thanks to the commencement of cooperation with the Ukraine Foundation, current needs are identified, and the activities undertaken by the Cluster are coordinated and purposeful.

	In addition to collecting funds, activities necessary to fight disinformation and identify fakes are carried out as part of the cluster news. Cluster members offer technical support in the form of products and services that improve the activities of volunteers in Poland, as well as the organization of transport of Ukrainian citizens and animals from across the eastern border.
	The cluster also launched an information campaign for refugees from Ukraine, offering them support in the form of counseling in the field of education, as well as starting or continuing a career in the IT industry. Together with the City of Szczecin, an industry website with job offers is run (Work Visit Szczecin), which contains content in Ukrainian. A tab was also created, which is an instruction on how to send your CV, which will be forwarded to cluster companies. Great emphasis was also placed on legal support related to employment and legalization of stay in Poland. In its social media, Klaster promotes cluster companies that provide support for Ukraine. In addition, the ICT Western Pomerania Cluster together with the ITCorner cluster and the SoDA organization referred to the prepared special act on assistance to Ukrainian citizens in letters to the relevant ministries and proposed specific changes in the regulations, including a declaration of willingness to participate in a working group that could implement the said provisions. Most of the demands have been met.
The effect of introducing good practice	War as an event of rapid change has shown that clusters, coordinators and cluster members are willing and able to help in an organized and purposeful way. Cooperation in the identification of resources and needs allowed for optimal use of the cluster's available resources, for the cluster to provide multidimensional assistance, which is not limited to material or cash donations. A valuable effect of the aid activities carried out by the clusters for Ukraine is the increase in commitment and strengthening the ties between the cluster and cluster members, the increase in the sense of belonging to an organization where humanitarian values are important, the integration of members and showing that corporate social responsibility is actions. In addition, the cluster's cooperation

	with the environment was expanded, which affects the visibility of the cluster and its members.
Possibility to use good practice	Clusters' involvement in CSR (Corporate Social Responsibility) is becoming more and more important, e.g. due to the possibility of credibly building an image as a socially responsible institution, involved in solving the problems of the ecosystem. It is also important for clusters having or applying for the status of the National Key Cluster. Involvement in pro-social activities is assessed in the competition. Thinking about CSR activities, it should be taken into account that there can be many forms of social involvement and assistance offered. CSR is a broad concept that encompasses numerous initiatives or procedures. Corporate social responsibility in the performance of clusters means not only caring for the interests of its members, but also for the environment. When planning its social activities, each cluster should examine the needs of this particular environment and confront them with its potential and possibilities. From the beginning, the coordinator should strive to include its members, as well as create a system to inspire/encourage involvement by showing an example. Thanks to the coordination of activities, specific aid reaches the right places, to the right people in need. Members see a concrete dimension of their help, which in turn drives their commitment.
Dr Magdalena Ławicka, Operations Director, IT Cluster (full name: ICT West Pomeranian Cluster Association)	*It is very important to be able to unite companies and jointly take action to help people in need. As one of the largest technology clusters in Poland, we have managed to carry out a number of initiatives to support people from Ukraine. We actively encouraged our member companies and also joined forces with other organizations that operate in other parts of the country and together we increased the scope of our activities. Currently, our companies still provide computer equipment, which is sent to Ukraine through us. So far, we have managed to send several dozen items, including: laptops, monitors, UPS, VOIP phones, servers, etc.*

6.2.5. Together for Industry 4.0 in Lubuskie Province

Cluster name	Lubuskie Metal Cluster
A 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 of introducing good practice	A number of projects were undertaken in Lubuskie Voivodeship in 2021 to stimulate the regional innovation ecosystem. The Marshal's Office of the Lubuskie Voivodeship initiated a two-stage competition, which was to verify the areas of smart specializations and indicate those with high R&D potential, and above all to activate cooperation between various types of entities. The above activities were related to the preparation of the Innovation Development Program 2030 (PRI), necessary from the point of view of using funds from the new EU financial perspective 2021-2027. The Lubuski Metal Cluster has taken active steps to take advantage of the opportunities for the growth of innovativeness of its members related to the development of smart specializations in the region. The cluster has been actively participating in all activities initiated by the UMWL as part of the process of selecting, monitoring and updating smart specializations since 2014. The proposal submitted by the cluster to include the metal industry in the scope of Lubuskie Smart Specializations was approved by the region's authorities. The cluster is perceived in the region as a credible and developing partner, and the entities forming the cluster expect from the authorities of the region more support for the actions taken so far than before. The competition for selecting the key areas of Lubuskie Smart Specializations gives the cluster a chance to obtain additional funds for the implementation of cluster projects.

Description of the good practice	The cluster's participation in the process of entrepreneurial discovery (PPO) and its involvement in the process of shaping regional policy supported a number of cluster activities for the transformation of Lubuskie enterprises.
	Lubuski Metal Cluster (leader) together with numerous partners from the region (entrepreneurs (30), universities (12), institutions supporting entrepreneurs (9) and the City Hall of Gorzów Wielkopolski) decided to establish a partnership entitled SMART FACTORY 4.0, which took part in the competition for the selection of key areas as part of the Lubuskie Smart Specializations. The competition was part of the process of entrepreneurial discovery (identification of new technological and business trends, expectations of entrepreneurs and verification of policy and instruments to support innovation). The proposal submitted by the Partnership combines activities falling within the scope of two Lubuskie Smart Specializations: Innovative Industry and Green Economy. SMART FACTORY 4.0 received a positive recommendation from the Competition Commission and is waiting for the signing of an agreement with the UMWL. The main objective of the activities undertaken by the Partnership is the transformation of Lubuskie enterprises towards Industry 4.0, including in particular: support for entrepreneurs focusing on creating new products and services through the implementation of research, development and implementation works, taking into account the model of digital maturity in Industry 4.0 and reducing the negative environmental impact. The main research areas cover two dimensions:
	▪ Dimension I: technological (automation and digitization of production, advanced materials, additive technologies and eco-technologies in industry)
	▪ Dimension II: process (production management, integration of business systems, intelligent processes and production equipment).
	As part of the cooperation between the cluster and the Gorzów Technological Center GOT PNP Sp. z o. o. and the Academy of Jakub from Paradyż in Gorzów Wielkopolski. Sustainable Development Accelerator 3E - Earth, Energy & Environment will be established. The accelerator will support the development of innovations that

	strengthen the green transformation in the region. The project will contribute to building the competences of the future. The Accelerator, combining the competences of the indicated entities, will take key actions for the successful implementation of high-quality services in the field of green economy. The accelerator will also support the implementation of R&D projects of entities in the region.
	Establishing such a diverse partnership is also conducive to cooperation in the preparation of innovative projects and undertakings to be financed under the new EU financial perspective 2021-2027. Thanks to participation in it, members can apply for innovation vouchers. Partnership members are awarded additional points in the merit-based evaluation, an additional 20 points can be obtained in the criterion: The applicant operates in a partnership, established as part of the Regional Smart Specializations, during the Lubuskie Innovation Forum.
The effect of introducing good practice	Thanks to the cluster's initiative, multi-level cooperation between active and innovative entities was launched in the region. Its aim is to create specific projects and innovative ventures. The undertakings agreed in the EDP will be able to obtain financing at the national level and will be promoted by the Lubuskie Voivodeship Self-government under the territorial contract and other modes of agreeing regional priorities at the central level. The self-government of the Lubuskie Voivodeship will also support such projects for financing at the international level (eg Horizon, COSME, etc.).
	Thanks to the actions taken, the cluster confirmed its position as a strong partner, ready to cooperate with the authorities in the region, an entity with ideas, initiative and resources necessary to implement activities supporting innovation and entrepreneurship in the Lubuskie region. Taking the initiative attracted new members to the cluster and contributed to the increase in the cluster's recognition in the region.
	The implementation of these activities, including the Sustainable Development Accelerator 3E, will expand the scope of the cluster's activities to the national level and help the cluster obtain the status of the KKK.

Possibility to use good practice	The transformation of the economy to Industry 4.0 is a long-term process and requires changes on many levels, not only in enterprises. Comprehensive activities undertaken by the Lubuski Metal Cluster, taking the initiative and attracting many diverse partners for the idea, constituting a valuable example of regional cooperation between science and business, should be considered a good model for other clusters. An important feature of effective transformation strategies is the cooperation of cluster members both with each other and with external entities. When implementing the ecosystem transformation strategy, it is worth establishing partnerships in order to implement joint projects with clients, suppliers, partners, universities, research centers, and sometimes even with industry competitors. The aim is to involve the widest possible range of partners, which will facilitate the delivery of the greatest possible added value to the value chain.
Dr. hab. Catherine Cheba, of the family. ZUT, *member of the board, Lubuski Metal Cluster*	*In the Cluster, we highly value the possibility of taking actions that fit into the strategic development goals of the Lubuskie Voivodeship. The greatest difficulty in establishing the Partnership and carrying out the tasks we have set before it is for us the integration of representatives of various environments around one goal. There is a very high risk of lack of understanding for this idea and willingness to implement projects initiated jointly - on their own by individual members of the Partnership. This requires many joint meetings, concessions and understanding for the idea of the Partnership.*

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)
A key area of good practice	Innovative activity
Other areas of good practice	▪ Cooperation with the environment ▪ Development of cluster cooperation
Purpose and circumstances of introducing good practice	New technologies, digitization of certain processes, are increasingly present in the construction sector, but the opportunities they create are still not fully used. Meanwhile, in a construction project, more and more information is generated without its ordering. Moving from paper to digital documents makes it easier to manage information (constituting a competitive advantage in the modern world) and to approach this process in a more organized way than it could be in the case of traditional methods. Data management and further use to improve processes and decision-making is the key to the success of the development of the construction sector. Thanks to the use of the digital information modeling methodology, it is possible to increase the cost effectiveness of the investment throughout the life cycle of the building and to ensure the quality and timeliness of deliveries. In the context of the above, bearing in mind the need for digitization and increasing the efficiency of investment and construction processes, BIM Klaster joined, at the invitation of PwC, the project entitled "Digitization of the construction process in Poland" implemented by the Ministry of Development and Technology and supported by the European Commission (DG Reform), which initiated the process of building a strategy for the implementation of the BIM methodology in public procurement (construction industry).
Description of the good practice	Building Information Modeling) technology is based on the electronic recording of full knowledge and data regarding the building object, in order to use them in the design, construction and subsequent use of the object. As part of the project, an analysis of experiences related to the implementation of the BIM methodology and digitization of

construction in selected European Union countries was carried out, including an analysis of the domestic market. The processes in which it is possible to use BIM technology in public projects have also been defined, and templates of strategic BIM documents have been developed, including e.g. Roadmap for the implementation of the BIM methodology in public procurement, BIM document templates, IT BIM Digital Platform Concept.

Part of the process of developing the Roadmap included extensive consultations and meetings with stakeholders in the construction industry: cluster members, investors, public entities, designers, general contractors. Due to the PUSH-PULL approach, the Map refers not only to the public procurement sector, but also to the actions taken (necessary) in the private sector.

The BIM Platform under development is to be a place that presents the most up-to-date information on top-down activities aimed at disseminating BIM in Poland and their effects. In addition, as part of the functionality of the BIM Platform, it is planned to launch interactive tools that will directly support activities and processes related to BIM undertaken by project stakeholders as part of the implementation of investment projects. The use of the "tool" will allow for better preparation of proper project documentation for public procurement Building.

The use of digital tools at the investment planning stage will allow you to optimize the implemented projects and generate savings. This is a huge field for increasing efficiency - from the investor's decision to start the investment, estimating its costs, through the schedule, risk identification, design and implementation with supply logistics, to the operation of the facility.

Importantly, the results of the project can also be used by the private sector. All materials developed as part of the project are available on the website of the Ministry of Development and Technology[86] and the cluster website[87] and can be used free of charge.

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[86] www.gov.pl/web/ Rozwoju-technologia/cyfralizacja-procesu-budowlnego-w-polsce--zakonczenia-projektu (accessed on April 19, 2023).

[87] www.bimklaster.org.pl/projekty/cyfrizator-procesu-budowlanych-w-polsce (accessed on April 19, 2023).

The effect of introducing good practice	The materials and documents prepared as part of the project, the systemic nature and effectiveness of the solutions contained in the developed Roadmap made them the basis and starting point used in the work of the formal BIM Working Group (GRdsBIM), whose task is to develop a coherent strategy for the implementation of BIM in Poland. This group was established in 2022 by order of the Minister of Development and Technology and included, among others, Cluster representatives. The basic task of the group is also to provide support to the Minister in activities related to the implementation of BIM. In addition, the Group prepares proposals for legislative actions regarding the implementation of investment projects in the construction industry in accordance with the BIM methodology, including public procurement.

The effects of introducing good practice should also be seen in:

- promoting the use of BIM technology elements in the investment and construction process,
- delivery of BIM document templates to the market (with an overview), which support the participants of the investment and construction process planning the implementation of investments with the BIM requirement,
- the involvement of industry representatives in the process of developing both BIM Templates and the Roadmap for BIM implementation in public procurement, which translated into their usefulness. |
| Possibility to use good practice | The main beneficiaries of the good practices developed under the project are representatives of the construction industry (investors, designers, contractors), but also other clusters and organizations associating micro, small, medium and large enterprises from the investment and construction industry both in Poland and in the world. As part of the "Digitalization of the construction process in Poland" project, a number of BIM documents and templates were created and processes were defined in which it is possible to use BIM technology in public and private projects. They can also be used by other clusters, including foreign ones, in pilot projects. The documents developed as part of the project are a rich source of knowledge and an extremely substantive base material for creating |

	BIM templates or developing BIM implementation maps in other EU Member States that are just starting their adventure in this area (on the MriT website there are also documents in English). In terms of good practice, the openness of the cluster to share highly specialized knowledge and experience can also be perceived. Cluster companies and experts have been conducting information and educational activities for years. Participation in the "Digitalization of the construction process in Poland" project, in which foreign experts who previously cooperated with the cluster were also invited to cooperate, is only a confirmation that this method of work works and has a practical impact on both the development of the cluster itself and its members, as well as the industry this cluster represents.
Katarzyna Orlińska-Dejer, President of the Management Board of the Information Technology in Construction Cluster (BIM Klaster)	*In the Cluster, from the very beginning, we focused on openness, teamwork and knowledge sharing, both within the cluster and outside. Using the cluster's most important resource, which is know-how, we have been involved in information and education projects for years, the purpose of which is to raise the level of knowledge on the use of innovative technologies in construction among representatives of the industry. Project The digitization of the construction process in Poland fits perfectly into these activities. The method of project implementation, its transparency and open nature (surveys, extensive consultations with the market) allowed for the development of results that reflect 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
A key area of good practice	Innovative activity
Other areas of good practice	▪ Development of cluster cooperation ▪ Cooperation with the environment
Purpose and circumstances of introducing good practice	The technology of unmanned vehicles is considered one of the main global trends and will be one of the most influential and attractive directions of development in the field of broadly understood transport, both in Europe and in the world. Members of the Interizon - Pomeranian ICT Cluster are companies that participate in global value chains, and their business partners are looking for reliable solutions to improve the security of cyber-physical systems, the costs of which are as low as possible, which was an additional motivation to get involved in the work on creating a prototype unmanned boat. At the same time, the Pomeranian Voivodeship, which is the largest center of the maritime economy in the country, may in the near future become one of the key centers providing products and services on the Unmanned Surface Vehicle (USV) market. At the same time, various activities are carried out in the cluster aimed at integrating cluster members, e.g. through joint work of the Task Force Autonomous Vehicles (GZPA) of the Interizon Cluster[88]. Considering the above, during the work of the Group, a need arose to conduct research and implement a new innovative product of the cluster. The coordinator prepared a report covering the

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[88] 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.

| | characteristics of USV vessels in the region and Poland. The report is useful for entities and institutions from the maritime and ICT industries that create or in the future may create a value chain related to the market of unmanned surface vehicles, including autonomous vehicles.

The cluster coordinator was also involved through the Group in activities aimed at creating a prototype of the USV "Hornet" unmanned boat. |
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| Description of the good practice | The cluster coordinator undertakes a number of activities integrating members around topics and issues important to them. One of such activities is the integration of members in Task Forces, including GZPA. The most interesting activities of this Group are presented below.

USV report

prepared by the cluster coordinator, the Interizon Foundation, summarizes the current state of knowledge on the types of unmanned surface vehicles, presents the possible use of such units and provides data on the market structure. Thanks to this, it is crucial for further activities of the Autonomous Vehicles Task Force, it is a source of knowledge both for decision-makers representing national and regional interests, as well as for entrepreneurs and institutions that can co-create complete value chains offering innovative and competitive products on global markets.

Offshore and port and logistics technologies and ISP2: Interactive technologies in an information-saturated environment.

USV Hornet, a prototype of the first Polish unmanned boat for the needs of the maritime industry

The idea of a prototype unmanned boat was born in the Group's discussions for port and offshore needs. " Hornet " will be the first unit of this type in Poland with the possibility of semi-autonomous and autonomous operation. Substantive work of the Task Force Autonomous Vehicles was launched by the Digital Technology Center of the Gdańsk University of Technology, which also acquired an international project under the Horizon 2020 program. The prototype was created as part of the research and development project "TRANSACT - Transform safety-critical cyber-physical work |

	distributed solutions for end- users and partners " (Transformation of security-critical cyber-physical systems into distributed solutions for end-users and partners). The boat with basic equipment is ready. Scientists are currently working on solutions in the field of so-called edge (rod) and cloud (cloud) technologies 154with the use of artificial intelligence and machine learning. They develop and implement a system of secure, reliable (e.g. resistant to jamming devices) wireless communication, which will be used to ensure communication with many unmanned units at the same time. The Hornet boat will be able to function autonomously, which means that it will be able to "learn". The Polish port and offshore industry is already interested in using boats. The unmanned boat " Hornet " will be able to be used e.g. when inspecting shipping channels and patrolling offshore wind farms (e.g. to detect objects that should not be in a given area).
	Lodz will be a common product of the cluster, to which components and technologies are provided by members. The coordinator watches over the integration process and animates cooperation.
	Promoting cooperation in the region
	Parallel to the implementation of the European project, cooperation on the local level was inaugurated under the Smart Specializations of Pomerania. This is an initiative launched by the Marshal's Office of the Pomeranian Voivodeship, and one of the goals of its initiation was to consolidate and tighten cooperation between the maritime and ICT industries in Pomerania, which are animated by the Interizon Cluster and the Gdańsk Incubator Starter, respectively. As a result of the cooperation, a task group of the Pomeranian ICT Interizon Cluster bringing together entities interested in joint development of products in the field of unmanned and autonomous boats.
The effect of introducing good practice	In connection with the identified needs within the project, it was even more noticed that access to specialized and educated staff and appropriate technological facilities are the factors necessary for the development of the maritime industry towards the design, manufacture, servicing and implementation of products and services based on USV.

	As part of the work on creating an innovative product, thanks to the openness of the Gdańsk University of Technology to cooperation, a value chain was created with the participation of the Interizon ICT Cluster, which allowed the cluster members to create components, including advanced algorithms and systems that are part of the solutions of the future autonomous boat. At the same time, the cluster coordinator undertook a number of activities aimed at integrating its members around issues related to the USV unit industry, as a result of which cooperation was intensified both within the cluster and with its surroundings.
	Initiating cooperation on a common product, still in the process of its development, was inspiring and stimulated the coordinator and cluster members to look for further areas of cooperation.
Possibility to use good practice	The identified good practice may be an inspiration for other clusters in terms of their potential to offer unique, innovative ways of solving problems of their members or the environment and, as a result, implementing solutions focused on market demand. Studying a given industry and related industries by clusters creates new opportunities for joint ventures, ways to reach potential contractors, and allows you to stand out from the competition. At the same time, it is a way of aggregating knowledge in the cluster and popularizing innovative solutions in the economy and society. Therefore, one of the activities of cluster coordinators should be open communication in the scope of presenting the importance of the benefits of the work for the development of the economy and society, as well as striving to identify innovations beneficial for the ecosystems in which the clusters operate and engaging members in their implementation.
Jarosław Parzuchowski, President of the Board of the Interizon Foundation, coordinator of the Pomeranian ICT Interizon Cluster	*The openness of the Gdańsk University of Technology to cooperation allows companies from the ICT industry associated in the Interizon Cluster to create components, including advanced algorithms and systems that are part of the solutions of the future autonomous boat. We hope that a value chain with the participation of many Polish companies and an innovative product will be created.*

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
A 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 of introducing good practice	Members of the Silesia Automotive & Advanced Manufacturing cluster are primarily large enterprises, branches of international concerns. For this reason, the cluster coordinator, taking actions in the field of internationalization of activities, puts the focus on slightly different aspects than in the case of clusters with a significant percentage of companies constituting SMEs. One of the most important aspects of international cooperation in this case is the exchange of knowledge, experience, joint projects aimed at implementing modern digital and green technologies in order to optimize processes and transform enterprises towards climate neutrality. For cluster development, it is important to create conditions for the spread of knowledge and good practices between cluster participants and foreign partners, i.e. enterprises operating in other countries, European clusters, European business environment institutions supporting digital and green transformation, etc. The involvement of the manufacturing industry in the digital and green transformation is essential to keep companies competitive and achieve the goals of the Green Deal.
Description of the good practice	As part of the COSME program in the years 2018 - 2021 Klaster Silesia Automotive & Advanced Manufacturing implemented, in a consortium of 6 automotive clusters, the project "EACN for Joint Industrial modernisation Investments"[89], which concerned

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[89] 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.

supporting the automotive industry in digital transformation. Due to the great demand for knowledge on how to effectively implement and use new technologies in production processes and the great value of the possibility of exchanging experiences between European partners in this aspect, the project resulted in the creation of an ongoing partnership of over 25 European automotive clusters. The effect of cooperation within the European Network of Automotive Clusters are, among others, another joint project implemented by the Clusters for the digital and green transformation of the automotive industry.

An example of such a joint project is GreenSME, in which Cluster Silesia Automotive & Advanced Manufacturing participates. This project aims to support SMEs in their green transition towards a sustainable EU manufacturing industry that is more adaptable and resilient to the current and future challenges of the industrial sector. GreenSME strengthens the ability of SMEs to absorb advanced technologies, making them more competitive, climate neutral, maximizing benefits for all social groups, towards a sustainable European manufacturing industry. This vision assumes that SMEs should develop a strategic approach to sustainable development. According to the project's vision, this goal will be achieved by creating a greenSME HUB and developing a sustainable SME transformation path. This path will cover the whole process of support that will be offered to manufacturing SMEs to strengthen their capacity to implement advanced technologies for sustainable development. SMEs that have taken part in the Sustainability Assessment will be able to apply for a follow-up advisory service that will provide an Advanced Sustainability Action Plan tailored to each SME's needs. Once the project has been prioritized (and approved by the project consortium), SMEs will receive financial support of up to EUR 40,000 to implement the developed action plan.

The effect of introducing good practice	Thanks to cooperation within the framework of an international partnership, initially for the purpose of implementing the project, the cluster strengthens its position and increases its recognition on the international arena. The exchange of experience and knowledge between entities with complementary experience in the transformation of SMEs towards digital and green industry in Europe and access to know-how other than local in the cluster strengthens the competences of the cluster coordinator and members. GreenSME HUB allows you to build a community of innovative SMEs dealing with sustainable production. The HUB becomes a knowledge exchange area that brings together resources, activities and stakeholders to enable the adoption of advanced technologies by SMEs for sustainable development.
Possibility to use good practice	Building international inter-cluster networks allows for the internationalization of the activities of Polish clusters, and at the same time involves the acquisition of new knowledge. By establishing cooperation with other organizations, the scale of the cluster's operation is also increasing. As a result, learning processes of the coordinator and cluster members take place. All this results in projects that allow cluster members to develop their potential even more. Concluding international partnerships strengthens the ability of SMEs to absorb advanced technologies.
Łukasz Górecki, Director of the SA&AM Cluster	*The SA&AM Cluster is a local initiative, but it operates internationally, especially in projects that are thematically related to the interests of Cluster members and bring them measurable benefits. The specificity of the Cluster and our region makes the topics of digital and green transformation particularly important for entrepreneurs today. That is why Cluster SA&AM has been involved in such projects for many years, often in international consortia. The last example of this type is the GreenSME project. The target group of this project are SMEs that we want to support in testing and implementing new technologies and climate-neutral solutions. We want companies operating in our region to be modern, operate ecologically and at the same time be effective and competitive on the national and international arena. Each cooperation builds, and*

	cooperation with more experienced and developed ones is particularly valuable, which is why we carry out our activities not only locally, but also with European partners, often more experienced, and we have been gradually developing it for many years. Initiating project cooperation at the European level certainly facilitates participation in the European Network of Automotive Clusters, under which we previously implemented a project in the area of digital transformation.

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

Cluster name	Bydgoszcz Industrial Cluster Tool Valley
A 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 of introducing good practice	The difficult period of the COVID-19 pandemic was conducive to inducing cooperation, which involved the participation of clusters and their members in extensive projects dedicated to fighting the coronavirus. Clusters have become cooperation platforms to deal with the Covid crisis, which caused serious disruptions in the economy and the activities of companies. In order to counteract declines in turnover and build the resilience of enterprises, cluster coordinators adapted their activities in various aspects of the organization's functioning and areas relevant to value creation.

Description of the good practice	The activities of the Bydgoszcz Industrial Cluster of the Tool Valley in the fight against the pandemic were implemented comprehensively and on many levels.
	The employees of the cluster office cooperated with the Marshal of the Kuyavian-Pomeranian Voivodeship in obtaining protective materials from the market (e.g. masks, aprons, gloves) for hospitals and health and care centres. The cluster coordinator mediated and coordinated cooperation activities between companies, universities and health centers in the production of protective visors and masks. Enterprises and universities associated in the cluster are actively involved in, among others, in activities in areas aimed at helping the medical sector. Joint activities of the university and cluster members resulted in the production and then transfer to companies of visors based on own materials and 3D printing.
	Another example of cooperation aimed at dealing with the crisis caused by the coronavirus was the launch of a cooperation exchange in terms of offers and needs among members, i.e. a website to support cooperation. The platform offered collaborative opportunities to work together to help the healthcare industry and hospitals that had shortages of protective products. The announcements were posted on the Cluster's website in the Cooperation tab. The cluster coordinator has also started cooperation with the Association of Entrepreneurs of Kujawy and Pomerania and the ADEP Tax Office in organizing HR and accounting consultations. Webinars addressed to entrepreneurs entitled: "Employer's subsidy under the anti-crisis shield" and "Restructuring and transformation in my company" were prepared. Cooperation with Syneo.pl, a member of the Cluster, resulted in the creation of a webinar entitled "Remote work, how to win this crisis?".
	In addition, the coordinator propagated and promoted the Solidarity Radio Action of the WNET radio among the members of the cluster - free radio advertisements for companies affected by the crisis.
	At the national level, the coordinator established cooperation with other clusters and took part in consultations on the so-called Anti-crisis shield and Anti-crisis shield 2. Comments on supporting entrepreneurs were also prepared and submitted to the Marshal of the Kujawsko-Pomorskie Voivodship.

The effect of introducing good practice	The consequence of the COVID-19 pandemic on the side of clusters and their members is the increased interest in the development of cooperative behavior. The coronavirus pandemic, due to its intensity and the multitude of areas it affected, contributed to the increase in the intensity of cooperation among cluster members. In addition, the cluster and its members established cooperation with other entities from their own industry (other R&D companies and institutions), as well as with a much wider group of stakeholders than before, eg with medical and care facilities. The threat became a test of the quality of partnership between individual entities inside and outside the cluster, which was reflected in the active involvement, readiness of various entities to eliminate conflicts of interest or share resources.
Possibility to use good practice	The state of the epidemic has shown that a common goal triggers the cooperation of very different entities, even those that have not had previous experience of cooperation within the cluster. A very important role in this type of activities and in integrating different environments can be played by the cluster coordinator, who automatically, thanks to his experience, becomes an entity coordinating cooperation for a common goal, not only of the cluster members. Practically from day to day the scope of its operation is expanding. In such situations, the human resources of coordinators are extremely important, as they can perform tasks in various areas. Various types of electronic tools that certainly support such activity are also useful. In a crisis situation, companies, despite their own problems and many challenges, are motivated to analyze the existing applications of their components or final products and to identify new development paths. Therefore, it is easier for the coordinator to initiate specific cooperation. What is important, cluster members working together can use this fact not only for their own economic purposes, but also direct them to important social goals. Thus, the pandemic and the behavior of clusters and their members, but not only, in relation to cooperation

	indicate the usefulness and timeliness of the concept of creating shared value (shared value).
Piotr Wojciechowski – Managing Director – Bydgoszcz Industrial Cluster Tool Valley	*The period of the pandemic was a very big challenge for companies - cluster members, but also for their coordinators. In a very short period of time, it was necessary to change the scope of activity - some activities had to be suspended, and many new needs and challenges appeared. Coordination of this type of activities required very quick changes and adaptation to the prevailing conditions. Despite this difficult situation and many challenges, clusters have shown that they are very flexible organizations, and their members are willing to cooperate and support various types of activities at the regional or national level. This is certainly the positive side of this crisis. In addition, these events allowed to gain many valuable experiences that are used during the next crisis, which is the war in Ukraine, where cluster member companies once again show great support.*

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

Name of good practice and cluster	Silesian Aviation Cluster
A 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 of introducing good practice	Among the members of the Silesian Aviation Cluster and in its immediate vicinity (area of operation and the aviation industry) there are numerous companies, including the leaders of the drone industry in Poland. These are companies involved in the production, design and services related to the use of drones, including both civil and military applications.

	The establishment of the Silesian Drone Valley is a response to the need to consolidate the drone industry in Poland. This need was identified by the cluster coordinator.

Drone companies are mostly small, rarely medium, and very rarely large. The market is dispersed, entities, including scientific and research units or potential users of drone systems (administration - e.g. Górnośląsko-Zagłębiowska Metropolis, large companies) do not have sufficient knowledge about other market participants. This limits the pace of development of new drone products and services. In the near future, the growing drone market and the anticipated demand for services performed by unmanned aerial vehicles may become an important new element of the industrial sector of the economy. It is still a young market where domestic companies can still exist. Currently, the industry is moving towards more and more automation, which opens the door for more hardware and software manufacturers.

The Silesian Aviation Cluster is an association of over 100 companies and institutions, over 20 of which are actively involved in the drone market. By definition, it is a kind of natural platform for integrating market participants and an institution influencing regulations important for market participants. Coordination of cooperation and integration of entities focused around unmanned and autonomous technologies covers a number of entities: from suppliers and integrators, through customers, scientific institutions, local governments and public administration, to financial institutions and investors. The cluster itself is a big undertaking, but there was a need to achieve a greater effect and to concentrate the industry on a larger scale. |
| Description of the good practice | **CEDD**

In the first stage of activities, the Silesian Aviation Cluster, the Upper Silesian - Zagłębie Metropolis (GZM), the Institute of Aviation in Warsaw and the Silesian Marshal's Office together with the Civil Aviation Office and the Polish Air Navigation Services Agency established the Central European Drone Demonstrator (CEDD). CEDD was created due to the need to support the implementation of |

modern technologies in the field of data analysis and modern means of transport in the area of cities and agglomerations

The demonstrator operates in the Silesian Voivodeship and is open to all interested participants of the drone market in Poland. It is a place of testing technical solutions for the drone industry in an urbanized area and testing the possibility of providing drone services in terms of applicable and possible new legal regulations.

Drone Valley

The cluster coordinator took action to create the Drone Valley. The Silesian Drone Valley was established by signing the declaration of its founders in November 2019.

It is an initiative broader than the cluster, including also entities not belonging to the cluster. It serves to integrate the entire drone sector in Poland and connect it with partners from other European Union countries and beyond.

The Silesian Aviation Cluster is open as part of the Drone Valley to cooperation with entities belonging to other Clusters (e.g. Aviation Valley). This creates the conditions for future cooperation and practical applications within the rapidly emerging and growing new market, testing drone systems both in safe laboratory conditions as well as in real urban conditions.

Additional activities for the Drone Valley

In addition to activities under the Silesian Drone Valley, the cluster was co-founded and actively operates in the European organization of drone clusters: "European Drone Cooperation", associating clusters from over a dozen European Union countries. As part of this organization, the cluster co-organizes the European drone conference in Wildau near Berlin (so-called CURPAS conference) and organizes the national Silesian Aviation and Drone Days.

In addition, the cluster is in the process of building an online transaction platform with a database and an information portal for the drone market. The platform will be available and open to all entities who want to share their knowledge and experience, both entities providing services using unmanned aerial vehicles (UAVs), as well as constructors, scientific institutions, local government institutions, etc. The platform is being created as part of the

	development of new coordinator services Silesian Aviation Cluster under sub-measure 2.3.7 SG OP[90].
	This is not the cluster's last initiative, as the coordinator has also been involved in creating a regulatory framework for a new area of the economy, i.e. drones, through e.g. participation in the consultations announced by the European Commission regarding the "Strategy for Drones 2.0".
The effect of introducing good practice	Among the most important effects of the establishment of the Silesian Drone Valley for the benefit of the UAV industry, the fully operational CEDD test area in the area of the Metropolis GZM should be indicated, as well as the prepared procedure for verifying the maturity of drone solutions for entities that will use the above-mentioned services. test areas in the GZM area. In addition, an important effect is the publication of recommendations on smog monitoring using UAVs and a model ToR supporting the process of ordering smog monitoring services.
	Thanks to the integration of various environments around the idea of Dolina Dronowa, the cluster promotes its activities better. It organizes stakeholder meetings and tests of the use of drones to monitor landfills, open webinars addressed to operators performing UAV flights in a special category and to entrepreneurs considering implementing services using UAVs. These activities are met with an increasing response from the industry.
	The cluster also deepened its cooperation with local governments and prepared documentation for local government units on how to carry out local government tasks in the field of environmental protection with the use of drones. Numerous industry meetings and conferences were also organized, where representatives of the Polish UAV industry had the opportunity to take part in a discussion on, among others, issues of legal regulations in the field of BSP, as well as present its solutions and services.
	At the same time, the cluster has become a place of even deeper integration of the Polish drone environment, which it successively supports and promotes, also on the international arena.

[90] Smart Growth Operational Programme.

Possibility to use good practice	The above good practice proves that clusters have the potential to expand their traditional area of operation, which so far has been supporting the innovativeness of their members, combining economy with science in a mainly regional dimension.
	Clusters can represent the industry on a national scale, they can coordinate large or many nationwide projects, and even represent the industry before public administration, including regulators.
	Strengthening the integration of the industry gives cluster enterprises the ability to influence the entire ecosystem around the cluster, e.g. authorities in terms of legislation or directing support. For the cluster itself, it may contribute to an increase in the number of cluster members in the future and the implementation of more projects, new projects and cluster services.
	Good practice can be used by other clusters operating in other market sectors as a model for integrating participants of the entire sector, not just cluster members. The sequence of potential cluster activities for industry integration, including entities not belonging to the cluster, may be as follows:
	1. Identification and establishing relationships with public entities influencing regulations in a given sector.
	2. Identification and establishing relationships with potential customers (including institutional ones) for the sector.
	3. Identification and establishing relationships with entrepreneurs representing the sector in the country.
	4. Organization of meetings and conferences (including international ones) to build relationships between the above-mentioned entities.
	5. Building an Internet platform (knowledge base) facilitating the acquisition of information, contact and cooperation between entities in the sector.
	6. Undertaking or initiating or supporting specific projects that facilitate doing business in the sector (in our case, CEDD).
	7. Representing the interests of the environment in relations with the administration and regulators.

| Krzysztof Krystowski, President of the Management Board of the Silesian Aviation Cluster | The drone industry around the Silesian Aviation Cluster is an initiative that goes beyond the standard scope of cluster activities, and at the same time a logical consequence of these activities carried out by the cluster coordinator. The cluster, previously associating numerous drone entities located in the Silesia region, has become a "gravity center" for drone market entities from all over Poland. The cluster has built partnership relations not only with regional entities interested in the development of the drone market (GZM[91]), but also with the most important entities (including regulatory entities) throughout Poland (Ministry of Infrastructure, Civil Aviation Office, Polish Air Navigation Services Agency, Institute of Aviation, etc.). We managed to combine both the needs and ambitions of the region with the interests of entrepreneurs.

In order to be successful, a cluster must undertake many initiatives and relations with partners outside the cluster, and even its immediate environment. It is difficult to build the Cluster's credibility, including credibility in terms of financial and human potential, in order to undertake such ambitious tasks, so other clusters undertaking activities for the benefit of the entire industry must take care of building their strong financial and organizational position. |
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[91] Metropolitan Association of Upper Silesia and Dąbrowa Basin (Górnośląsko-Zagłębiowska Metropolia - GZM).

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
A 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 of introducing good practice	The dynamic development of technology and the changing needs of customers make enterprises, including cluster members, face the difficult challenge of keeping up with trends and reacting quickly to changes. Companies that are not open to them often do not use their full potential. Good practice responds to the challenges of the need for: ▪ new technologies and solutions to reduce the use of raw materials and their reuse; ▪ knowledge of design and production technology enabling effective recovery of raw materials for further use; ▪ standardization of recycling processes; ▪ cross-sectoral innovations to create new value chains and new business models in line with the principles of the circular economy; ▪ initiating, supporting the development and dissemination of innovative solutions in the field of circular economy for the benefit of both its members and the circular economy as a whole; ▪ support for investment implementation; ▪ competences in the implementation of innovations or Industry 4.0 solutions. It is also a response to the lack of knowledge, negative attitude of employees to changes in the organization and high implementation

	costs, which are a barrier for many enterprises that are difficult to overcome without external support.
	Good practice is part of the plans for the Circular Economy (CE), which is an important means to achieve climate goals, and which - declared at the national, EU or global level - are not possible to achieve without thorough changes in the ways of production and use of resources and products. Closing the loop is a key element of the European Green Deal, which translates into the regulatory and business environment in which companies operate.
Description of the good practice	From the beginning of its activity, the Waste Management and Recycling Cluster has been taking actions in response to the market demand in the field of circular economy transformation and innovation, including digitization towards Industry 4.0. Both the companies associated in the cluster and external clients, the cluster coordinator offers a number of services that support their development and increase competitiveness, in particular through the digital and circular transformation of enterprises, creating new business models, support in the process of implementing innovations or certification of waste recycling companies, with particular emphasis on post-consumer waste.
	The ProGoz, ProInno, KNR Green and Klaster Box services should be mentioned in particular. These activities present a comprehensive approach of the cluster coordinator to the needs of the industry, a response to various problems reported by e.g. cluster members.
	ProGoz
	The first one is a comprehensive support service for companies in the field of building and improving products, services and business models towards the Circular Economy. The recipient may be companies regardless of their size and area of activity, as well as broadly understood public administration.
	ProGOZ is a modular service whose idea is to provide knowledge and solutions in the field of circular transformation using modern methodologies such as Human Centered Design / design thinking, Lean, Lean startup, Jobs -to-be done. It is based on original tools - such as workshop scenarios, boards, playing cards.

The result of the service is a report and an action plan based on the best global standards and the company's readiness to certify e.g. in accordance with the KNR Green standard. The service is based on designing together with the client's company - solutions are developed in cooperation with the internal team.

ProInno

Another service of the cluster is ProInno - two paths of supporting the development of the enterprise:

- Innovations - support for innovative transformation.
- Industry 4.0 - support for digital transformation, including the creation of digital road maps.

As part of the service offered, a development plan with specific actions is developed, and a dedicated expert guides the company through all stages of its implementation. Importantly, the service recipient is indicated the source of financing for defined projects.

KNR Green

KNR Green is the first Polish recycling certification standard, addressed to recyclers operating in 7 industries: textile, metallurgy, paper, wood, glass, chemical and plastic. The certificate was created on the initiative of the cluster coordinator in cooperation with various entities focused around the recycling industry.

The certificate confirms compliance with the legal and quality requirements that must be met by recyclers operating on the European Union market. It is also an official certification for the holders of the content of post-consumer waste in final products, thus supporting the concept of circular economy. It is a tool that enables companies to meet the growing requirements of major retail chains for labeling products with sustainable development standards, as well as existing national and European Union legislation, which obliges companies to increase the level of waste recycling.

ClusterBox

KlasterBox is a completely new space for members of the Waste Management and Recycling Cluster. The platform creates new opportunities for communication with Cluster Members, introduces a system for managing and monitoring membership status, and

	supports processes within the cluster. KlasterBox is also a changed sales platform with new functionalities, on which each Cluster Member will be able to offer its products and services and purchase products and services of other Cluster Members.
The effect of introducing good practice	The effects of implementing good practice include, above all, introducing innovations in enterprises, creating a circular innovation ecosystem, building and strengthening competitiveness, improving competences and strengthening relationships, connections and value chains.
	Both cluster members and external entities, thanks to the services offered by ProGoz, ProInno, KNR Green or KlasterBox, have the opportunity to analyze the potential of their companies, receive knowledge, inspiration and tools for creating and managing innovations, creating a circular economy strategy, acquiring new customers and building an image and adapting companies to the requirements of new regulations and business expectations. Companies also receive active support at the stage of seeking and obtaining external sources of financing.
	Thanks to the digitization of internal and external processes, the Waste Management and Recycling Cluster will support its development even better, improve its knowledge and competences, and offer services to its Members.
	It also strengthens the image of the cluster as an entity that comprehensively supports entrepreneurs and effectively responds to their needs.
Possibility to use good practice	The potential of the circular economy is located in innovations - it assumes thinking through the entire product life cycle, as well as creating new services and business models that can open up completely new spaces for the company's business activities.
	The activities of clusters and their members in the field of transformation towards a circular economy require a number of activities at all stages of a product's life, starting from product design, through the acquisition of raw materials, processing, production, consumption, waste collection to its management. Success comes from a comprehensive coordinator's approach, planning a logical

	sequence of activities, although of course cluster services can be created successively, step by step. Clusters that do not find in their resources the potential for independent activities in the field of circular economy may consider establishing cooperation with the Waste Management and Recycling Cluster acting as an information, communication and cooperation platform in the field of circular economy.
Katarzyna Błachowicz, Vice-President of the Management Board, Waste Management and Recycling Cluster, National Key Cluster	*The key to achieving the competitiveness of the economy, which is increasingly based on research, development and innovation, as well as the ability to dynamically absorb, participate in the creation and development of new technologies, are i.a. clusters. Thanks to the naturally established cooperation of enterprises, research institutions, business environment institutions, non-governmental organizations and local authorities, they are referred to as a catalyst for innovative processes.* *Undoubtedly, projects supporting the innovativeness of companies provide support in the implementation of innovations. Cluster's products are the result of the " ClusterLab " project. These are services in the field of digital transformation and circular economy, and the only certification in this area with the KNR Green standard. In the Cluster, with our ideas and innovations, we are one step ahead of the established and implemented law, including the European Green Deal. This carries the burden of risk and investment preparation, but what counts is the environment and how, thanks to our actions, we have a real impact 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
A 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 of introducing good practice	Support for smart specializations (IS) means that public funds in the EU are directed in a special way to activating and using the potential of those areas or sectors of the economy that in a given area stand out from other sectors of the economy with a high capacity for dynamic development and expansion to foreign markets. Support for entities operating within selected ISs is mainly aimed at the implementation of innovative projects and research and development works, strengthening the potential of the selected specialization. The Coordinator of the North-South Logistics and Transport Cluster, recognizing the innovative and competitive potential of its members, taking into account the context of the dynamics of the national environment and global conditions, became involved in activities related to the identification and monitoring of smart specializations of the Pomeranian Voivodeship.
Description of the good practice	In Pomorskie, a bottom-up IS definition process has been adopted. They are submitted in a competition procedure by interested economic and scientific circles, and regional authorities select those with the greatest development potential from among those submitted. The Management Board of Baltic Sea Cluster Initiatives Sp. z o. o., which is the coordinator of the North-South Logistics and Transport Cluster, striving to increase the competitive advantage of its members and bearing in mind that entering the ISP area is a formal and obligatory criterion for access to public funds, actively engaged in activities aimed at recognizing offshore and port and logistics

	technologies as one of the smart specializations of the Pomeranian Voivodeship (ISP).
	This was done e.g. through active participation in the formulation of the voivodeship strategy and assumptions for this IMS area. The representatives of the cluster defined the development directions of this specialization.
	It should be noted that the IS selection process is repetitive and is launched by the Pomeranian Voivodeship Board on a regular basis to update knowledge and plans. This requires, among others, verification of ISP areas from the cluster coordinator and confirming the adequacy of its scopes in consultation with cluster members.
	At the same time, the cluster engages in a number of activities aimed at intensifying and deepening cooperation for the development of ISP, in particular between entrepreneurs and entities representing the science sector in order to jointly develop unique technologies, products and services. Similar activities concern the deepening of cooperation between cluster members and local government units.
The effect of introducing good practice	Building a culture of openness, cooperation and partnership with local government authorities as well as with other entities interested in developing smart specialization contributed to the success of selecting offshore and port and logistics technologies as one of the smart specializations (ISP 1).
	The cluster coordinator is one of the signatories of the Agreement for the Smart Specialization of Pomerania in the area of Offshore and port and logistics technologies, the purpose of which is to agree on the goals of ISP development, its subject scope and priority research directions, relating to research problems, the solution of which is crucial for the development of the specialization as well as defining, on the basis of the declaration of the Management Board of the Pomeranian Voivodeship, the principles and forms of support for projects contributing through the development of unique technologies, products and services to the development of ISP, e.g. based on research and development projects.
	Offshore and port and logistics technologies is to significantly strengthen international competitiveness and accelerate the growth rate of enterprises in the maritime economy sector in the Pomeranian

	Voivodeship through the implementation of research and development works and the creation of innovative products, services and technologies based on them in the field of exploration and exploitation of marine resources in an environmentally safe manner. As part of developing smart specialization and creating space for diverse cross-sector links, the cluster also actively cooperates with other voivodships.
Possibility to use good practice	It is worth developing the activities of coordinators in terms of influencing public institutions. The idea of smart specializations creates the basis for systemic support for cluster members in order to stimulate their development and, consequently, to increase the region's competitiveness. Clusters themselves can play an important role as effective instruments for implementing smart specializations. Thanks to their active involvement in the process of defining specializations, it is possible to more effective implementation of technological solutions on the market and the chances of a faster return on investment in R&D&I increase. Cluster members can increase their innovativeness by participating in and using projects for the development of smart specializations.
Jerzy Uziębło, Vice-President of the North-South Logistics and Transport Cluster	*Our cluster is distinguished by a fairly wide group of members participating in various initiatives, including meetings organized by us, which foster the creation of relationships between participants and later result in effective cooperation for the development of the industry and smart specializations. At the same time, it is a derivative of the fact that we have very good internal communication, which translates into the commitment, openness and readiness to cooperate of our members. We also learn from other, more experienced, foreign clusters.*

6.2.13. Comprehensiveness of activities in the field of internationalization

Name of good practice and cluster	Cluster Polish Automotive Group
A 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 of introducing good practice	Building working value chains within clusters is an important task for coordinators, which turned out to be particularly important during the COVID-19 pandemic. At that time, the cluster faced the risk of breaking the supply chain from production plants located in Asia. Cluster members became aware of the limitations of globalization and the associated difficulties with supply and the logistics chain. The socio-economic situation caused, among others, by The COVID-19 pandemic inspired the Polish Automotive Group Association (PGM) to launch a project called the Polish Automotive Production Hub (PAPH). Practically on the eve of the outbreak of the COVID-19 pandemic, a group of Klaster members established an export consortium called "PGM AUTOMOTIVE" to make it easier for Polish suppliers of spare parts for motor vehicles to appear with their products on distant and difficult markets. Together with other activities, it added comprehensiveness to the internationalization offer of the PGM cluster. It is worth noting that thanks to the commitment of members, the offer was created with private funds.
Description of the good practice	**Polish Automotive Production Hub** One of the manifestations of the internationalization of enterprises that PGM wants to develop as part of its activities is the acquisition of foreign capital and encouraging foreign companies to invest in Poland, as part of the cluster. Polish Automotive Production Hub is a project addressed to companies, in particular from the automotive industry, interested in relocating their industrial production and locating it in Poland.

PAPH aims to provide technological and production support for new investments in Poland. The objectives of the activity also include: promotion of the Polish automotive industry, supporting the competitiveness of Polish manufacturers of parts and components from the automotive industry, incorporating Polish manufacturers of automotive parts into new supply chains, stimulating cooperation between foreign investors and Polish automotive manufacturers, e.g. in the Joint Venture formula or in other cooperation variants.

The support is multi-level and flexible, depending on the needs of the investor.

The cluster offers potential investors support in such areas as: development of supply chains, cooperation in research and development, exchange of knowledge and cooperation, investment support and legal assistance. The coordinator promotes the cluster and tries to attract contractors, directs interested parties to the appropriate member of the cluster. Cluster members, on the other hand, are prepared to start cooperation with the investor, eg locating the investor's production line in their plant, using their own technologies and those of a business partner.

The factories operating in Poland, together with their production potential, create favorable conditions for foreign investors to consider the possibility of transferring production without building new plants from scratch.

PGM AUTOMOTIVE

Due to the fact that a comprehensive broad one offer is more effective for servicing potential customers and investors, it was decided to create an export consortium under the name of "PGM AUTOMOTIVE". Such an offer attracts contractors more easily, so it gives an opportunity to increase the interest of entities from outside the cluster.

The commercial company established by PGM members represents several cluster entities. Under a common brand, PGM AUTOMOTIVE is to distribute automotive parts from domestic factories to distant and difficult markets - in Africa or the Middle East. In such difficult markets, the use of synergy thanks to cooperation gives good results, e.g. we managed to attract customers for a diverse product offer of

	various members of the Cluster in Algeria, Saudi Arabia, Morocco or Guinea. **Other activities** The Polish Automotive Group also organizes inbound missions for customers and outbound missions for its members (e.g. a COSME project in which 4 PGM members take part in missions to Japan, Singapore and the USA), as well as seminars for potential suppliers, prepared in cooperation with with automotive concerns. He is also a partner of such industry giants as HYUNDAI Motor Manufacturing Czech or KIA Motors Slovakia, which he helps to find new suppliers in Poland.
The effect of introducing good practice	PGM's initiatives are undoubtedly an example of effective action. The Polish Automotive Group supports its members in the internationalization of their products and promotion on international markets. Several PGM members were successfully recommended as future suppliers to Hyundai Motor Manufacturing Czech, Toyota Tsusho Company and Norauto France. Polish companies are very modern, well-invested and at the same time open to cooperation with foreign partners who can not only outsource production or use their research centers, but can also provide new technologies. In turn, the effect of establishing an export consortium is significant facilitation in the arrangement of B2B talks and their more efficient course.
Possibility to use good practice	The challenge for companies operating in clusters is the reorganization of knowledge flow channels - moving away from focusing only towards the inside of the cluster towards opening to the outside. It is worth building a comprehensive internationalization offer, even without public funds, because it positively affects cooperation within the cluster, builds an atmosphere of trust and increases the turnover of cluster members. A joint offer is also a value on the market. The coordinator should be strongly involved in the activity and integrate the cluster members. The coordinator must be well acquainted with the activities of its members, their potential for international

	cooperation, in order to integrate activities in the cluster and be able to effectively acquire contractors.
	Such activities contribute to building global production networks in which cluster members are included.
Bartosz Mielecki *Cluster manager and managing director of PGM* *Polish Automotive Group*	*"The key to a cluster's success is committed members. It is extremely difficult to make them want to share their best experiences or problems, let alone solve them together. At PGM, we manage to create a community of entrepreneurs in the automotive industry that are friendly and open to cooperation, and an example of this is the creation of the PGM AUTOMOTVE 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
A 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 of introducing good practice	Protein Industries Canada (PIC) is one of Canada's five innovation clusters selected to strengthen Canada's economy and become an engine of growth. Canada's clusters were selected through a competitive process and receive public funding – which must be matched by industry – to advance collaborative projects and ecosystem initiatives. The clusters are aligned with government priorities, but operate independently as not-for-profit entities, directed by each cluster's Board 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. In order to take full advantage of the 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 use their strengths to accelerate innovation. The cluster also works with partners and members to co-invest in R&D projects implemented 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 members and the entire value chain. The cluster has approximately 250 members (in total, over 4,000 entities belong to all clusters). Protein Industries Canada provides an effective structure for selecting and co-investing in collaborative R&D projects. This reduces the risk of conducting R&D works and allows for bold

	initiatives and the creation of new ingredients and food products, facilitates the establishment of industry partnerships, and opens the door to new promising investments. With a current portfolio of nearly half a billion dollars in innovative research and development projects, Protein Industries Canada works with companies to create solutions to the global food challenge.
	Government funding for the implementation of these projects of small and large companies is provided through a competitive process. This means that the condition for access to funds is the presentation of an effective industry cooperation plan, including the implementation of R&D works. The aim of the work is the effective transformation of agriculture and the food processing industry. The necessary condition is to submit projects in partnerships (e.g. with the participation of, among others, an SME enterprise and a scientific unit). This positively affects the cooperation processes in the cluster, which can be very large considering the number of members. The fact that most of the implemented projects (72%) reduce impacts on the natural environment is also noteworthy.
	The cluster sees an opportunity to use the strengths of the entire value chain to produce new ingredients and products. This requires a strong plant-protein ecosystem that spans the agri-food value chain and includes members not only from Canada but from countries around the world. It also requires an ecosystem that values innovation and collaboration, combines research with hands-on experience, and reduces environmental impacts.
The effect of introducing good practice	PIC is a catalyst for innovation, driving business-to-business collaboration to tap Canada's agri-food potential. PIC encourages private sector partners to co-invest in projects and build the power of Canada's plant-based protein industry. Members of Protein Industries Canada jointly introduce new protein ingredients for plant-based food and feed to the market, create new technologies and crop varieties for farmers, thus opening up new market opportunities for exporters.
	Over the past four years, Protein Industries Canada and its industry partners have invested more than $477 million in Canada's plant-based food, feed and ingredient ecosystem through 55 innovative

	projects. In total, 445 partners were involved in the implemented projects. The results of these investments are becoming more tangible, with new ingredients and food products hitting retail shelves and restaurant menus in Canada and beyond. It is worth noting that nearly ¾ of all projects simultaneously reduce impacts on the natural environment.
Possibility use good practices	The practice is a Canadian example of how to support selected sectors of the economy (in this case, the agri-food sector in the field of plant proteins) based on clusters, paying particular attention to values, e.g., reducing the impacts of agriculture and the food industry on the natural environment. It shows the effective building of industry cooperation within the cluster to implement innovative projects by leveraging public funding and industry co-investment. Cooperation connects cluster members with each other and with new clients, supporting participation in global value chains. The coordinator builds the potential of members and the industry through mentoring. The applied solution can be an example of supporting cooperation within large clusters with more members, but it can also be a model for smaller clusters. It shows how important it is to build a value chain to drive the entire industry. The element of increasing the global competitiveness of the cluster members by building partnerships within the cluster is also gaining in importance. The partnerships created use strengths to create innovations, overcome barriers and discover new opportunities. An important role for the development of the cluster and its members is played by access to public and private funding.
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 supports innovative projects with the support of the Governement of Canada. Since being announced, the cluster has helped Canada become a leader in the plant-based food sector and has demosntrated 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
A 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 of introducing good practice	Good practice is a response to the problem of an unsatisfactory level of cooperation in the area of implementation of joint R&D projects in clusters. One of the leaders in Europe in terms of building trust and R&D cooperation in the cluster is the French XYLOFUTUR cluster, which has initiated/supported the implementation of nearly 300 projects over the 15 years of operation (mainly in the area of R&D in the forestry, wood and paper sector). It is worth mentioning that the areas of activity, research and innovation of cluster members cover the entire value chain.
Description of the good practice	The aim of the cluster's activity is to develop the competitiveness of the domestic forestry, wood and paper sector through innovation and R&D activities. The activities of the Xylofutur cluster coordinator are aimed at unlocking the innovative potential of cluster members, especially SMEs, by supporting the creation of their projects, connecting SMEs in partnerships with key entities and stakeholders, and identifying sources of public and private funding. The cooperation of the cluster members takes both a formalized form (both contracts and agreements on cooperation[92] are concluded) and an informal one, based, for example, on mutual understanding of the objectives of a given activity and joint working groups. Among the actions taken, the following can also be indicated: ▪ assessment of innovative projects from a market perspective by industry experts;

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[92] 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.

- dissemination of innovative solutions and techniques towards the sector.

Xylofutur has also developed the initiative "La Wood Tech", a French center for start- ups in the forestry and wood sector. Every two years, it organizes competition for innovation called " Canopée Challenge". As an innovation cluster open to all entities from the forestry sector, Xylofutur does not provide any guidance or recommendations regarding the areas of research and innovation that its members should address. Projects submitted to Xylofutur (in order to obtain the label of excellence, as discussed further in the good practice) are mostly bottom-up (with national strategies and available funding schemes having an impact on their subject matter).

The Xylofutur cluster has also undertaken some collective actions in recent years where a top-down approach has been applied. Such actions are usually aimed at 'structuring' the sector. Most of the companies in the sector are small or medium-sized enterprises. Not all of them are well equipped with the resources to run innovative projects. Xylofutur provides them with the skills and knowledge to organize their resources and move them forward. It also helps them identify possible funding schemes and prepare for the labeling process mentioned below.

Within the cluster, there is a specially appointed team that helps in the implementation of projects from "genesis" to commercialization. In the case of French competitiveness clusters (fr. *Les pôles de compétitivité)* their specificity is what is called "labelling" (that is, giving the status of excellence). This is the process by which a project can achieve 'Status of Excellence'. It is awarded by a committee of experts who are industry professionals from both academia and industry. They are selected from Xylofutur members and according to specific criteria, such as national/ regional recognition, sector-specific skills and expertise. Obtaining the above status confirms that the project is innovative and collaborative, is technically and economically feasible and will have an impact on the sector and area concerned (local, regional and/or national). It should also include a dissemination strategy that can be supported by Xylofutur.

	Excellence status ensures public funding. Some public sponsors are unable to assess the technical feasibility or innovative added value of a project submitted for funding. For them, the above status is a guarantee that the project is well prepared, financially realistic and has the right impact on the ecosystem.
	The activities of the cluster are also aimed at the development of the cluster and its members at the European level. The cluster advises its members on raising funds and supports the establishment and integration of consortia for the implementation of joint European projects. Among other things, activities such as the monitoring of European " calls for proposals " in order to promote the participation of cluster members in competitions, including Xylofutur in European research networks.
	Xylofutur identifies two main goals for the future in the area of R&D projects/initiatives:
	▪ Initiating/carrying out more activities or projects with a high impact across the sector and/or industrial regions that could generate more synergies between different stakeholders in the forest and timber value chain. ▪ Coordination of cascading funding projects[93] as this would help Xylofutur to gain greater visibility among SMEs that are not yet members of the cluster and offer new ways of networking.
The effect of introducing good practice	Thanks to the created organizational structure and implemented procedures aimed at identifying, selecting and selecting ideas for further implementation (including seeking external financial support), the cluster coordinator successfully supports its members in undertaking activities in the above-described area.

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[93] 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 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.

	The effect of the actions taken are 272 jointly implemented projects, of which 192 with external financing[94]. This translates into an improvement in the competitiveness of companies from the forestry, wood and paper sector, thanks to innovations and research and development works. The cluster prides itself on creating lasting links between various entities: companies, universities and research organizations, communities, broadly understood institutions, investors, in order to implement innovative projects and create added value. One of the important reasons why companies and research organizations become members of Xylofutur is to join the sectoral and innovation network. In this way, they are given the opportunity to connect with partners with complementary knowledge or end-user partners or part of the supply chain. This helps speed up the development of their projects. Being a member of Xylofutur also means greater visibility in the market. The cluster regularly participates in (inter)sectoral innovation events at regional, national and European level and gives voice to its members in these forms. Xylofutur helps them to disseminate project results as widely as possible within and outside the sector (with a view to also fostering cross-sectoral cooperation).
Possibility to use good practice	Coordinated and interconnected action by all parties is a prerequisite for excellence in research, development and innovation. The creation of special structures by a cluster coordinator and the implementation of appropriate procedures in the field of R&D activities may contribute to improving the effectiveness of activities undertaken in this area, streamline the process of generating new ideas, and as a result bring measurable benefits to clusters. It is worth mentioning, which may also be an indication for Polish clusters where to look for funding, that the Xylofutur cluster wants to become more and more involved in programs such as Euroclusters or European Innovation Ecosystems (EIE) to further develop and provide its members with activities supporting innovation and cascading finance.

[94] 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).

Information from the cluster's website	*For 16 years, the Xylofutur Competitiveness Cluster has been developing its professions, research topics and spheres of influence in order to come as close as possible to the economic and operational reality of its members. 275 members in January 2023 and 273 marked projects with a budget of EUR 461.3 million, including 197 projects financed (EUR 290.5 million) up to EUR 104 million of state aid.*

6.3.3. Forming alliances, opening markets

Cluster name	Cluster Czech purchase
A 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 of introducing good practice	About 70% of the 130,000 companies in the furniture manufacturing sector in the European Union are small or medium-sized companies employing a total of over one million people. According to data from the Czech Ministry of Industry and Trade, this industry employs over 100,000 people. people. For comparison, in Poland, according to the data of the Polish Chamber of Commerce of Furniture Manufacturers, approx. 200,000 people are employed in the furniture industry. people. Furniture clusters operating internationally indicate a lack of knowledge about entering and developing activities on international markets as the main challenges for their SME members in terms of internationalization. Significant barriers are also the lack of stability of the law and the volatility of the situation on the logistics market, as well as difficulties in accessing public funds. Serious perturbations also resulted from the COVID-19 pandemic. With the above in mind, the European Commission has decided to fund an international furniture cluster partnership project after noticing the severe economic impact of COVID-19 on sectors that typically require products and services from the furniture and wood industries, such as tourism and retail.

	The cluster of Czech furniture manufacturers is active on the international arena, establishing partnerships and engaging in the implementation of international projects, as well as supporting its members in submitting applications and obtaining national and international funds, enabling them to develop and access new international value chains.
Description good practices	An example of a project in which the cluster was involved in order to stimulate the export of member companies is FURNITURE GO INTERNATIONAL: FORMING ALLIANCES, OPENING MARKETS, i.e. a project managed by 8 European clusters from 6 European countries representing together over 500 SMEs and the complete value chain of the furniture industry, and funded by the European Commission. The aim is to help SMEs enter new markets through cooperation and innovation, and to create a new European Strategic Cluster Partnership, the aim of which is to strengthen cooperation in the furniture industry and related industries within the EU, as well as in relation to selected third countries: USA, Canada, Egypt and South Africa. The clusters involved in the project are: 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 identifies and establishes new strategic partnerships throughout Europe and organizes exploratory visits of cluster representatives to selected third countries. Managing the entire so-called project package (WP6), which is focused on long-term durability of established partnerships in order to conclude cooperation agreements between the Project Partnership and international business organizations or organizations focused on research and development.
	The cluster coordinator supports its members in taking advantage of business opportunities and becoming competitive on the global market, e.g. by providing support in adjusting the product portfolio of its members to the needs of target markets, collecting and processing information and experience needed to enter new markets. The

	involvement of companies is based on their interest and goals related to internationalization. The cluster coordinator aims to strengthen the position of its members on the market, improve the quality of products and increase the competitiveness of the Czech furniture industry.
Effect introduction good practices	Thanks to their involvement in the project activities, cluster members gained e.g. access to the results of a study on the furniture industry in the target third countries: USA, Egypt, Canada and South Africa, and access to the matchmaking platform, which is a closed community that is used to promote, match partners and establish cooperation. The possibility and feasibility of extending partnerships in third countries is also being explored to ensure first contact relationships with market stakeholders. In addition, the cluster, together with project partners, is currently negotiating the possibility of opening a joint showroom of a joint representative office in Cairo, Egypt.
Possibility use good practices	In order to further develop in the European cluster environment, cooperation opportunities with other clusters and companies should be sought. The internationalization of clusters no longer refers only to the internationalization of clusters and their members from individual countries, but also manifests itself in building clusters at the level of European Union regions. Cooperation with other entities, especially other clusters, is perceived as a very good source of new ideas. Cluster Czech nábytkářů supports its members in many ways, e.g. by: ■ Business cooperation: The cluster organizes business meetings, seminars and conferences, during which members can exchange knowledge and experience and establish business contacts. ■ Research and development cooperation: The cluster works for the development of new technologies and innovative solutions in the furniture industry. Cluster members have access to research results and can participate in research projects. ■ Promotion: The cluster of Czech buyers organizes promotional campaigns, exhibitions and furniture fairs, during which furniture produced by cluster members is presented.

	▪ Cooperation with institutions: The cluster establishes cooperation with public institutions and industry organizations to represent the interests of its members before authorities and regulations. ▪ Training and support: The cluster organizes training in management, marketing, sales and other areas to help its members develop their business. Therefore, the cluster coordinator has identified important areas/actions that enable members to create a competitive export offer and stimulate their development in the cluster, as well as engage in international projects and foreign partnerships to explore new markets.
Information from the cluster's website on internationalization	*The global goal of the cluster is to increase the international competitiveness and economic development of the cluster's member companies by focusing on the development of research, development and innovation, permanent improvement of links between scientific units and the business sphere in the furniture industry and strengthening internationalization.* *An example of this activity was the organization of 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 between 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 Partnership of Furniture and Wood Processing Clusters. The basic motivation for creating the platform was to establish international cooperation in the field of scientific research, transfer of technology and know-how, as well as the preparation of joint international projects that will lead to the creation of the European Strategic Partnership of Clusters in the furniture and wood sector.*

7.   Cross-industry analyses

This section presents the method of dividing the clusters participating in the study into their industry structure. The clusters were divided into 6 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 operate at the intersection of at least two of the above-mentioned areas. Examples include:

1. Cluster of Information Technology in Construction - a cluster in the field of construction, with a significant participation of members representing ICT.
2. Sustainable Infrastructure Cluster – operates at the intersection of construction, material engineering and energy.
3. Lublin Cluster of Enterprises - brings together a diverse group of members with a certain advantage of construction companies, but also with the presence of companies operating in the area of quality of life or tourism and recreation.
4. Polish Cluster of Composite Technologies - operates within one of the defined industry groups (materials engineering). In turn, the products and technologies produced by cluster members are widely used in other industries (including automotive, aviation production, construction, metal production and processing).

It is worth taking into account the growing number of cluster members in recent years. The number of members among the surveyed clusters is 4,208, with an increase of 16.8% in the period of 2 years (since the previous edition of the study). Taking into account the possibility of a limited population of enterprises and other organizations operating in a given industry in a specific geographical location, this may mean processes related to the development of interdisciplinarity of clusters (e.g. expanding clusters to include members from industries forming wide value chains).

The percentage of enterprises operating within the cluster's leading industry (according to PKD) is 60%, which confirms the earlier conclusion.

Cross-sectoral analyzes were carried out at the level of each of the 19 sub-areas in Chapter 6. Data at the area level and in total is presented here. Calculations were made for the median and the benchmark.

Analyzing the results, the best median value was obtained by clusters from the chemistry, bioeconomy, materials engineering and energy (0.46). This means that at least half of the clusters in this group achieved very high results in overall benchmarking. Clusters from this industry obtained the best results for each sub-area of the study, with the exception of cluster resources (where clusters from the ICT area obtained a slightly higher median value). At the other end are those from the construction industry and quality of life, tourism and recreation. Their median of 0.18 means that at least half of these clusters obtained very low results overall. From the point of view of cluster coordinators, the chart below may be helpful in that it enables the identification of the greatest weaknesses of clusters at the area level and the remedial action necessary. For example, from the perspective of construction clusters, there is a great need to strengthen activities, especially in resources, impact on the environment and internationalization.

Graph 76. Median value for clusters by industries and benchmarking areas and in total
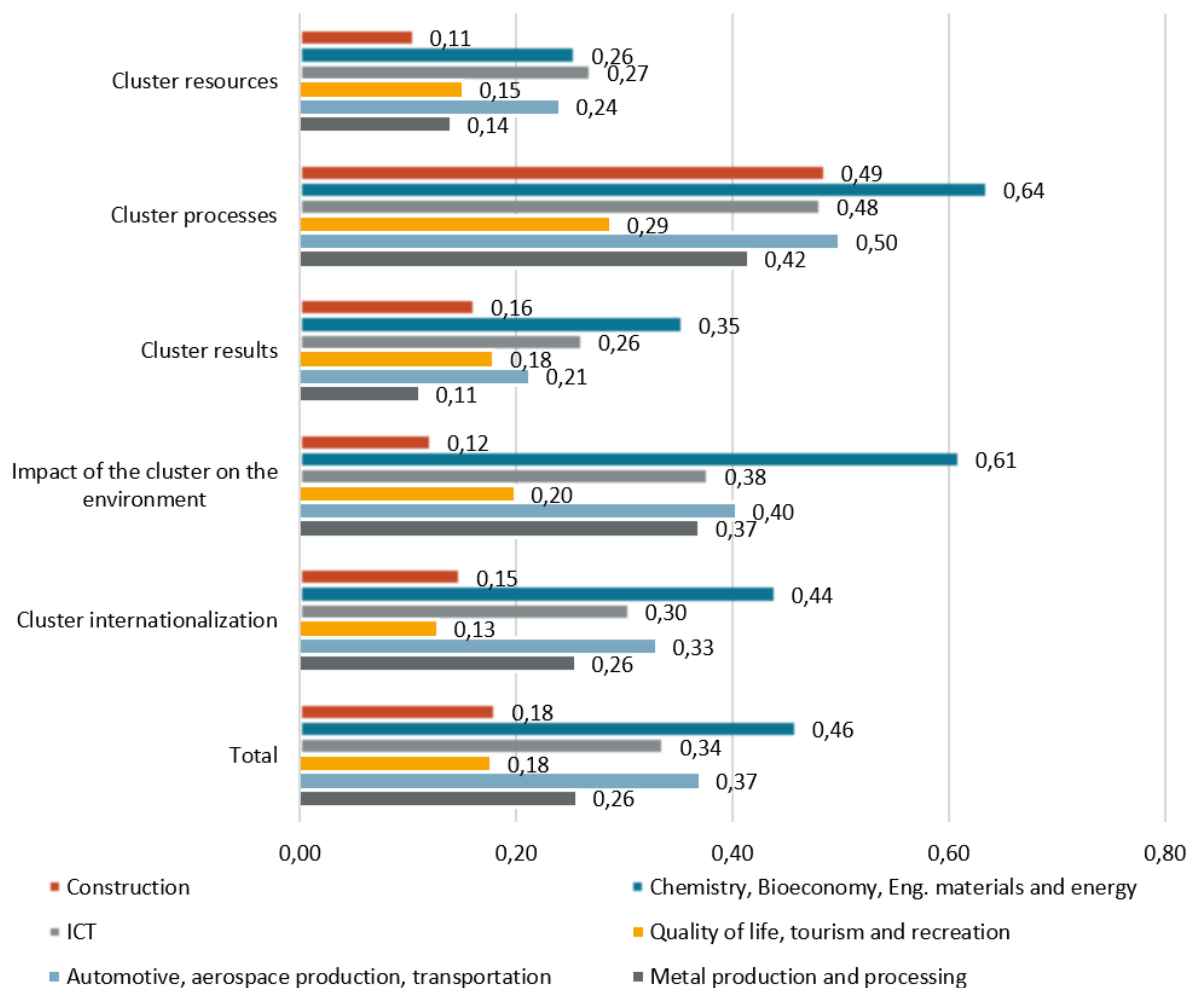
Source: own elaboration based on a survey of cluster coordinators (N=41).

Then, the results for benchmarks, i.e. the best values obtained in a given area and overall by the best cluster in a given industry, were presented. In this case, the differences are not so significant between clusters in individual industries. This means that in practically every industry there is at least one cluster achieving very good or good results.

Graph 77. Average value of the median for clusters broken down by industries and benchmarking areas
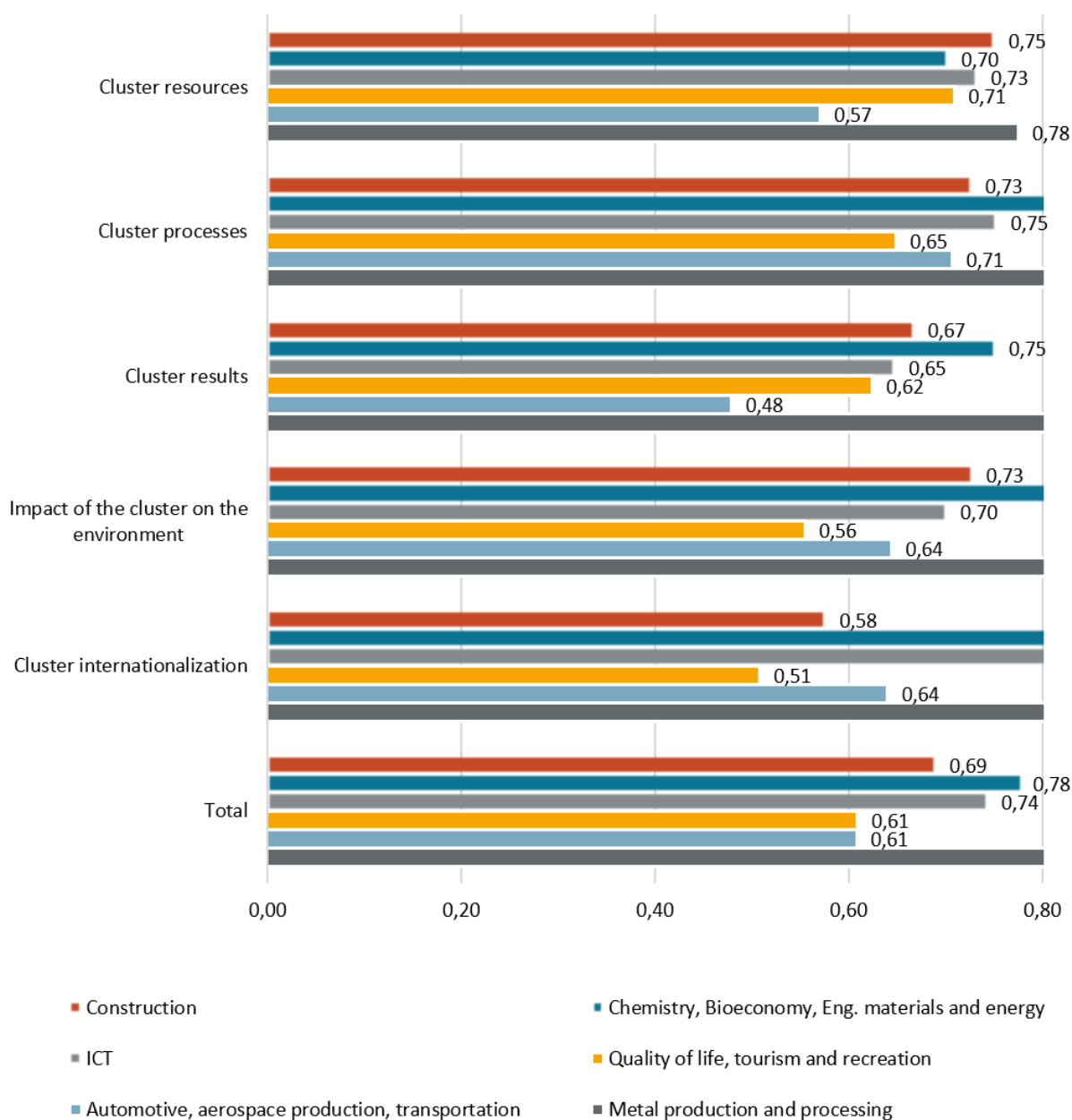
Source: own elaboration based on a survey of cluster coordinators (N=41).

Then, the position of the cluster against the background of the industry was analyzed for selected partial indicators. An illustration of the indicators is included in the next table, while a discussion of the results is provided below.

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 in 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 a survey of cluster coordinators (N=41).

The first indicator concerns the change in the value of total sales revenues of cluster enterprises between 2020 and 2021. The indicator provides information on changes that took place in the first two years of the spread of the COVID-19 pandemic. The result at the level of industries is an average. It is worth noting that each of the industries recorded an increase in the value of sales revenue, with the highest in the chemical, bioeconomy, material engineering and energy industries (29.2%) and metal production and processing (26.7%). These values exceeded the average increase in the value of total sales revenues for all enterprises (approx. 23% based on Central Statistical Office data). The construction sector fared worst (only increased by 12.5%). This is because construction, unlike most other industries, did not record

significant decreases in the first year of the COVID-19 pandemic (2020). While other industries recovered in 2021 after a weak 2020, the construction industry has been developing at a relatively stable pace in recent years.

Another indicator determined the level of penetration of a given cluster by 13 specified Industry 4.0 technologies (details on the method of calculation can be found in chapter 6.2.6). The maximum value that a given cluster could obtain is 36.0. Since a significant part of these technologies concerned the use of information systems (e.g. digital platforms, blockchain, Internet of Things, industrial Internet of Things, artificial intelligence, cloud computing, big data analytics, etc.), it is not a surprise that clusters from the ICT area recorded almost the maximum value. Entities from these clusters are not only users of these technologies, but in many cases they are also involved in their creation and sale. The smallest penetration of these technologies can be observed in the quality of life, tourism and recreation industries.

The average number of jointly implemented innovative and R&D projects, clusters representing the metal production and processing industry are the clear leader (on average 6.8 projects per cluster). In turn, the clusters representing the following industries performed the worst: construction (2.4), automotive, aviation production and transport (2.4) and quality of life, tourism and recreation (2.5).

The measurement also concerned taking actions by clusters with a positive impact on society, e.g. using the concept of common value (*creating shared value* -CSV). Recommended actions in this area are discussed in more detail in chapter 6.4.2. In this case, the evaluation was binary (1 meant that the cluster was active in this respect). In this case, the ICT clusters and the automotive, aerospace production and transport clusters fared most favorably (average value of 0.9).

On the other hand, the indicator concerning the number and type of actions aimed at improving the condition of the natural environment consisted in summing up the actions indicated in the cafeteria of answers (taking into account, among others, the use of the circular economy concept in activities, possession of environmental certificates, R&D works in the field of low-emission technologies/ in the area of green economy or generation and distribution of energy from RES). Actions in this area are discussed in more detail in chapter 6.4.3. In this case, it is worth distinguishing the chemical, bioeconomy, material engineering and energy industries. This is not surprising, as cluster entities from this industry are most often suppliers of various technology products that enable the improvement of the natural environment. Clusters from the area of quality of life, tourism and recreation, and construction performed the worst. The coordinators of these clusters should consider taking wider action in the field of positive environmental impact (e.g. using the experience of clusters in the field of bioeconomy and energy).

Another indicator concerns the share of entities with foreign capital in the cluster (i.e. entities with direct foreign investments). In this case, the automotive, aerospace production and transport industries are the clear leaders (the average number of such entities is 12.9) and ICT (12.1).

The last indicator concerns the average number of foreign markets where cluster enterprises are present. Due to the ease of distribution of digital products and technologies, the ICT sector is the leader (almost 48 markets on average). On the other hand, the production and distribution of building materials and the provision of services in the field of construction is often strongly geographically limited. For this reason, construction clusters received the lowest rating here (18 markets on average). More information on which specific markets Polish clusters are present, can be found in chapter 6.5.3.

Cross-industry analysis summary

- The clusters participating in the benchmarking were divided into 6 industry groups, consisting of 4 to 11 clusters (some operate in more than one industry). The area of quality of life, tourism and recreation was most represented.
- In the two analyzed years, the number of cluster members participating in benchmarking increased (by nearly 17%). In addition to a moderate percentage of enterprises operating in accordance with the leading industry of the cluster (60%), led to greater interdisciplinary of clusters.
- As for the median, the best results were obtained by clusters in the area of bioeconomy, material engineering and energy (0.46), and the worst in the area of quality of life, tourism and recreation, and construction (0.18).
- In each of the industry groups an increase in the value of total sales revenues was recorded in the period 2020-2021. The highest was related to chemistry, bioeconomy, materials engineering and energy (29.2%), metal production and processing (26.7%) and ICT (25.3%). This was a higher level than it would appear from the index published by the Central Statistical Office for the entire economy (increase by approx. 23%).
- Clusters with the highest level of internationalization (considering their presence in foreign markets) include ICT, metal production and processing as well as chemistry, bioeconomy, material engineering and energy.

8.   Conclusions

The current edition of the study in the field of data collection was carried out in the second half of 2022 and covered the period of the analysis of phenomena in 2020 and 2021. Comparing the results obtained under individual editions of the study is subject to possible error due to, amongst others: different selection of clusters, the method of calculating benchmarks and medians based on the unitarization of results[95], 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 was 88 (some of them more complex, eg using complex answer cafeterias)[96]. As a result, comparing the values of synthetic indicators will not provide precise information between individual editions of the study. At the same time, the changes make it possible to capture new and interesting phenomena in the activity of clusters, broadening the picture of the potential of Polish clusters.

The further part of the conclusions from the analysis of cluster trends was based primarily on selected values of several partial indicators, which were quoted in the 2020 report.

- 47 clusters participated in the 2010 study, bringing together 1,866 entities, including 1,469 entrepreneurs. In the 2012 study, the number of entities belonging to the 35 surveyed clusters amounted to approx. 1,535 organizations, of which 1,137 were enterprises. In the 2014 edition of the study, the number of entities belonging to the 40 surveyed clusters amounted to 1,917 (1,550 enterprises), and in the 2018 edition, as many as 3,374 (2,718 enterprises)[97]. According to the collected data, in the period 2018-2019, 872 organizations became new members of the surveyed clusters, while 326 organizations resigned from membership in the same period. Based on the data obtained from the coordinators, it can be said that at the end of 2019, in the surveyed 41 clusters (increase by 1 cluster compared to the 2018 edition of the survey), the number of members was 3,813 organizations (3,133 enterprises). The current edition of the study was also carried out with the participation of 41 clusters, and a further increase in the number of members can be observed. Currently, 4,208 organizations are associated in the surveyed clusters, of which 3,534 are enterprises. Therefore, an important phenomenon is the increase in the number of cluster members. Since 2018, clusters have been gaining approximately 10% of new members on average. However,

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[95] 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).

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

[97] No survey was conducted in 2016.

the researchers also noticed a decrease in the number of active clusters meeting the entry requirements for the study. In addition, a large group of new clusters has appeared that do not yet meet the requirements for entry into the study, e.g. in terms of the period of activity in order to be able to participate in benchmarking.

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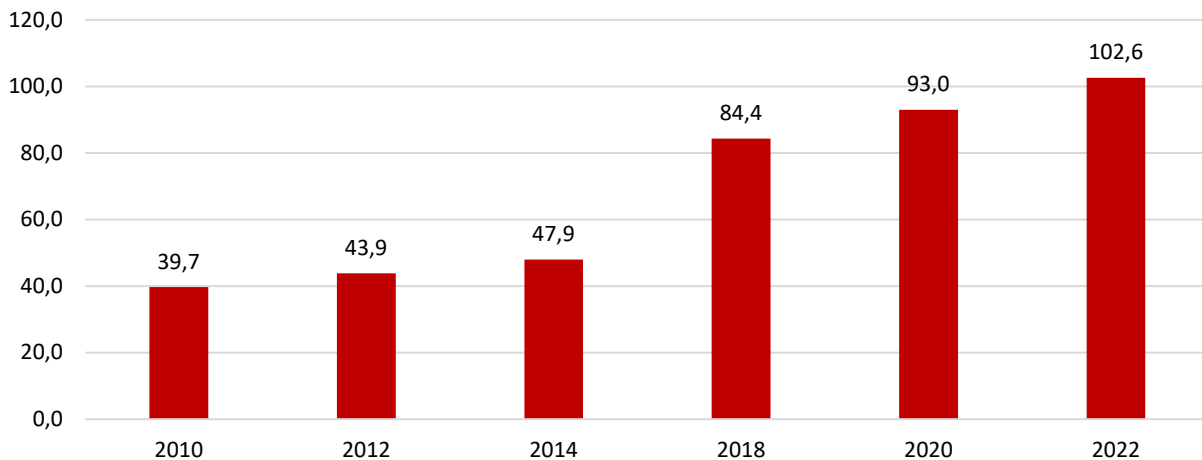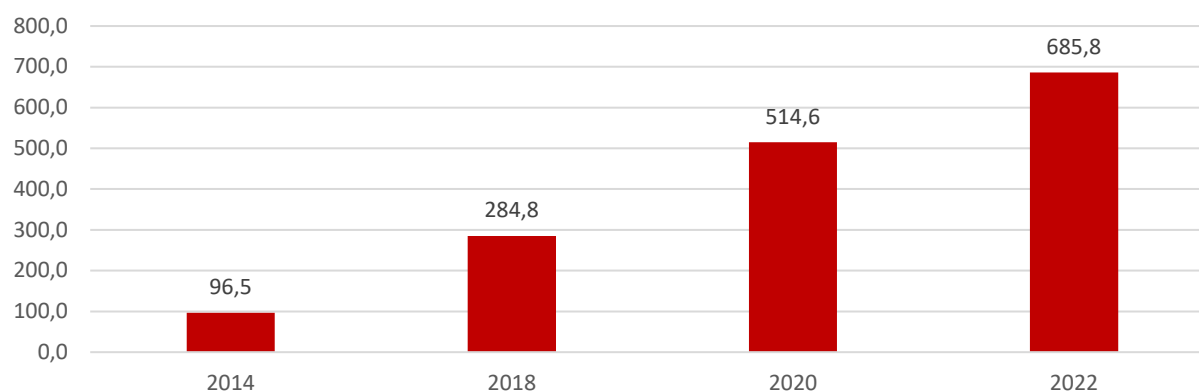

Source: own elaboration based on a survey of cluster coordinators (N=41).

- Most clusters are still regional in nature. The percentage of cluster members based in the same voivodship as the coordinator were examined. In this case, the average percentage was 70.7% and the median was 74.0%. In the previous edition of the study, the average was 71.8% and the median was 77.0%. Thus, certain trends related to the expansion of clusters outside the home region are visible, but at present it is difficult to say that this is a common direction of cluster development. Meanwhile, in the current financial perspective (period 2021-2027), supra-regional clusters will become more important, which together with KKK clusters may receive support under the 2.17 FENG instrument[98] and which may significantly contribute to the implementation of public policies. In this situation, the expected direction of development of clusters, especially those that are not KKK, should be further quantitative development (e.g. expansion to voivodships with very low cluster activity - Warmińsko-Mazurskie and Opolskie voivodships, or expansion to neighboring voivodships, for which there is no equivalent for a given cluster).
- In the last few years, a significant increase in employment can be observed in entities that are members of the analyzed clusters. In 2014, it was 96.5 thousand.

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[98] The rules for obtaining co-financing have not yet been defined. The competition for the call for proposals will be announced after the preparation of this report is completed and will be published on the PARP website.

people. In the 2018 edition, it was already 284.8 thousand people. According to the estimated data from the 2020 edition, the total employment among cluster members amounted to 514.6 thousand people. At the turn of these two editions, the total employment in member entities almost doubled. In the current edition, a further, estimated increase in employment can be observed to the level of approx. 685.8 thousand people.

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

Source: own elaboration based on a survey of cluster coordinators (N=41).

▪ Current benchmarking shows an increase in the number of people delegated to service clusters, in the coordinating institution, was observed (the total number of employees increased from 135 FTE at the end of 2019 to 251 FTE at the end of 2021). This means an improvement in the staff situation of clusters and much greater opportunities to initiate various development activities. Errors in the estimation of these phenomena may result from the selection of different clusters that participated in the study in the 2020 and current editions. There were no clusters that would significantly overestimate the level of this indicator (in the case of 9, the number of delegated employees exceeded 10, but at the same time it did not exceed 20 people in any cluster).

▪ In 2012–2013, the budget of the surveyed clusters amounted to PLN 139.4 million. In 2016-2017, it was more than four times less, at PLN 35.25 million, including PLN 23.5 million of external funds. In the period 2018-2019, the value of the budgets of the surveyed clusters increased nearly 10 times, amounting to PLN 222.1 million (however, changes in the sample of the surveyed clusters should be remembered). Own funds amounted to over PLN 17.3 million, while over PLN 200 million came from external funds (mainly grants received for activities consistent with cluster coordination). In the period 2020-2021 there is a significant decrease in the availability of external funds (grants), mainly as a result of the termination of calls for proposals under individual

operational programs and the ending financial perspective. For this reason, the amount of cluster budgets was significantly reduced, reaching a total of approx. PLN 96.0 million. In this regard, however, it should be remembered that the payment of funds to the KKK under sub-measure 2.3.3 of SG OP could have been suspended to a large extent in the COVID-19 pandemic (activities ensuring physical participation in foreign fairs were suspended for a certain period, and online events began to appear after a certain lapse of time), which will probably also affect the accumulation of payments from this sub-measure in the next research period (2022-2023). However, with regard to sub-measure 2.3.7 SG OP, in the period under review, activities in the field of designing and contracting were carried out, therefore, the payments of co-financing are expected later.

8.1.   Specific and atypical phenomena for individual groups of clusters

Below are specific and unusual phenomena for various groups of clusters that were identified and described at this stage of the study:

- The impact of the COVID-19 pandemic in the analyzed period (2020-2021) did not have a particularly significant impact on the level of cluster development. Analyzing the revenues generated by entities in clusters, a rebound in 2021 after a relatively weak 2020 is clearly visible (when the greatest restrictions were in force due to the COVID-19 pandemic). Regardless of the above, a further increase in the number of cluster members can be observed.

- The impact of the COVID-19 pandemic had the greatest impact on cluster processes, primarily in the area of cooperation development. The use of online communication to organize meetings and various types of events has gained significant importance. Thanks to this, the coordinators acquired valuable skills for "remote" cluster management, which may be important in the case of very large clusters with a significant geographical dispersion (i.e it is better to meet more often in a wider group, but online, than to meet in a traditional formula, but with high absenteeism). Cluster Coordinators said that thanks to the pandemic, the attendance of cluster members during meetings increased (because there was no need to travel).

- In the previous edition of the survey, there was a trend of resigning from having the badge endorsed by EUCLES. Currently, the situation is still quite unfavorable, i.e. only 12 out of 41 clusters have any badge (8 bronze, 3 silver and 1 gold). This may be due to the changes taking place in recent years, under which EUCLES takes over the role of the certification authority. Since cluster certification has already established value on the European market, it is worth coordinators considering renewing / obtaining a new certificate. This is particularly important for their image in the international arena (e.g. cooperation between clusters, creating joint partnerships for the purposes of project

implementation). It is worth the KKK and also supra-regional development clusters to use the 2.17 FENG[99] funds for certification, and for other clusters to lobby to encourage local authorities to finance certification, which will positively affect these clusters, as well as help the development of individual regions in which these clusters operate.

- Out of 16 clusters only one member is a local government unit (LGU). The percentage of LGUs among cluster members is below 1%. The situation looks a bit better when it comes to contracts signed with public authorities (local and central government). In this case, 26 clusters can show at least one active cooperation agreement. Over 1/3 of clusters do not use/have not obtained any public funds. The cooperation of clusters with local government units acquires particular importance in the current financial perspective. Clusters may be entrusted with public tasks under national and regional funds, in accordance with the provisions of the document entitled *Directions of the cluster policy after 2020,* where tightening cooperation between clusters and local governments should be important for this process.

- As in the previous edition of the study, at the stage of cluster recruitment, there was a group of several established in the last 2-3 years, which have great development ambitions. They include: adopted solutions in the field of management processes, communication or digitization, which can be observed in longer operating clusters. Most of these did not meet some of the criteria for participation in the current edition of benchmarking. However, it is worth taking them into account when organizing various types of cluster events and recruiting for future editions of the benchmarking.

- As part of the assessment of management processes, the activities of coordinators were confronted with the opinions of cluster members. The basic areas of cluster functioning, such as building a network of relations with cluster enterprises or the development of cooperation between cluster members, were rated highly (about 2/3 of positive votes). On the other hand, the implementation of their objectives in the areas of creating local supply chains, improving the quality of products and services, reducing the costs of running a business, and influencing public authorities and other institutions was assessed as low. In each of these areas, the percentage of positive assessments was approximately 30%.

- In this edition of the survey, for the majority of respondents (70%), participation in the cluster was associated with great benefits. It is worth noting that half of the respondents (50%) thought so in the previous edition. The percentage of respondents who were of the opposite opinion, for whom these benefits were small, also decreased (26% in the current edition, in the 2020 edition - 41%).

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[99] The European Funds for Smart Economy.

8.2.   Strengths and weaknesses of clusters

In assessing their strengths and weaknesses, the value of the median of scores obtained by clusters in individual sub-areas was used. The strengths were those of the examined elements for which the median score for the entire group under study exceeded 0.30, while the weaknesses were those elements for which the median did not exceed 0.20. Compared to the previous edition, this is an increase in the value of these indicators and a reduction in the number of cluster weaknesses, which results primarily from better results of 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 a survey of cluster coordinators (N=41).

Based on the results obtained in the study, it can be concluded that the position of clusters within individual sub-areas, as well as between sub-areas, was equalized. Despite the small range between the adopted median values, there are relatively few obvious weaknesses. In this situation, the median gives information that at least half achieved very poor results in three areas: financial resources, infrastructural resources and the development of innovation. In the light of the previously analyzed results, it is not surprising that young clusters, with a small number of members, without the KKK status (and most often without ambition to obtain this status) received the lowest scores. In these sectors, the area of construction, quality of life, tourism and recreation is relatively weak. Analysis of the strengths of clusters, the area of management processes and cluster digitization can be assessed particularly well.

Additional conclusions were provided by analyzing the distribution of synthetic indicators obtained by clusters (bottom 25%, middle 50% and top 25%). The analysis showed that the greatest differentiation between the clusters concerned the best of them (range of values: from 0.26 to even 0.57). This shows that weaker clusters would rather not compare their position to indicators for the best clusters, but rather to the average values (statistical annex) or the median or borderline ranges for average clusters.

Compared to the previous edition of the study, the disproportion decreased in areas such as processes in the cluster and impact on the environment, while it increased in the cluster's results. This area of processes is the best. There are no clusters that would declare none or marginal activity.

Graph 80. Values of synthetic indicators for cluster groups (bottom 25%, middle 50%, top 25%)
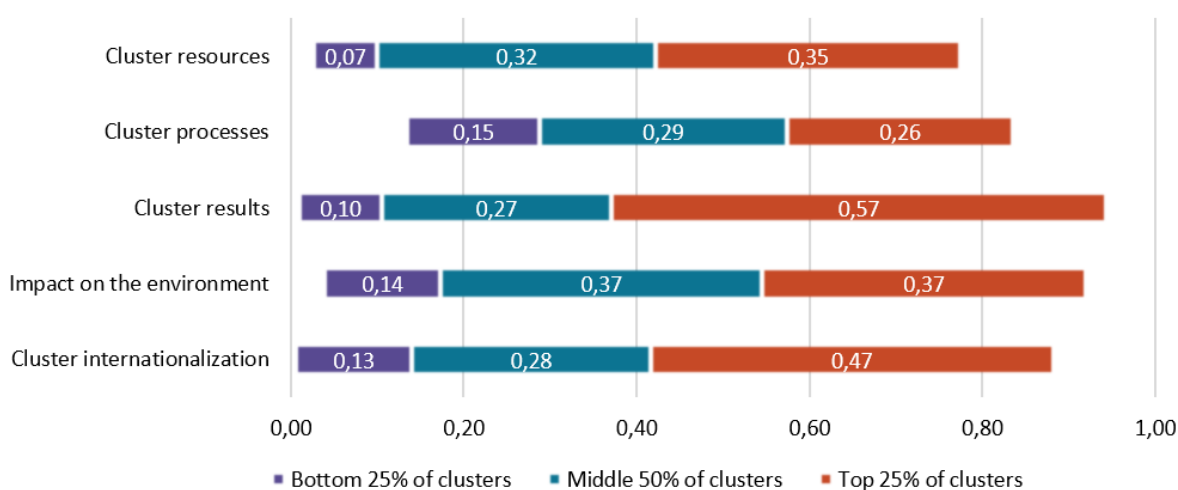
Source: own elaboration based on a survey of cluster coordinators (N=41).

The chart also illustrates a situation where clusters appeared in the study for such areas as cluster results and internationalization, which did not show any activity or achievements (analogous situation as in the previous edition).

9.   Recommendations

The most important sources of formulating recommendations are:

- Benchmarking results, including cluster strengths and weaknesses. Weaknesses were used to identify and describe recommendations aimed at improving the situation in individual areas.
- Conclusions of a qualitative nature were developed on the basis of conversations/interviews with representatives of the surveyed clusters. During the project implementation, there were often situations in which cluster representatives provided valuable additional information on the condition of a given cluster or other clusters in Poland, along with recommended solutions.
- An in-depth analysis of good practices of domestic and foreign clusters carried out using all available sources, provided inspiration to implement proven and effective solutions in other cluster structures.
- Results of opinion polls of cluster members, in sections relating to the weaknesses of cluster activity.

Some of the proposed recommendations are completely new compared to the previous edition of cluster benchmarking. Some on the other hand, concern current problems/challenges/development goals faced by both cluster coordinators and public administrations responsible for their policy. For this reason, some recommendations have their source in the previous benchmarking edition. However, it should be noted that they have been adapted / updated to the current situation of clusters in Poland, taking into account the current results of the study.

Recommendations have been formulated with cluster coordinators and other institutions creating the cluster ecosystem in Poland having in mind, government and local government institutions, business environment institutions as well as universities and other entities of the higher education and science system. Firstly, recommendations addressed to institutions responsible for shaping cluster policy in the country were presented. Next, recommendations were presented regarding horizontal areas of cluster activity (e.g. cooperation development, quantitative development), and then recommendations for more specific areas of activity (e.g. improving competences, digitization of the cluster, implementation of Industry 4.0 technology, internationalization).

Table 24. Recommendation table

Recommendation name	Addressee	Recommendation content
Regular review and update of the cluster policy, taking into account the sources of financing 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 was published setting out the directions for the development of cluster policy in Poland after 2020. However, since then it has not been updated despite major changes in the economic situation (including the COVID-19 pandemic, the war in Ukraine, the energy crisis, etc.), therefore, the underlying assumptions of the policy model and the operationalization of the assumptions need to be updated. This is particularly visible at the level of regions, where there is no unified approach, especially in terms of involving clusters in the implementation of public tasks. It is justified to create a body of all stakeholders of the cluster policy, which will have an opinion-forming and decision-making character in the field of shaping the cluster policy. It is justified to maintain a maximum cycle of activity at least every 2 years (similar cycle as in the case of benchmarking).
Promotion and dissemination of knowledge on instruments, activities and initiatives aimed at involving 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	Currently, the flow of information on available cluster support instruments for the purposes of implementing public policies is insufficient. There is no single, reliable and comprehensive source of information on the available instruments, activities and initiatives in this area. Taking into account the limited human resources of cluster coordinators, it would be justified to create a single website where information on the needs and offers of local governments would be published. It is also justified to involve partners representing the cluster environment (e.g. the Polish Clusters Association) in order to disseminate current information. Later, the service can be supplemented with additional information, e.g. concerning the effects of the actions taken (e.g. evaluation reports).

| Support for regional governments in shaping development policy with 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 obtained results of the accompanying qualitative research (including meetings with cluster policy stakeholders, desk research analysis) allow to put forward the thesis that the regional government has difficulties in implementing public policy implementation instruments by clusters. One of the reasons is the difficulty in translating various legal and strategic documents to the regional level and additional conditions related to the implementation of European Funds. For this reason, it is recommended to take a number of actions:

1. Detailed analysis of legal compliance at various levels (EU, national, regional, strategic documents, programming documents of European funds) in terms of the possibility of involving clusters in the implementation of public policies.
2. Creation of a guide for local governments on the implementation of public policy instruments by clusters (including instruments based on the use of European funds in the current financial perspective).

Popularization of good practices in the implementation of instruments, especially among representatives of local governments. |
| Promotion and dissemination of knowledge on instruments, activities and initiatives aimed at involving 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 | Currently, the flow of information on available cluster support instruments for the purposes of implementing public policies is insufficient. There is no single, reliable and comprehensive source of information on the available instruments, activities and initiatives in this area. Taking into account the limited human resources of cluster coordinators, it would be justified to create a single website where information on the needs and offers of local governments would be published. It is also justified to involve partners representing the cluster environment (e.g. the Polish Clusters Association) in order to disseminate current information. Later, the service can be supplemented with additional information, e.g. concerning the effects of the actions taken (e.g. evaluation reports). |

Involvement of clusters in shaping industry development and forecasting strategies	▪ Ministry of Development and Technology ▪ Ministry of Development Funds and Regional Policy ▪ Cluster coordinators	Currently, moderate activity of clusters can be observed in terms of involvement in shaping the development strategy (e.g. at the level of industries and geographical region / country) or forecasting. It should be emphasized that there is a huge potential in the clusters and associated entities in the field of e.g. creating BTR (Business Technology Roadmap), forecasting or creating development strategies in the field of e.g. specific industries. The potential benefits of the introduced changes may be an incentive for an increased level of cluster involvement (an example of the involvement of the cluster environment for the purposes of selecting a regional smart specialization Automotive in Podkarpacie or offshore and port and logistics technologies in Pomerania). Therefore, it is postulated to increase the involvement of clusters in shaping the development strategy and other documents setting out the technological / industry development at the level of regions and the country.
Unification of 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 reported an urgent need to standardize reporting obligations under various types of instruments and activities. This applies in particular to: recruitment for the KKK/renewal of the status of the KKK, monitoring of the KKK, cluster benchmarking, issuing certificates by EUCLES. Unification should concern, among others, indicators used (e.g. introduction of a certain group of unified indicators in terms of the units of measurement used, a cafeteria of possible indications, or the period under review). Then the benchmarking contractor would obtain a set of collected data to the extent necessary for the study.

| European benchmarking (KKK against the background of European structures) | ▪ Ministry of Development and Technology
▪ Polish Agency for Enterprise Development | In the current edition of the study (as in the previous one), there is a significant advantage of National Key Clusters over other cluster structures, both at the level of the total, areas and most sub-areas. Therefore, these clusters receive fewer tips as to weaknesses and related recommendations as part of dedicated reports. This may lead to a disadvantageous situation where KKK coordinators will not see development challenges in benchmarking results. This may result in lower interest of the KKK in participating in this study. For this reason, it is recommended to take into account the European perspective, i.e. to provide a level of comparison between the KKK and the European leaders of clusters (e.g. with a silver or gold EUCLES badge). Obtaining primary data on a larger group of European clusters of this type may be difficult from the organizational and financial point of view (the cost of research). For this reason, it is recommended to establish cooperation with the EUCLES organization regarding the possibility of obtaining aggregated data for selected indicators used as part of the cluster assessment process. Ideally, they should be as consistent as possible with the indicators used in benchmarking (which may require the implementation of the previous recommendation, i.e. adjusting selected benchmarking indicators to the EUCLES certification system). The contractor of future benchmarking editions could then carry out a comparative analysis (benchmarking) of the KKK against the background of European structures for selected indicators. |
| Creation of a platform for the exchange of good cluster practices | ▪ Cluster coordinators
▪ Polish Agency for Enterprise Development
▪ Polish Clusters Association | The implementation of both the previous and the current edition of the benchmarking confirms the situation in which cluster coordinators want to share good practices from the activities of their clusters. In both the previous and the current edition, more than 50 initial ideas for describing good practices were collected. At the same time, the format of the benchmarking report makes it impossible to present all good practices. Moreover, benchmarking is carried out in a two-year cycle. On the other hand, good practices are often created as a response to the current socio-economic situation (e.g. the occurrence of the COVID-19 pandemic, conflict in Ukraine). For this reason, it is recommended to create a website where coordinators could continuously publish information on good practices implemented in their clusters. |

Increasing cooperation between clusters in Poland	▪ Cluster coordinators	The clusters participating in the study represent a diverse industry profile. This gives the possibility of networking clusters by creating comprehensive offers dedicated to entities from other clusters (e.g. the offer of IT clusters addressed to members of other clusters from other industries in the field of implementation of Industry 4.0 technologies or the offer of clusters in the area of bioeconomy, sustainable development and energy in terms of increasing energy efficiency waste management, etc.). On the one hand, the offer of the cluster / cluster entities will gain credibility and reliability, on the other hand, it is worth considering a system of preferential access to services / products for members of other clusters. It can be considered to create a platform for publishing clusters' offer together with access information.
Undertaking activities aimed at searching for and obtaining new sources of financing (internal and external)	▪ Cluster coordinators ▪ Business environment institutions	Securing the financing of cluster activities is crucial for their durability and level of activity. This requires efficient identification of new sources of financing and effective use of available financial resources. Coordinators must ensure the financing of the costs of both their own activity and the joint activity of members, e.g. in the implementation of specific projects. Coordinators have a number of possibilities to increase the budget both from their members (e.g. development of the offer of paid services in the cluster, development of the cluster's business activity based on members' products/services, profits from common intellectual property rights) and from public funds administrators. In the second case, the key role will be played by EU funds in the new financial perspective (both at the national level, eg FENG, and at the regional level). It can also be the acquisition of new members offering financial services to provide cluster members with access to additional external sources of financing (e.g. commercial financial instruments).

Cluster internationalization activities	▪ Cluster coordinators ▪ Polish Clusters Association (as a national representative in the European Clusters Alliance)	Based on the benchmarking results, it can be concluded that the internationalization of Polish clusters is at a moderate level. There is still a group of clusters that are not included in the database of the European Cluster Collaboration Platform - an initiative of the European Commission. Entry to the database is the first, cost-free step for clusters, which increases their visibility on the international arena and authenticates their operations. The next step may be to verify the standards of cluster management and its functioning. This can be done initially by from the cluster management standards developed by PARP - a self-assessment tool available free of charge on the PARP website[100]. This will allow verification of meeting the requirements for obtaining the EUCLES bronze badge. A more advanced approach will be to obtain an international quality certificate under the EUCLES initiative. Currently, only 12 out of 41 clusters have any quality label. It is worth for the KKK and also supra-regional development clusters to use the FENG 2.17 funds for certification, and for other clusters to lobby to encourage local authorities to finance certification (which will positively affect the credibility of these clusters on the international arena). Clusters at a high level of development may additionally become members of the TCI Network. It is the oldest global cluster organization. Presence in various types of cooperation networks, supported by quality certificates, can be a pass for cluster coordinators to build international partnerships and implement projects financed under programs such as Horizon Europe 2021-2027.

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[100] www.parp.gov.pl/clusterfy#politykaklastowa (accessed on April 19, 2023).

| 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) | As part of the successive editions of benchmarking, the growing importance of clusters can be observed, e.g. in terms of indicators such as the number of associated entities, the average number of members per cluster or total employment in cluster entities. Analyzing good practice from Canada in the field of creating the so-called superclusters, it can be considered that gaining new members, expanding activities outside the region and diversifying activities within wide value chains may be a justified step for some clusters.

Clusters striving to increase their potential should first of all strive for geographical expansion at the supra-regional level. It may be justified to enter regions with low cluster activity (including the Opolskie and Warmińsko-Mazurskie voivodeships, where no cluster was included in the study in the current and previous edition of the benchmarking). Geographical expansion to other voivodeships, where there are no clusters with similar business profiles, can also be considered. Thanks to, among others such action, clusters without the KKK status could apply to the FENG 2.17 competition as supra-regional growth clusters.

Finally, it should be noted that the creation of supra-regional clusters (i.e. recruitment of members from across the country, following the example of global innovation clusters from Canada) may generate difficulties in obtaining the KKK status. As part of the last recruitment, at the stage of the preliminary substantive assessment, the criterion of geographical concentration of the cluster was applied (required value: >50% of cluster members have their seat within a distance of not more than 200 km (+/- 10 km) from the seat of the cluster coordinator). It is worth considering abandoning or modifying this condition so that it does not constitute a hindrance to the creation of large clusters of significant importance for the national economy. |

| Promotion of solutions in the area of Industry 4.0, digitization of clusters and enterprises, green transformation and implementation of solutions in the area of key enabling technologies (KET) | ▪ Cluster coordinators | Among the surveyed clusters, there is a group with significant experience in creating and implementing solutions in the area of Industry 4.0, digitization and entrepreneurs (ICT clusters), green transformation (chemistry, bioeconomy and energy clusters) and KET (e.g. in the field of photonics, materials engineering or bioeconomy). Implementation of the above solutions requires appropriate preparation and technical knowledge. Therefore, it is recommended to organize training and workshops for cluster coordinators and members to help them gain knowledge and skills needed to implement advanced technological solutions. With reference to the previous recommendation, it is justified to create an offer by cluster coordinators with experience in one of the above-mentioned for clusters less advanced in these areas. Thanks to this, companies from clusters with less knowledge and experience will be able to take advantage of the knowledge and skills of experts from technologically advanced clusters, which will allow them to increase their competitiveness and operational efficiency. At the same time, the results of the opinion poll of cluster members confirms the legitimacy of actions in this direction (for example, more than 50% of cluster members are interested in services in the area of digital transformation, implementation of Industry 4.0 technology and green transformation). Cooperation between clusters allows for mutual benefits. For clusters that provide technological solutions, this means increasing the number of orders and developing their business. On the other hand, for clusters that use these solutions, it means improved quality, productivity and competitiveness, which translates into better financial results and market position. |

Undertaking activities aimed at searching for and obtaining new sources of financing (internal and external)	▪ Cluster coordinators ▪ Business environment institutions ▪	Securing the financing of cluster activities is crucial for their durability and level of activity. This requires efficient identification of new sources of financing and effective use of available financial resources. Coordinators must ensure the financing of the costs of both their own activity and the joint activity of members, e.g. in the implementation of specific projects. Coordinators have a number of possibilities to increase the budget both from their members (e.g. development of the offer of paid services in the cluster, development of the cluster's business activity based on members' products/services, profits from common intellectual property rights) and from public funds administrators. In the second case, the key role will be played by EU funds in the new financial perspective (both at the national level, eg FENG, and at the regional level). It can also be the acquisition of new members offering financial services to provide cluster members with access to additional external sources of financing (e.g. commercial financial instruments).
Development of the cluster offer and building a portfolio of services	▪ Cluster coordinators ▪ Universities and other entities of the higher education and science system ▪ Business environment institutions	The previous recommendation included provisions concerning the development of the service offer by cluster coordinators, which would be addressed to coordinators and members of other clusters. The coordinator has the ability to both create an independent service offer, as well as become an intermediary in the provision of services by third parties (e.g. cluster members or organizations / experts not related to a given cluster). Taking into account the results of the opinion survey of cluster members, they are particularly interested in such categories of services as: promotion, marketing, internationalization activities, training (including specialized training), networking within the cluster and with external entities. Due to the use of these services, some members are willing to accept a higher membership fee or make additional payments for the use of these services. Important areas of coordinators' activity in this regard may include the above-mentioned: ▪ Pro-innovation services - e.g. in the area of green transformation, digital transformation, implementation of Industry 4.0 technologies (in the case of these areas,

		over 50% of the surveyed members have not used them so far, but are interested in the future). Internationalization services – e.g. in the area of cooperation with foreign entities, initiating international projects, organizing trips to trade fairs and foreign economic missions, and organizing international industry events (over 85% of members express interest in each of these areas).

Inclusive character of the process of creating strategic documents of the cluster	▪ Cluster coordinators and members	The conducted analyzes indicate that the cluster coordinator plays a key role in planning and implementing strategic activities. To ensure the effectiveness and involvement of cluster members in the process of planning and implementing activities, the coordinator should enable them to participate in the creation of strategic documents. In the current edition of the benchmarking over 46% of cluster members did not participate in this process.
		
		Activities enabling the involvement of cluster members in shaping the strategy and operational documents include:
		
		    ▪ Using various forms of consultation, e.g. publishing a document and allowing members to propose changes / additions (this form is also possible online).
		    ▪ Regular (e.g. annual) organization of strategic workshops with the participation of cluster members, organization of task groups. By working in groups, exchanging views and creating solutions, it will be possible to update documents with which cluster members will identify to a greater extent.
		
		Creating operational plans involving the largest possible groups of cluster members in the planned activities. Plans in this category should include the allocation of the necessary resources needed to implement the action along with the implementation schedule. Thanks to this, cluster members will have a better understanding of operational goals and priorities.

Supporting enterprises in the development of competences and qualifications of employees and in	▪ Cluster coordinators ▪ Universities and other entities of the higher education and science system	The results of the conducted research indicate that it is necessary to continue and intensify activities to support enterprises in the development of employees' competences and qualifications and in attracting new staff. In the era of rapidly changing labor market and growing competition, having qualified employees is crucial for the

attracting new staff		success of enterprises. Clusters and universities as well as entities of the higher education and science system can play a key role in providing enterprises with access to modern training, qualification development programs and innovative employee exchange programs.
		In this regard, activities in the areas of organizing specialist job fairs, addressed to students and graduates, are worth considering, in particular in the area of information technology (including Industry 4.0) and green economy, as well as in the area of industry majors (e.g. automotive, construction, chemistry energy, medicine). Thanks to this, enterprises will have a chance to acquire highly qualified specialists who will contribute to the development of innovative solutions.
		Actions aimed at creating partnerships between clusters and universities or other entities of the higher education and science system are also recommended. Partnerships of this type can develop mutual cooperation in the field of education, training and research and development. As a result of the cooperation, dedicated training programs may be created that will respond to the needs of enterprises from the cluster. In this way, enterprises will have access to specialized training and qualification development programs that will respond to the current needs of the labor market.
		Coordinators can also initiate staff exchange programs between cluster enterprises and universities. Representatives of enterprises will gain access to the scientific potential and knowledge of specialists from universities, as well as research infrastructure. In this way, enterprises will have access to new technological solutions, and universities will be able to learn about the practical aspects of business operations.
		Cluster representatives can and should engage in creating policies that create educational standards for individual industries by participating in Sectoral Competence Councils[101] at PAED (in the previous edition, the practice of the West Pomeranian Chemical Cluster Green Chemistry entitled Sectoral Competence Council for the Chemical Sector was described as an example).

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[101] 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 be able to determine sub-synthetic indicators
and synthetic for individual areas, it was necessary to standardize the values. The indicators
collected in the study are expressed in various units and take values from various numerical
ranges. In order 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 purpose 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,
equal to constant 1. in this benchmarking study all determined indicators are stimulants) was
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 a survey of 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	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[102]

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[103], NCN[104]):	
▪ 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%**

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[102] 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.

[103] National Centre for Research and Development Poland.

[104] National Science Center Poland.

Question	Answers
4. Participation in the implementation of the cluster project[105]:	
▪ 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%**

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[105] 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)[106]:	**PLN 10,500**
▪ in exchange for the following services[107]:	**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%**

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

[107] 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][108]	
▪ 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%**

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[108] 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 environment 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]*[109]	
▪ 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**

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[109] 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 environment 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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