

# **Cluster benchmarking in Poland – edition 2020**

## **General report**

**Warszawa, 2021**

This study 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 cannot be held liable for any opinions expressed in the study, those being the authors' opinions, and as such not being reflective of the Polish Agency for Enterprise Development's position; nor is it bound by those opinions in any manner.

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## 1. Introduction

This publication was prepared as part of the fifth edition of a study entitled "**Benchmarking of clusters in Poland – 2020 edition**" aimed at expanding knowledge about the condition and current state of cluster development in Poland, and carried out for the **Polish Agency for Enterprise Development**.

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 (alphabetical order):

- Agri-Cluster Kujawy – Association for Innovation and Development
- Association of West Pomeranian Chemical Cluster Green Chemistry
- Aviation Valley Association
- BIM Cluster
- Biomedical Engineering Center Cluster
- Bydgoszcz ICT Cluster
- Bydgoszcz Industrial Cluster
- Cluster for Photonics and Fiber Optics
- Construction Cluster INNOWATOR
- East Automotive Alliance
- Eastern Cluster ICT
- Eastern Poland IT Companies Cluster
- Food Cluster of Southern Greater Poland - Association
- Interizon ICT Cluster
- ITC Central Poland Cluster
- Klaster LifeScience Krakow
- „LODZistics” - Logistics Business Network of Central Poland
- Lower Silesia Automotive Cluster
- Lublin Business Support Institution Cluster
- Lublin Eco-Energy Cluster
- Lublin Enterprise Cluster
- Lublin Medicine – Medical & Wellness Cluster
- Lubuski Metal Cluster
- Mazovia Cluster ICT
- MedSilesia Cluster – the Silesian Network of Medical Devices
- Metal Processing Cluster
- North South Logistics & Transport Cluster
- NUTRIBIOMED Cluster
- Polish Cluster of Composite Technologies
- Polish Construction Cluster

- Polish Nature Cluster
- Radom Metal Cluster
- Silesia Automotive & Advanced Manufacturing
- Silesian Aviation Cluster
- South Poland Cleantech Cluster
- Sustainable Infrastructure Cluster
- The Cluster of Tourist Brands of Eastern Poland
- The Eastern Metalworking Cluster
- Waste Management and Recycling Cluster
- West Pomeranian ICT Cluster
- Wielkopolska ICT Cluster Association

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. Key terminology

**Benchmark** – The highest rate reached by a cluster in a given area or sub-area<sup>1</sup>.

**Benchmarking** – benchmarking is a well-known and functioning method of imitating others in the process of organization for many years. It is a technique that allows you to know best-in-class solutions through observations and existing examples and implement them into action. Positive imitation, as you might call the discussed method, is a way of learning and adapting, with a high risk of making mistakes<sup>2</sup>.

**Best Practices** – the concept of good practice comes from the area of organization management and is directly linked to benchmarking [...] Good practices are not new solutions – these are activities verified in practice and actions previously used successfully in other organizations. Their implementation is aimed at improving the performance of the organization as well as improving its efficiency and efficiency<sup>3</sup>.

**Cluster** – Geographical clusters of interconnected companies, specialized suppliers, service providers, companies operating in related sectors and related institutions [...] in specific areas, competing with each other but also cooperating<sup>4</sup>.

**Cluster coordinator** – legal entity that organizes and animates the development of interactions, links, knowledge flows and cooperation in the cluster, as well as provides specialized services to companies and other entities operating within a given cluster. The coordinator represents the cluster in external relations, deals with daily administration of the cluster, and performs other functions necessary for its proper functioning. In the initial stages of cooperation development, these functions are often performed not by an institution, but by a specific person identified as a cluster animator. At a later stage at the operational level, you should also refer to a person who is defined as a coordinator or cluster manager<sup>5</sup>.

**Cluster digitization** – the use by members of the Industry 4.0 technology solutions cluster and/or at least two management systems: ERP, CRM, CMS, MRP, DMS, SCM, WMS, RCP, DMS, BI.

**Cluster initiative** – organized activities aimed at increasing the growth and competitiveness of clusters in the region, involving cluster companies, government and/or a research community<sup>6</sup>.

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<sup>1</sup> Szczegółowy Opis Przedmiotu Zamówienia, PARP.

<sup>2</sup> K. B. Matusiak (red.), Innowacje i transfer technologii. Słownik pojęć, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa 2008.

<sup>3</sup> K. B. Matusiak (red.), Innowacje i transfer technologii. Słownik pojęć, PARP, Warszawa 2011.

<sup>4</sup> M. E. Porter, Porter o konkurencji, Polskie Wydawnictwo Ekonomiczne, Warszawa, 2001, s. 246.

<sup>5</sup> J. Hołub–Iwan, Ł. Wielec, Opracowanie systemu wyboru Krajowych Klastrow Kluczowych (Raport I „Charakterystyka krajowego klastra kluczowego w oparciu o analizę źródeł wtórnych”), PARP, Warszawa 2014.

<sup>6</sup> Ö. Sölvell, G. Lindqvist, Ch. Ketels, The Cluster Initiative Greenbook, Ivory Tower AB, Stockholm 2003, s. 9.

**Cluster members** – entities operating within the cluster, including enterprises, R&D environment institutions (universities, research institutes, educational institutions) and creating business support infrastructures (incubators, science and technology parks, technology transfer centres, special economic zones, certification bodies, training and advise companies, financial institutions and other specialised business environment institutions), as well as public administration.<sup>7</sup>

**Direct inward investment** – the process of acquisition by residents of country X (home country) of ownership of assets to control the company's business in country Y (destination country, here in Poland)<sup>8</sup>.

**High or medium-high technologies** – areas and products with high or medium-high levels of R&D intensity<sup>9, 10</sup>.

**Industry 4.0** – a concept describing the complex process of technological transformation integration of the value chain, the introduction of new business models and the digitization of products and services. These solutions can be implemented through the use of new digital technologies, data resources and communication in a cooperation network of machines, devices and people<sup>11</sup>.

**Knowledge-absorbing service sector** – service activities in a sector with a high share of highly skilled workers and more innovation than in other sectors<sup>12</sup>.

**Median** – divides the group organized into two equal parts in such a way that 50% of units have lower characteristics and 50% higher than the median<sup>13</sup>.

**Outward direct investment** – the process of acquisition by residents of country X (home country, here: Poland) ownership of assets in order to control the company's activities in country Y (destination country)<sup>14</sup>.

**Key National Cluster (KNC)** – a cluster significant for the country's economy with a high international competitiveness; Key National Clusters are identified on a national level, for example basing on criteria relating to critical mass, development and innovation potential, current and planned cooperation, as well as the coordinator's experience and potential<sup>15</sup>.

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<sup>7</sup> Kierunki i założenia polityki klastrowej w Polsce do 2020 roku. Rekomendacje grupy roboczej ds. polityki klastrowej, PARP 2012 r.

<sup>8</sup> Definicja za: Ministerstwo Rozwoju, Pracy i Technologii, Program wspierania inwestycji o istotnym znaczeniu dla gospodarki polskiej na lata 2011–2023; [www.gov.pl/web/rozwoj-praca-technologie/program-wspierania-inwestycji-o-istotnym-znaczeniu-dla-gospodarki-polskiej-na-lata-2011-2030](http://www.gov.pl/web/rozwoj-praca-technologie/program-wspierania-inwestycji-o-istotnym-znaczeniu-dla-gospodarki-polskiej-na-lata-2011-2030). (access: 21.05.2021).

<sup>9</sup> [www.stat.gov.pl/metainformacje/sloownik-pojec/pojecia-stosowane-w-statystyce-publicznej/773,pojcie.html](http://www.stat.gov.pl/metainformacje/sloownik-pojec/pojecia-stosowane-w-statystyce-publicznej/773,pojcie.html) (access: 21.05.2021).

<sup>10</sup> [www.przemyslprzyszlosci.gov.pl/tag/przemysl-4-0/](http://www.przemyslprzyszlosci.gov.pl/tag/przemysl-4-0/) (access: 21.05.2021).

<sup>11</sup> [www.przemyslprzyszlosci.gov.pl/tag/przemysl-4-0/](http://www.przemyslprzyszlosci.gov.pl/tag/przemysl-4-0/) (access: 21.05.2021).

<sup>12</sup> M. Zięba, Sektor usług wiedzochłonnych oraz jego dynamika i struktura zatrudnienia w krajach Unii Europejskiej, *Ekonomia* nr 40/2015.

<sup>13</sup> M. Sobczyk., *Statystyka*, PWN, Warszawa 2001.

<sup>14</sup> Ministerstwo Rozwoju, Pracy i Technologii, Program wspierania inwestycji o istotnym znaczeniu dla gospodarki polskiej na lata 2011–2023; [www.gov.pl/web/rozwoj-praca-technologie/program-wspierania-inwestycji-o-istotnym-znaczeniu-dla-gospodarki-polskiej-na-lata-2011-2030](http://www.gov.pl/web/rozwoj-praca-technologie/program-wspierania-inwestycji-o-istotnym-znaczeniu-dla-gospodarki-polskiej-na-lata-2011-2030) (access: 21.05.2021). *Rocznik Statystyczny Handlu Zagranicznego* 2014, red. H. Dmochowska, Warszawa, GUS, s. 15.

<sup>15</sup> [www.gov.pl/web/rozwoj/krajowe-klastry-kluczowe](http://www.gov.pl/web/rozwoj/krajowe-klastry-kluczowe) (access: 21.05.2021).



### 3. Summary

Cluster benchmarking is a continuation of the research cycle started by PARP in 2010. Previous studies were carried out in 2010, 2012, 2014 and 2018. This report presents the results of a survey of selected 41 clusters in Poland and 435 of their members.

The report provides key findings on the state of cluster development during the study period, i.e. 2018–2019. The following part of the study contains an analysis of best practices and recommendations addressed to various groups of stakeholders, including cluster coordinators, as well as entities from the cluster environment, government and local authorities shaping cluster policy in Poland.

Below there are the most important results of the study:

1. The benchmarking analysis was broken down into 5 main areas. The findings at the level of these areas were as follows:
  - a. **Cluster resources** – a fairly low median value (0.13) with a fairly low benchmark value (0.43) – a large group of clusters are clusters with a very low position in this area, while without a clear leader on the other side. In the area of resources, the best results were obtained by large clusters (100 and more members) with the status of Key National Cluster (KNC), established before 2010 and operating in the area of medium-low and low technology. Clusters from Eastern Poland and other regions of the country obtained similar results.
  - b. **Cluster processes** – the median (0.36) is about half the benchmark (0.73) – clusters present a pretty even level. In the area of processes, the best results were achieved by large clusters with the KNC status, established in 2010-2015, operating in the area of medium-high and high technology and located in Eastern Poland.
  - c. **Cluster results** – fairly low median (0.13) with moderate benchmark value (0.59) – there is a large group of very low-position clusters in this area, while without a clear leader on the other side. In terms of results, the best results were achieved by large clusters with the KNC status, established before 2010, operating in the area of medium-high and high technology and located in Eastern Poland.
  - d. **Environmental impact** – a moderate median value (0.21) means a group of relatively weak clusters, but this situation cannot be considered very unfavourable. However, the high benchmark value (0.74) shows the existence of a cluster/group of clusters with a very strong impact on the environment. In the area of environmental impact, the best results were obtained by large clusters with the KNC status, established in 2010-2015, operating in the area of medium-high and high technology and located outside Eastern Poland.
  - e. **Cluster internationalisation** – a fairly low median value (0.13) with a moderate benchmark value (0.56) – there is a large group of very low-position clusters in this area, while without a clear leader on the other side. In the area

of internationalization, the best results were obtained by large clusters with the KNC status, established before 2010, operating in the area of medium-high and high technology and located outside Eastern Poland.

2. The most important conclusions and results for each of the above-mentioned area are presented below:
  - a. **Cluster resources.** Almost half of the clusters were served by 1-2 delegated persons by the coordinator (with the average being 3 persons). Nearly 60% of cluster members believe that this is a sufficient number. Academics actively participate in the work of the clusters. On average, about 12 scientists cooperate with a given cluster. Coordinators provide office and administrative area to clusters (average area approx. 70 m<sup>2</sup>). More than half of the clusters incurred expenditure on IT infrastructure. Clusters actively use IT platforms for communication (84% of clusters), database storage (42%), knowledge repository (39%) and collaboration (39%). The budget of the studied clusters in the period 2018-2019 was very diversified. 15 clusters had a budget in excess of PLN 1 million. One of the sources of financing clusters are membership fees. For 21 clusters, the revenues from this source in period of two years exceeded PLN 100,000. PLN. Clusters actively obtained funds from external sources. 27 clusters acquired a total of approx. PLN 295 million, of which approx. PLN 215 million from public sources.
  - b. **Cluster processes.** 70% of clusters had a written strategy that is upgradable. The development of a strategy is often associated with the involvement of cluster members (this was confirmed by 55% of the surveyed representatives of this group). Nearly 2/3 of the clusters conducted research on the needs/satisfaction of cluster members, but only in the case of 6 clusters it was carried out in a cyclical manner. There is considerable polarization as to the benefits of cluster participation. Around half of cluster members consider participation in the cluster to be beneficial, while the other half see no benefit or small. Regular meetings are an important area of clusters' activity. On average, 10 meetings were held in the surveyed clusters during the year. Thanks to the presence in the cluster, about 1/3 of the members established business relations with foreign partners. Clusters also support the stages of the value chain. This applies in particular to marketing and sales as well as the production or provision of services. Almost 3/4 of the surveyed cluster members highly appreciate the activities of coordinators in supporting various stages of common value chains. In terms of marketing activity, the most frequently indicated activities include the development of a common brand and logo, advertising activities and activity in the area of public relations. Achievement of the set goals in this area was indicated by 61% of the surveyed members. In the case of innovative activity, coordinators provide pro-innovation services, such as specialized training (78% of clusters), technology consulting (59%) and monitoring of technological trends (44%). The last analysed area was the digitisation of clusters. The achievements in this area were measured, inter

alia, by implementation of business management systems and the use of Industry 4.0 solutions. The leaders in these lists were primarily clusters in the area of ICT.

- c. **Cluster results.** Within this area, cooperation development in the clusters was analysed. The assessment covered, inter alia, jointly implemented projects, creating a joint offer and acquiring orders for joint implementation. Joint projects co-financed from the EU funds (mainly research and development) were implemented in 19 clusters. The average value of these projects per cluster is approx. PLN 20 million. Almost half of the clusters were involved in creating a joint offer, resulting in the development of over 100 products and services. Only 6 clusters were successful in obtaining joint orders. R&D and innovative projects were implemented in 23 clusters, and their total number was 131. On average, 15% of cluster members participated in such projects. As a result, innovations were implemented (350 product and process innovations), knowledge transfers were made (176) and applications were made in the field of intellectual property protection (307). 50% of cluster members confirmed the positive impact of cluster participation on the level of technological advancement. The last examined area was the development of competences in the cluster. Clusters are quite active in this area. For example, 34 clusters organized trainings and workshops (the total number of over 440) for their members. About 60% of cluster members were involved in these activities.
- d. **Environmental impact.** Within this area, cooperation of clusters with the environment was analysed. 16 clusters had contracts signed with public authorities, and 24 clusters had contracts with business support institutions. The clusters entered into partnerships also with educational institutions (a total of 73 signed contracts), other national clusters (27) and foreign clusters (104). Nearly 2/3 of the clusters cooperated with the science sector at the institutional or personal level (with a specific scientist). As part of the clusters' activity, over 1,400 internships were carried out) and 33 implementation doctorates were developed. Cluster representatives actively participated in the socio-economic life at the regional and national level. A very important part of the research was the impact of clusters on the natural environment. The situation in which 16 clusters did not declare any activity in this area can be assessed quite negatively. The remaining clusters most often undertook activities in the area of eco-innovation (16 clusters) and cooperation for the circular economy (15 clusters). Taking into account the specialization, each of the studied clusters can be associated with one or more National Smart Specializations (NSS). The most frequently represented NSS were: automation and robotics of technological processes (10 clusters) and intelligent networks and information and communication technologies as well as geoinformation technologies (9). Among cluster members, approx. 36% operate in the area of key technologies (KETs).

- e. **Cluster internationalization.** Cluster internationalisation 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. Over 70% of clusters offered support to their members in the area of internationalisation. Most often, these were preparatory activities (e.g. developing an export plan, consulting, training) and those which were implemented on selected foreign markets (e.g. organizing joint trips to trade fairs and economic missions, or promotional activities). Support from cluster coordinators was quite popular among members. This type of services was used by over 1/3 of entities included in the cluster. As a result of these activities, 229 trips to foreign fairs and exhibitions and 413 other foreign events (e.g. economic missions, study visits, conferences, seminars). Nearly half of the clusters implemented at least one international project (the total number of projects was 58, with a total value of nearly PLN 500 million).
3. At the level of each area there was a clear advantage: clusters with the status of a National Key Cluster, created in the period before 2010 and between 2010 and 2015. No particular differences were identified between clusters operating in Eastern Poland and other regions.
  4. In the case of some sub-areas exceptions to the above rule can be found, e.g. clusters set up after 2015, without KNC status, achieved better results in the sub-area: cluster digitization.
  5. The number of cluster members was positively correlated with the averaged benchmark. This is due to the fact that some of the indicators were related to indicators such as the budget of the cluster, employment in member entities, number of organised events. So large clusters automatically had an advantage over smaller clusters. The exceptions were indicators that measured the percentage of occurrences of certain situations (e.g. the percentage of members operating in a high-tech area<sup>16</sup>). Nevertheless, the relationship between the number of members and the benchmark is clear (the higher the number of members, the higher the benchmark value on average).

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<sup>16</sup> For better readability of further analysis and charts. Whenever the report mentions high and medium-high technologies, it also means knowledge-intensive services.

6. **Cluster strengths and weaknesses.** In the assessment of strengths and weaknesses of clusters the median value of scores obtained by clusters in particular sub-areas was used. The elements for which the median score for the entire surveyed group of clusters exceeded 0.20 were indicated as strengths, while weaknesses are those elements for which the median score does not exceed 0.10.

**Table 1. Strengths and weaknesses of analysed clusters (median in parentheses)**

Clusters' strengths	Clusters' weaknesses
Management processes (0.61)	Impact on the natural environment (0.01)
Specialization and technological advancement (0.44)	Financial resources (0.03)
Cluster digitization (0.43)	The development of collaboration within the cluster (0.04)
Communication within the cluster (0.37)	The development of innovation within the cluster (0.06)
Capability building within the cluster (0.26)	Internationalisation potential (0.08)
Market activity (0.25)	Infrastructural resources (0.09)
Human resources (0.25)	International activity (0.12)
Export and pro-export activities (0.21)	

Source: own study based on the survey of cluster coordinators (N = 41).

7. The study identified several dozen good practices implemented by national clusters. Most clusters were happy to share their achievements. According to the methodology of the study, 12 national and 3 foreign good practices were selected and described. For each of the good practices, a key area and other areas were identified. Most often, the subject of good practices was cooperation with the environment (6 clusters), then the impact on the natural environment, development of cooperation in the cluster as well as innovation activity (2 clusters each) and cluster digitization (1 cluster). The analysis also describes two practices that respond to the coronavirus pandemic.
8. The report is concluded with a list of recommendations addressed to various categories of institutions (including government and local government institutions, government agencies, cluster coordinators, business environment institutions and research units). Recommendations cover the following areas: financing of clusters, method of carrying out benchmarking research, development of the cluster offer, increasing the impact on the environment, recruitment strategies for cluster members, development of competences, internal mentoring, networking, internationalization, impact on the natural environment and implementation of modern solutions and technologies.

## 4. Introduction of research methodology

### 4.1. Research methodology

The basic assumption of cluster benchmarking was to perform a relatively comprehensive and cross-case analysis of clusters, so the logic and structure of the entire study were based on two integral elements:

- Cluster characteristics – a set of basic cluster characteristics that were used to perform cross-case analysis as part of benchmarking (e.g. comparing clusters by age, size, location, industry specialization). The emphasized areas of cluster characteristics are as follows: their formalisation, size, geographical concentration and sectoral concentration (NSS and RIS<sup>17</sup>).
- Cluster benchmarking – comparing the state of cluster development in different areas of their operation along with a presentation of good practices applied by clusters. As part of the adopted methodology, a division was applied into 5 key benchmarking areas composed of 19 detailed sub-areas.

The fifth edition of benchmarking involved 41 clusters from all over Poland. The project was implemented from January to June 2021 and it involved the following activities:

- interviews were conducted with the coordinators of the 41 clusters involved in the benchmarking research;
- a feedback survey of 435 cluster members participating in the study using the CATI and supplementary CAWI methods;
- good practices were developed (on the basis of knowledge acquired through desk research analysis and in-depth individual interviews of both Polish and foreign clusters);
- a general report and reports dedicated to each of the clusters involved in the study were prepared.

Cluster member feedback surveys were used to assess the perception of cluster benefits and satisfaction, and were used to confirm and verify data obtained from the cluster coordinators survey. The data collected during interviews with cluster coordinators was verified by researchers and supplemented with information collected in desk research analysis.

A total of 114 indicators regarding the functioning of clusters were analysed, based on which the state and level of cluster development in Poland was determined for the period covered by the study (2018-2019). A list of the areas and sub-areas studied is presented in a table on the next page.

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<sup>17</sup> National Smart Specialisations and Regional Smart Specialisations.

**Table 2. Schedule of the analysed areas and sub-areas of benchmarking with the tested number of indicators**

Benchmarking area	Benchmarking sub-area	No. of ratios
I. Cluster resources	I.1. Human resources	5
	I.2. Infrastructural resources	10
	I.3. Financial resources	6
II. Cluster processes	II.1. Management processes	6
	II.2. Communication within the cluster	4
	II.3. Market activity	6
	II.4. Marketing activity	8
	II.5. Innovation activity	6
	II.6. Cluster digitization	2
III. Cluster performance	III.1. Collaboration development within the cluster	11
	III.2. Innovation development	7
	III.3. Capability building within the cluster	7
IV. Cluster impact on the environment	IV.1. Collaboration with the environment	9
	IV.2. Impact on shaping the conditions of the environment	3
	IV.3. Environmental impact	1
	IV.4. Specialization and advanced technologies	4
V. Cluster internationalisation	V.1. Internationalisation potential	5
	V.2. International activity	7
	V.3. Export and pro-export activities	7

Source: Cluster Benchmarking Methodology - 2020 Edition.

The data needed for estimating the value of 110 indicators was collected based on a study of cluster coordinators. The estimate of 4 indicators was based on the Author's analysis of secondary data (websites, international databases, etc.).

The comparison was made on the basis of unitarized indicators – the values of the individual indicators were brought to form between 0 and 1 (so that averaging and comparing the results is possible). Comparisons and analyses of cluster benchmarking were made with the help of the following indicators:

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

Different combinations of their values may have occurred within these indicators. The following issues are interesting from the point of view of analyses of cluster phenomena:

- **Low median (close to 0)** – at least half of the clusters achieved 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 the remaining clusters.

- **The median is nearly half the benchmark** value – the level of cluster development was fairly evenly distributed across the area or sub-area of benchmarking (there is neither a strong group of cluster leaders nor weak clusters).

Finally, it is worth noting that it is not possible to fully precisely compare benchmarks from previous and current editions, due to the addition of new sub-areas, changes in indicators and another cluster list.



## 4.2. Cluster selection

When selecting clusters for the study, the following criteria were applied:

- the cluster had to be active in 2018-2019;
- the cluster must have an appropriate critical mass;
- the cluster had to have a certain organisational form (formalised cooperation between the entities that create it);
- there was a geographical concentration of most of the cluster members, which means that the majority of cluster members were located in the region of the province where the cluster's critical mass is concentrated;
- clusters representing different sectors of the economy were included in the sample.

Efforts were also made to include clusters representing each of the Polish provinces in the sample, but this could not be achieved due to the lack of entities meeting the eligibility criteria for taking part in the study or the refusal to participate in it (this applies to the Opole and Warmia-Mazury provinces).

To sum up the recruitment process, from the created unified database of over 200 clusters,<sup>18</sup> approximately 80 remained active (the number is subject to a certain error due to the inability to contact some of the clusters). Some clusters were rejected due to the lack of compliance with the above criteria. Out of the final number of approximately 55 compliant clusters, 41 clusters took part in the study with characteristics reflecting the cluster environment in Poland. The clusters selected for the study represented the Key National Clusters (14 with current status in April 2021 and one additional cluster with Key National Cluster status until 31 October 2019) and clusters that did not have such status (26). The clusters studied differed in service life, critical mass and industry specialization.

**Table 3. Characteristics of the clusters participating in benchmarking (alphabetical order)**

No.	Cluster name	Established year	Number of members	Dominant sector by Polish Classification of Activities (PKD)	Region
1.	Agri-Cluster Kujawy – Association for Innovation and Development	2014	24	industrial processing	kujawsko-pomorskie
2.	Bydgoszcz ICT Cluster	2015	29	information and communication	kujawsko-pomorskie
3.	Bydgoszcz Industrial Cluster	2007	112	other service activities	kujawsko-pomorskie
4.	Lower Silesia Automotive Cluster	2014	48	industrial processing	dolnośląskie
5.	ITC Central Poland Cluster	2012	33	information and communication	łódzkie
6.	Interizon ICT Cluster	2009	90	information and communication	pomorskie
7.	Biomedical Engineering Center Cluster	2012	70	professional, scientific and technical activities	mazowieckie
8.	Aviation Valley Association	2003	191	transport and warehouse management	podkarpackie

<sup>18</sup>The database was created on the basis of data from previous editions of benchmarking, a report on the inventory of clusters from 2016 made on behalf of PARP, statements obtained from the marshal's offices and the study Author's own research.

No.	Cluster name	Established year	Number of members	Dominant sector by Polish Classification of Activities (PKD)	Region
9.	Eastern Poland IT Companies Cluster	2010	86	information and communication	podkarpackie
10.	Cluster for Photonics and Fiber Optics	2012	32	professional, scientific and technical activities	lubelskie
11.	Waste Management and Recycling Cluster	2012	100	production and supply of electricity, gas, steam, hot water and air	świętokrzyskie
12.	West Pomeranian ICT Cluster	2011	75	information and communication	zachodniopomorskie
	Klaster LifeScience Krakow	2006	73	health care and social assistance	małopolskie
14.	North South Logistics & Transport Cluster	2012	138	transport and warehouse management	pomorskie
15.	The Cluster of Tourist Brands of Eastern Poland	2012	38	other service activities	podlaskie
16.	Metal Processing Cluster	2007	123	industrial processing	podlaskie
17.	Polish Nature Cluster	2016	15	agriculture, forestry, hunting and fishing	małopolskie
18.	Food Cluster of Southern Greater Poland - Association	2009	36	production and supply of electricity, gas, steam, hot water and air	wielkopolskie
19.	BIM Cluster	2012	61	professional, scientific and technical activities	małopolskie
20.	Sustainable Infrastructure Cluster	2011	146	construction	małopolskie
21.	Lublin Medicine – Medical & Wellness Cluster	2014	159	health care and social assistance	lubelskie
22.	Lublin Eco-Energy Cluster	2011	38	production and supply of electricity, gas, steam, hot water and air	lubelskie
23.	Lublin Business Support Institution Cluster	2014	30	education	lubelskie
24.	Lublin Enterprise Cluster	2008	21	other service activities	lubelskie
25.	Lubuski Metal Cluster	2008	38	industrial processing	lubuskie
26.	Mazovia Cluster ICT	2007	295	information and communication	mazowieckie
27.	MedSilesia Cluster – the Silesian Network of Medical Devices	2007	122	health care and social assistance	śląskie
28.	NUTRIBIOMED Cluster	2007	90	industrial processing	dolnośląskie
29.	Polish Construction Cluster	2011	359	construction	podlaskie
30.	Polish Cluster of Composite Technologies	2017	71	industrial processing	śląskie
31.	Radom Metal Cluster	2011	35	industrial processing	mazowieckie
32.	Silesia Automotive & Advanced Manufacturing	2011	146	industrial processing	śląskie
33.	South Poland Cleantech Cluster	2014	80	production and supply of electricity, gas, steam, hot water and air	małopolskie
34.	Wielkopolska ICT Cluster Association	2008	108	information and communication	wielkopolskie
35.	Silesian Aviation Cluster	2006	84	transport and warehouse management	śląskie

No.	Cluster name	Established year	Number of members	Dominant sector by Polish Classification of Activities (PKD)	Region
36.	Construction Cluster INNOWATOR	2010	80	construction	świętokrzyskie
37.	Eastern Cluster ICT	2007	170	information and communication	lubelskie
38.	The Eastern Metalworking Cluster	2009	102	industrial processing	lubelskie
39.	East Automotive Alliance	2015	38	wholesale and retail trade, repair of motor vehicles, including motorcycles	podkarpackie
40.	Association of West Pomeranian Chemical Cluster Green Chemistry	2007	203	industrial processing	zachodniopomorskie
41.	„LODZistics” - Logistics Business Network of Central Poland	2016	24	transport and warehouse management	łódzkie

Source: Authors' analysis.

Given the year of establishment, the study was dominated by clusters that were formed between 2010 and 2015 (21 clusters) and before 2010 (16 clusters). This was a period in the financial perspective of 2007-2014, as part of which instruments were available in Poland to support cluster formation.

At the cluster recruitment stage, it was discovered that a significant proportion of clusters created at that time did not survive the time trial (they failed or remained asleep). In comparison, a group of newly created clusters was identified in the period after 2015, but mostly did not meet the lifetime criteria and the minimum number of members, and therefore did not participate in the survey. Four clusters established after 2015 participated in the study.

**Graph 1. Characteristics of clusters that participated in benchmarking - year of establishment**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Taking into account the number of members, the survey covered clusters of up to 49 members (15 clusters), average clusters with 50-99 members (11) and large clusters with 100 members and more (15). The average number of members in all clusters studied was 93.

**Graph 2. Characteristics of clusters that participated in benchmarking – number of members**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The largest clusters in terms of the number of members at the stage of implementing the survey include the Polish Construction Cluster (317 members), Mazovia Cluster ICT (280) and Aviation Valley Association (178). It is worth noting that in the list of the largest clusters almost all had the status of KNC. Of the clusters with more than 100 members, only the Lublin Medicine – Medical & Wellness Cluster did not have this status at the time of the study.

The total number of members examined, according to the declarations submitted, was 3602 entities at the end of the study period, which means an average of 88 entities per cluster. The number of unique entities was lower of approx. 10%, due to the fact that some entities were members of more than one cluster. This applied in particular to scientific units and business environment institutions. Clusters also declared the "other" category for entities, with this category largely included natural persons. Taking into account the "other" category, the total number of members of the clusters examined was 3813.

During the benchmarking period (i.e. 2018-2019), there was an increase in the number of members in the clusters studied. In total, benchmarking clusters declared acceptance of 872 new members. During the same period, the number of resignations was 326 (which was therefore more than twice the number of applications).

The cluster structure was strongly dominated by enterprises (83%), followed by scientific units at a similar level (6%), business environment institutions (5%) and the category "other" including, for example, educational institutions, health facilities or individuals (6%). In total, 3,133 companies, 242 scientific units and 195 business environment institutions were members in the clusters studied.

Graph 3. Characteristics of clusters that participated in benchmarking – type of entities



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The structure of the enterprises that are members of the largest categories of clusters have also been analysed. In this respect, micro-enterprises (41%) and then small enterprises (24%) composed the largest group. A similar share involved medium and large entities in the cluster structure (17% and 18% respectively). The share in clusters of medium and large entities was significantly higher than the share of these groups among all companies registered in the country<sup>19</sup>.

**Graph 4. Characteristics of clusters that participated in benchmarking – structure of members (enterprises)**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The study also took into account the division into clusters from the area of Eastern Poland (15 clusters) and other regions of the country (26).

**Graph 5. Characteristics of clusters that participated in benchmarking – geographic concentration**

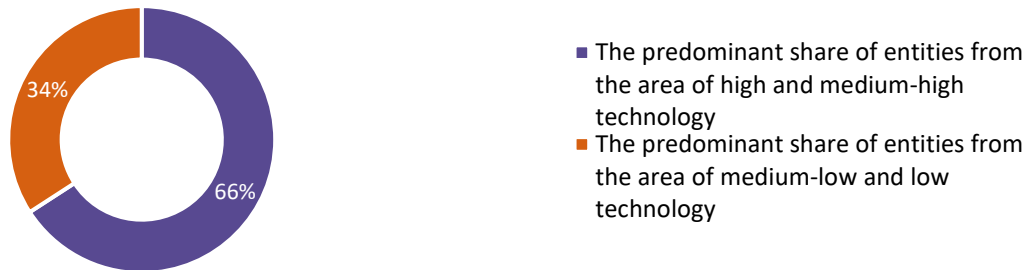


Source: Authors' analysis based on the cluster coordinator survey (N=41).

<sup>19</sup> Based on data from Central Statistical Office of Poland, at the end of 2020, the percentage of medium-sized enterprises in the country amounted to 0.59% and large enterprises only 0.02%.

The last criterion of division and at the same time one of the cross-sections of the analysis concerned the level of technology of activity of the majority of the members of the cluster. The study involved 27 clusters with a predominance of members operating in the area of high or medium-high technologies. For the remaining 14 clusters, the majority of members operated in the area of medium-low and low technologies.

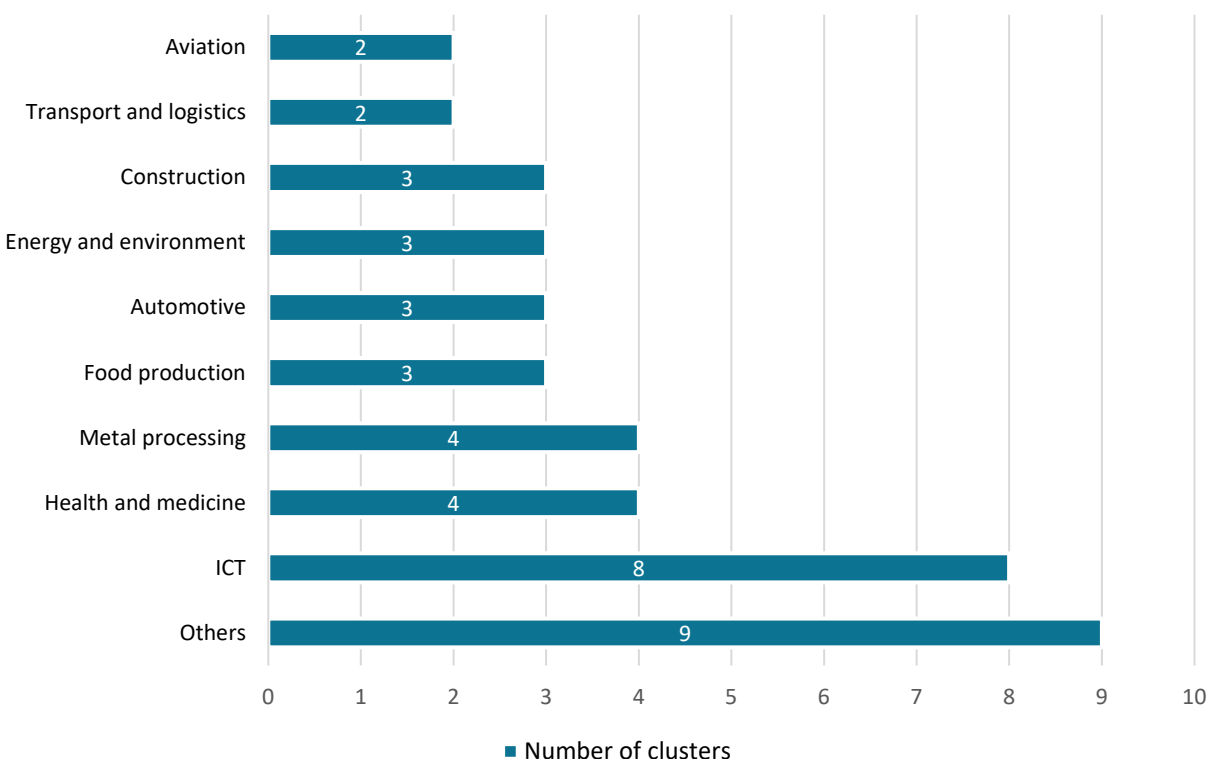
**Graph 6. Characteristics of clusters that participated in benchmarking – technologies**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Taking into account the industry structure according to the PKD classification<sup>20</sup>, industries related to industrial processing were the most numerous (9 clusters that represented metalworking, automotive and aviation) and clusters of ICT (8 clusters). In addition, 4 clusters operated in the broader area of health and medicine, while food production, energy and environment and construction represented 3 clusters each. Other areas of cluster activity covered transport and logistics, professional activities and tourism, etc.

**Graph 7. Number of clusters that participated in benchmarking - main areas of activity**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The studied clusters also declared membership of one or more National Smart Specialisations (NSS)<sup>21</sup>. The analysis was based on the applicable 14 NSS list, for the period from 1 January to 31 December 2020.<sup>22</sup> It is worth noting that each of the clusters surveyed indicated at least one NSS into which the area of activity is entered. Two clusters indicated 7 NSS each, which evidences a wide range of activity areas.

<sup>20</sup> Polish Classification of Activities.

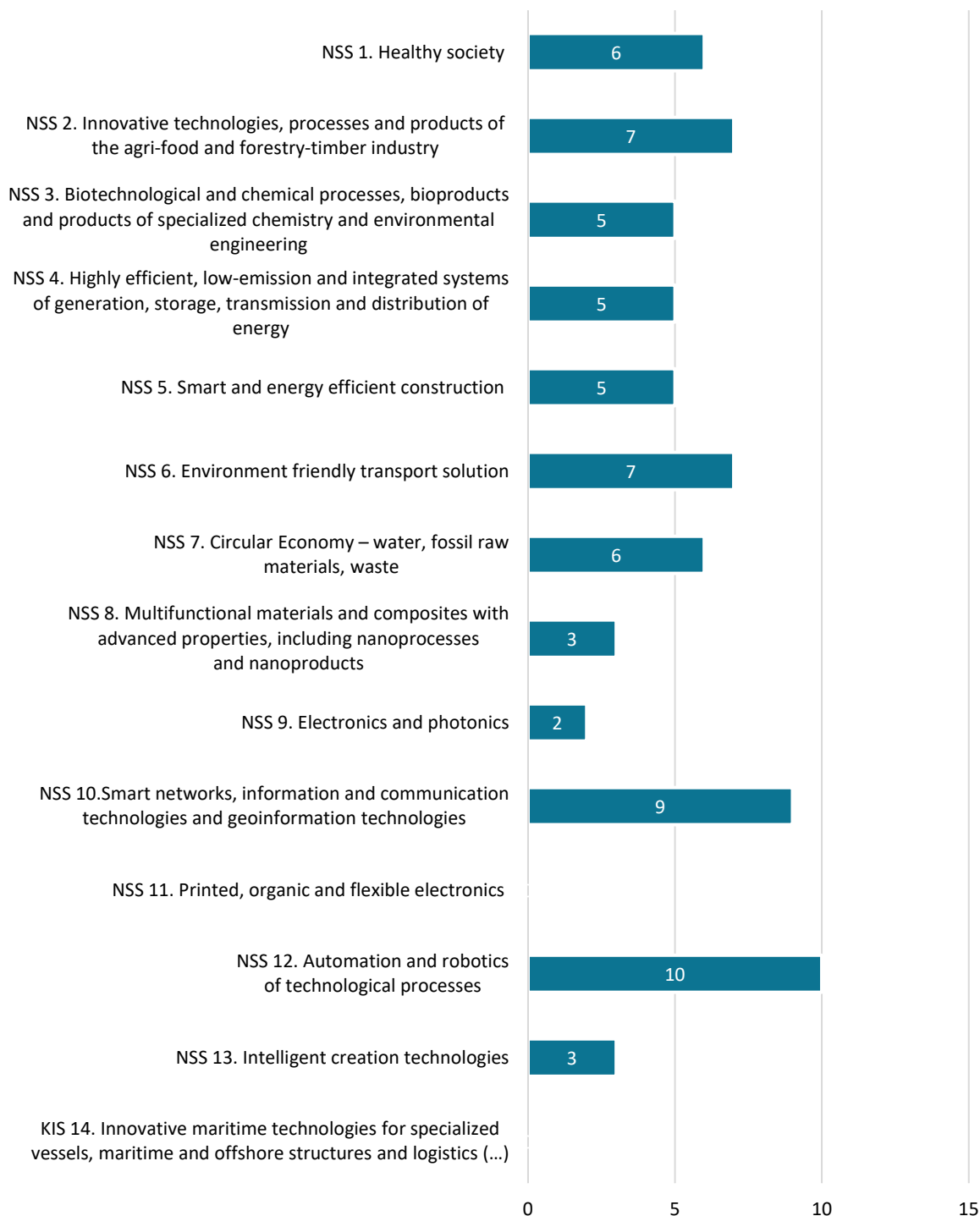
<sup>21</sup> National Smart Specialisations cover industries that, when developed, will ensure: the creation of innovative socio-economic solutions, increase in the added value of the economy and increase in its international competitiveness.

<sup>22</sup> [www.gov.pl/web/rozwoj-praca-technologie/krajowe-inteligentne-specjalizacje](http://www.gov.pl/web/rozwoj-praca-technologie/krajowe-inteligentne-specjalizacje) (access: 21.05.2021).



Taking into account the division into NSS, most clusters indicated automation and robotics of technological processes (10) as well as intelligent networks and information and communication and geoinformation technologies (9).

**Graph 8. Number of clusters that participated in benchmarking – activity in the area of NSS**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

## 5. Results of the study

The report first presents the results of the general data, and then the following subseap provides detailed results across areas and sub-areas. In the first place the obtained values were compared with reference to the synthetical indices on the level of 5 of the areas analysed between the current edition of benchmarking and the one from 2018<sup>23</sup> Comparison was conducted on the values provided for unitarization<sup>24</sup> with the aid of two measurements:

- **Benchmark** – obtained indicator values for the best cluster in a given area.
- **Median** – the values for a given area among all clusters.

As mentioned, comparing such values is fraught with some estimation errors. In order to achieve full benchmarking accuracy, the same cluster should be analysed using an identical set of indicators. For this reason, a comparison of the results obtained in the 2020 edition the results obtained is of greater informative value, taking into account the selected characteristics of the clusters.

The comparison was made for the following criteria:

- Key National Clusters (KNC) – other clusters.
- Small clusters (20-49 members) – medium clusters (50-99 members) – large clusters (100 and more members).
- Clusters created before 2010 (mature clusters) – clusters created between 2010 and 2015 (middle-aged clusters) – clusters created after 2015 (young clusters).
- Clusters located in Eastern Poland<sup>25</sup> – clusters in the remaining part of the country.
- Medium-high or high-tech clusters or service activities in the field of knowledge-intensive services<sup>26</sup> – clusters functioning in the area of medium-low and low technologies.

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<sup>23</sup> In the current edition, new benchmarking sub-area has been added: II.6. Digitize the cluster within Area II. Cluster processes and IV.3. Environmental impact in Area IV. The impact of the cluster on the environment. Additionally, some pointers in other areas and sub-areas have been modified or replaced. Finally, the total number of indicators assigned to each sub-area has changed (in the current edition, a total of 114 indicators were used compared to 110 in the 2018 edition).

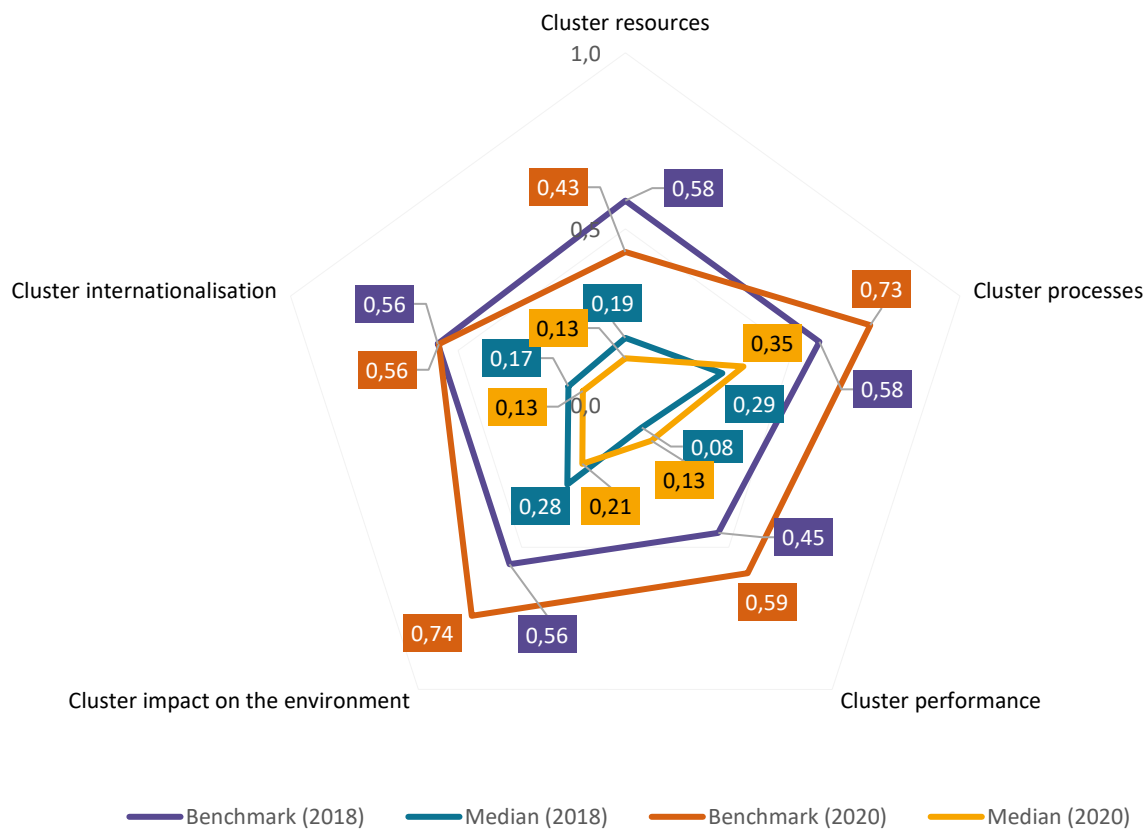
<sup>24</sup> The purpose of unitarization is to obtain variables with a uniform range of variability, defined, in classical terms, by the difference between their maximum and minimum values, which are consistently equal to 1. More in the statistical annex.

<sup>25</sup> Clusters with an area of geographical concentration of members in one of the provinces: Lublin, Podlaskie, Świętokrzyskie, Podkarpackie, Warmia and Mazury.

<sup>26</sup> Based on the results of the coordinators' survey, the percentage of cluster members operating in the high or medium-high technology area or activities in the field of knowledge-intensive services (min. 50% of members work in this area).

The chart below illustrates a situation where the best clusters (benchmark) in areas such as processes, results and environmental impacts have improved. In contrast, there has been a decrease in the benchmark in the cluster resources area. The median is much more illustrated by the situation of the whole cluster group. In this case, the situation of the in the area of internationalisation, cluster resources and environmental impacts was noted. Improvements in results were observed in the area of processes in the cluster and cluster results.

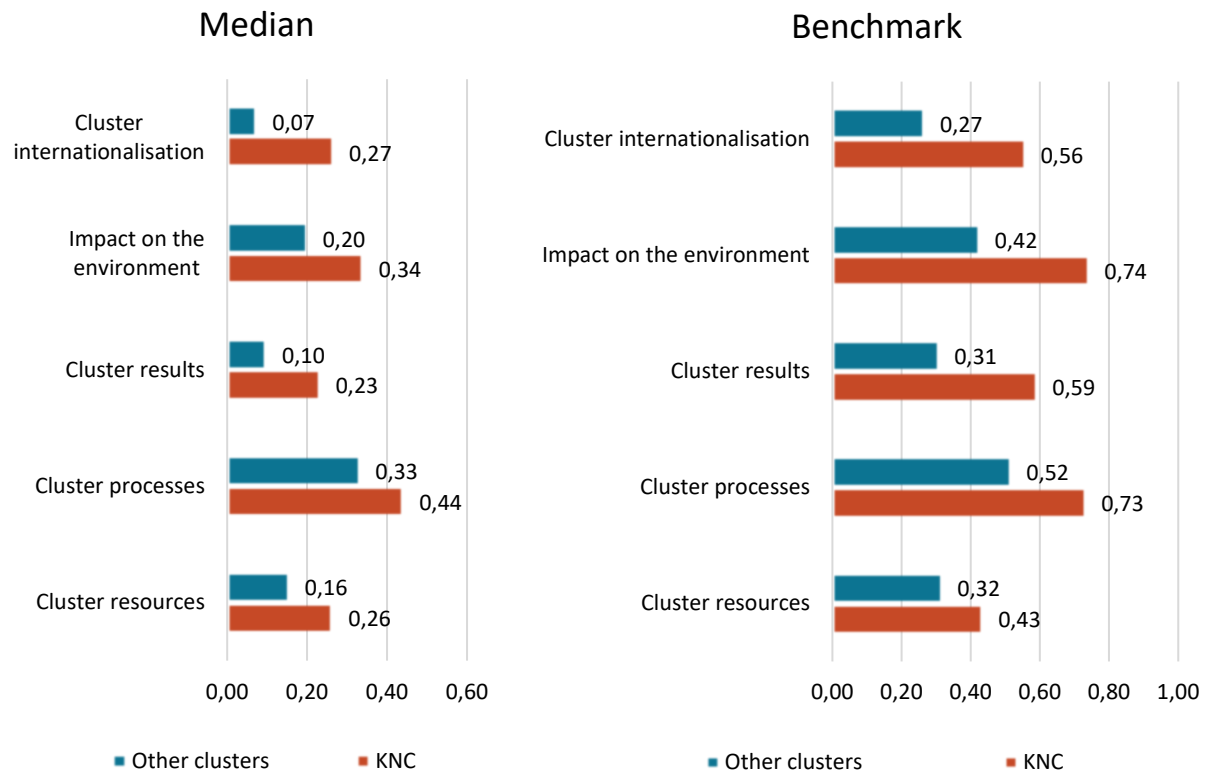
Graph 9. Median and benchmark values for 2018 and 2020 study



Source: Authors' analysis based on the cluster coordinator survey (N=41).

First, the analysis was done for the KNC and the other clusters. It is worth noting that for each criterion, the KNC achieved significantly better results measured by the median and benchmark than the other clusters. The biggest difference in cluster development was in the area of internationalisation and cluster performance, and relatively small processes in the cluster.

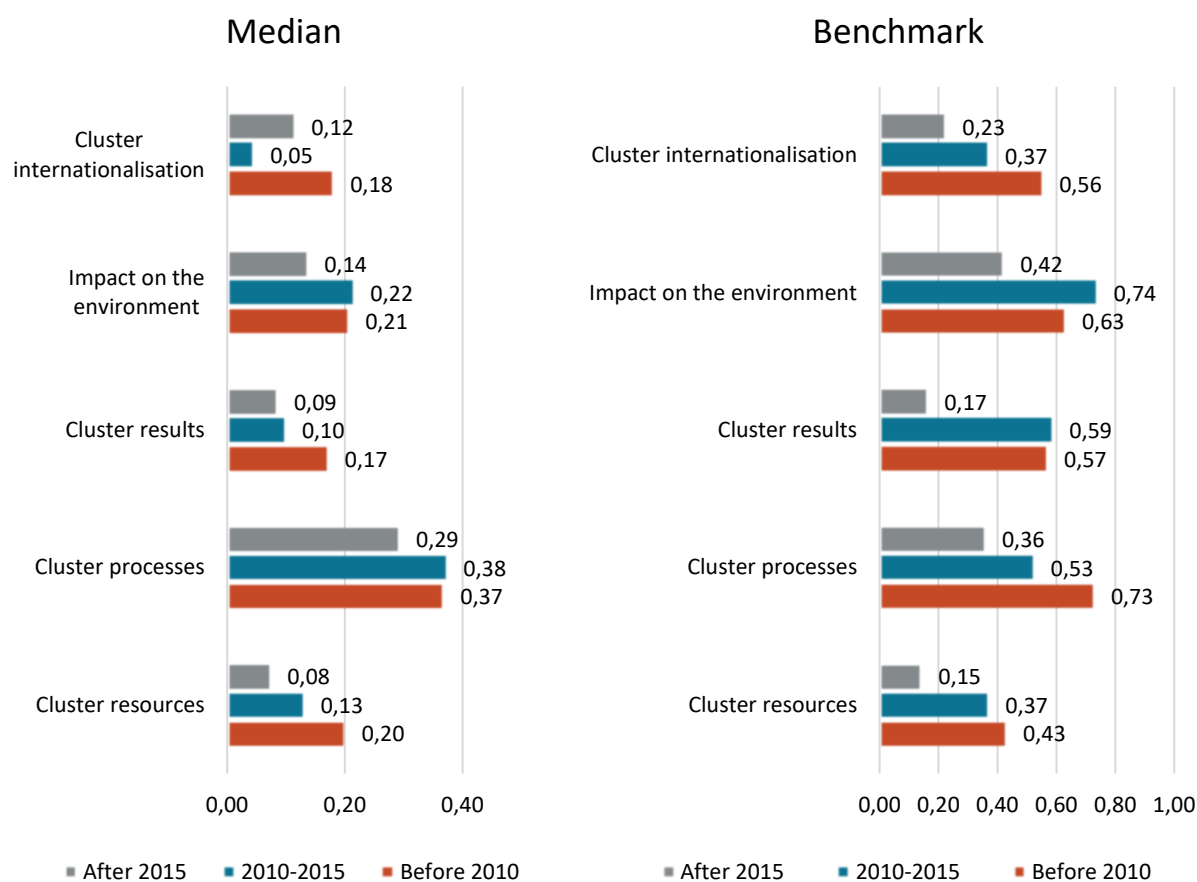
Graph 10. Median and synthetical benchmarks in the division into KNC and other clusters



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Another criterion for analysis was the age of the clusters. A fairly significant impact of cluster life on the results achieved in individual areas can be observed. The biggest difference was between clusters of young people (established after 2015) and clusters operating for at least 5 years. The difference was particularly pronounced for the resources at the cluster's disposal and the results obtained by the cluster. The relatively large differences between the median a benchmark value indicate that a certain group of clusters achieved a very high level of development, well above the average and median for the total clusters (the characteristics of the best clusters were carried out later in the analysis when discussing the different areas).

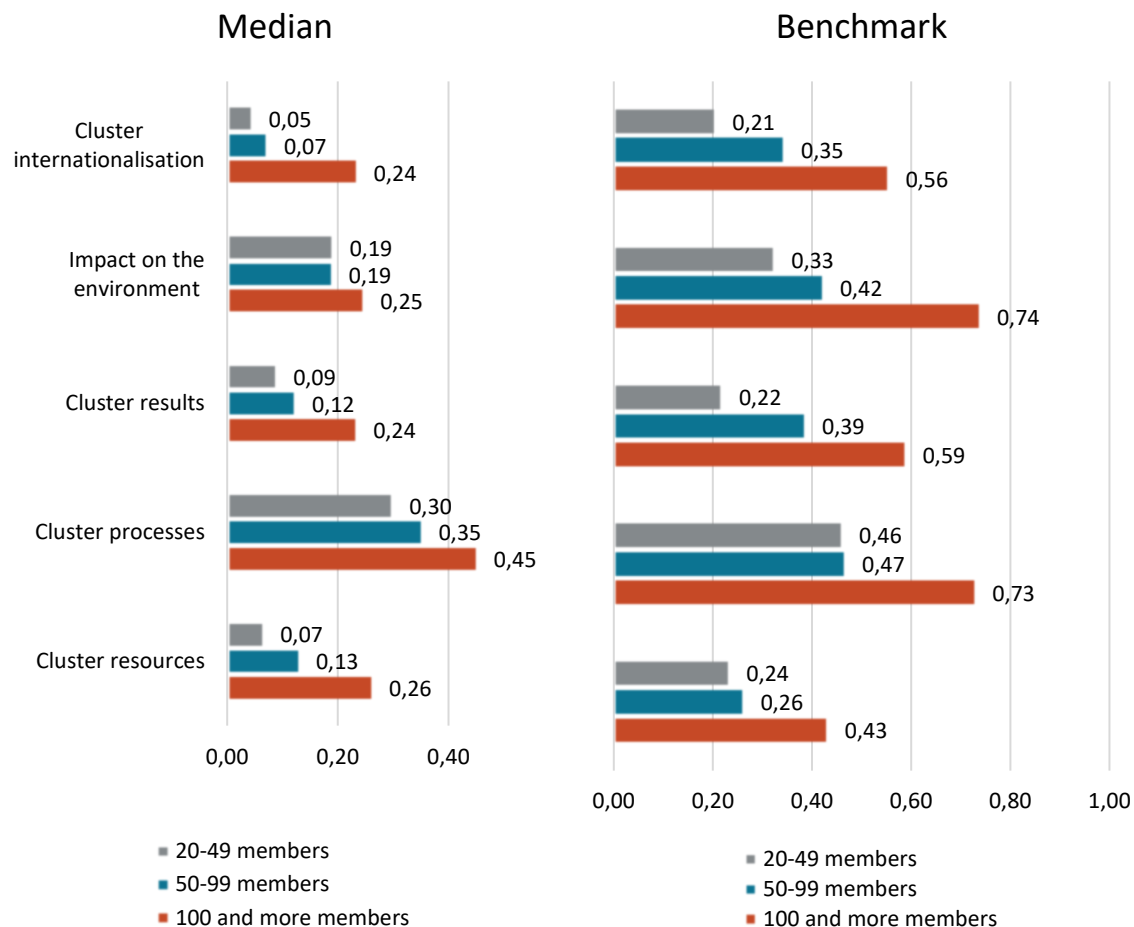
**Graph 11. The values of the median and synthetic benchmarks taking into account the year of clusters' establishment**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

They then investigated the relationship between the number of cluster members and the results obtained as part of benchmarking. Clusters are divided into three relatively equal groups in terms of size (20-49, 50-99, 100 and more). Clusters with a small number of members performed particularly poorly in areas such as cluster internationalisation, results and available resources. Having more than 100 members was almost a guarantee of the cluster's high position in each of the areas studied. Small structures performed relatively best in terms of processes in the cluster.

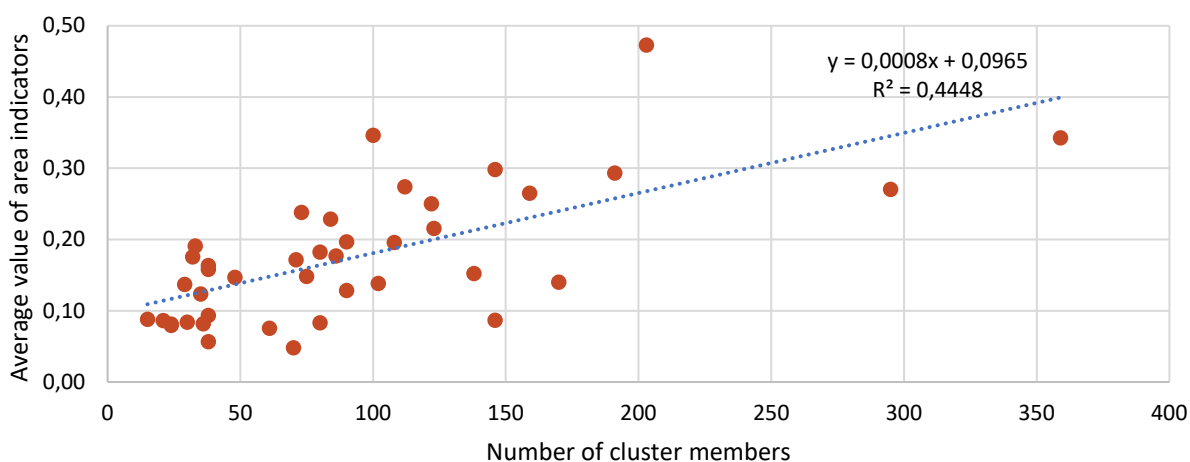
Graph 12. Median and synthetic benchmark values by area and number of members



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Previous conclusions are confirmed by a summary illustrating the relationship between the number of members and the average value of synthetic indicators for areas (each point represents one cluster included in the survey). The trend line has been quite clear. Only individual clusters of less than 50 entities were able to achieve relatively favourable aggregate benchmarking results.

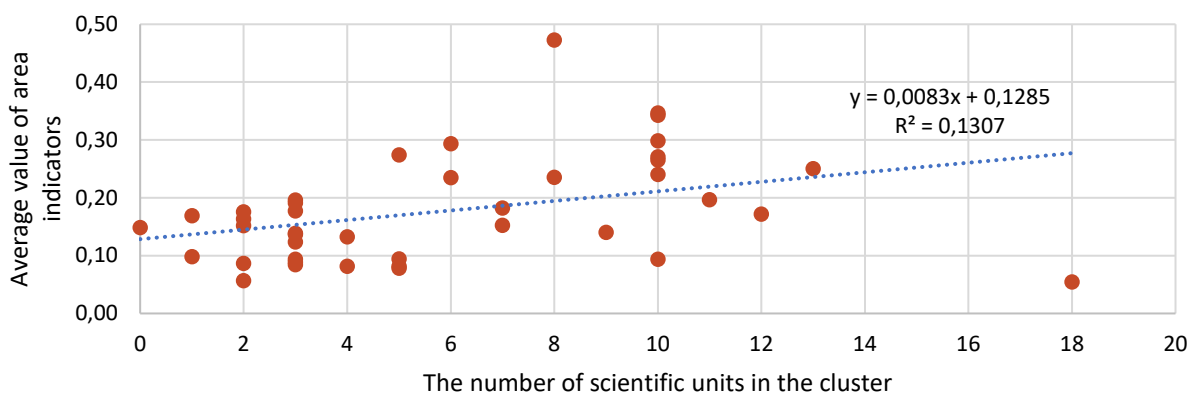
**Graph 13. Relationship between the number of cluster members and the average cluster rating for benchmarking areas**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

It is worth noting that a positive correlation also exists between the number of scientific units in the cluster and the average value of synthetic indicators for areas. The study involved one cluster in which there was not a single scientific unit among the members. The record holder is a cluster with 18 scientific units. In contrast to the trend observed, it received a fairly low benchmarking rating.

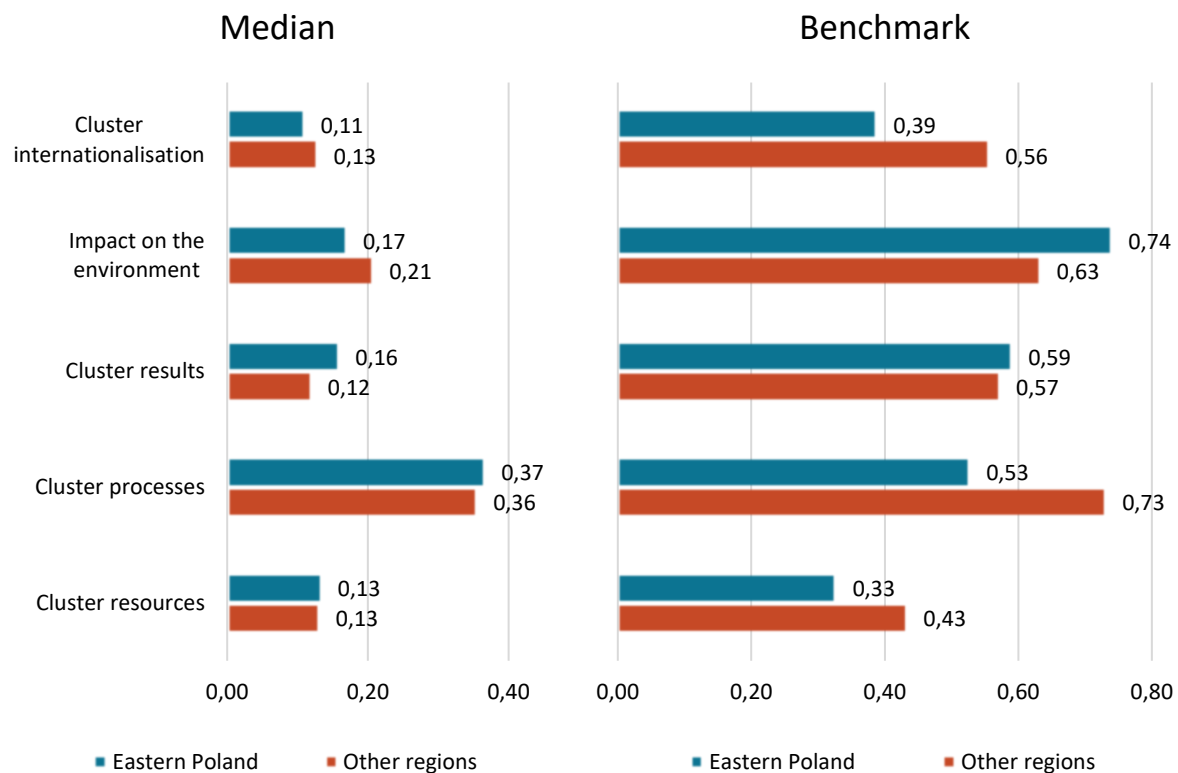
**Graph 14. Relationship between the number of scientific units in the cluster and the average cluster rating for benchmarking areas**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Another area of analysis was the comparison of the results obtained by clusters located in Eastern Poland<sup>27</sup> and in other regions of the country. The analysis in this respect may be interesting, as eastern European actors have had access to a separate support Polish programme, i.e. Operational Programme Eastern Poland 2014-2020 and the higher support intensity resulting from the regional aid map in force for the period 2014-2020. In this case, in terms of median, there were no specific differences between the two groups of regions, and the results were comparable. The fairly even distribution of benchmarks for Polish East (2 areas with the highest value) and the rest of the country (3 areas) shows that regardless of location, clusters have had a chance to develop into a national leader.

Graph 15. Median values and synthetic benchmarks by area of geographical concentration



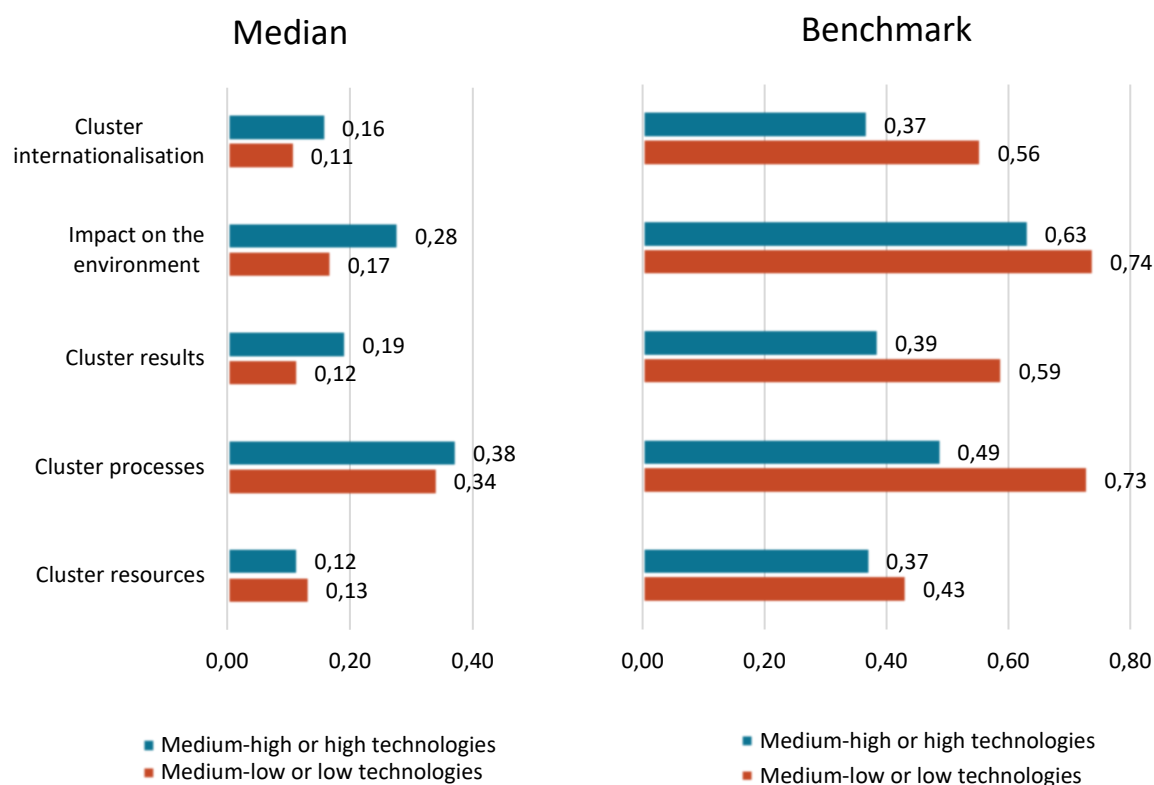
Source: Authors' analysis based on the cluster coordinator survey (N=41).

<sup>27</sup>Region Lublin, Podlasie, Podkarpackie, Świętokrzyskie, Warmia and Mazury.



The last area of comparison concerned the dominant level of technology used among cluster members. As a preliminary point, it is worth pointing out that high- and medium-high-tech clusters include aerospace and automotive clusters, health and medical clusters and most ICT clusters. Given the median value, high- and medium-high-tech clusters perform significantly better in the areas of cluster internationalisation, environmental impact and cluster performance. However, the cluster processes and the resources available to the cluster and members were at a similar level. For the benchmark, clusters with an overwhelming group of members operating in the medium-low and low-tech areas achieved the best results in each area. This result is largely due to the two clusters that received the best ratings in each area.

Graph 16. Median values and synthetic benchmarks by technology level



Source: Authors' analysis based on the cluster coordinator survey (N=41).

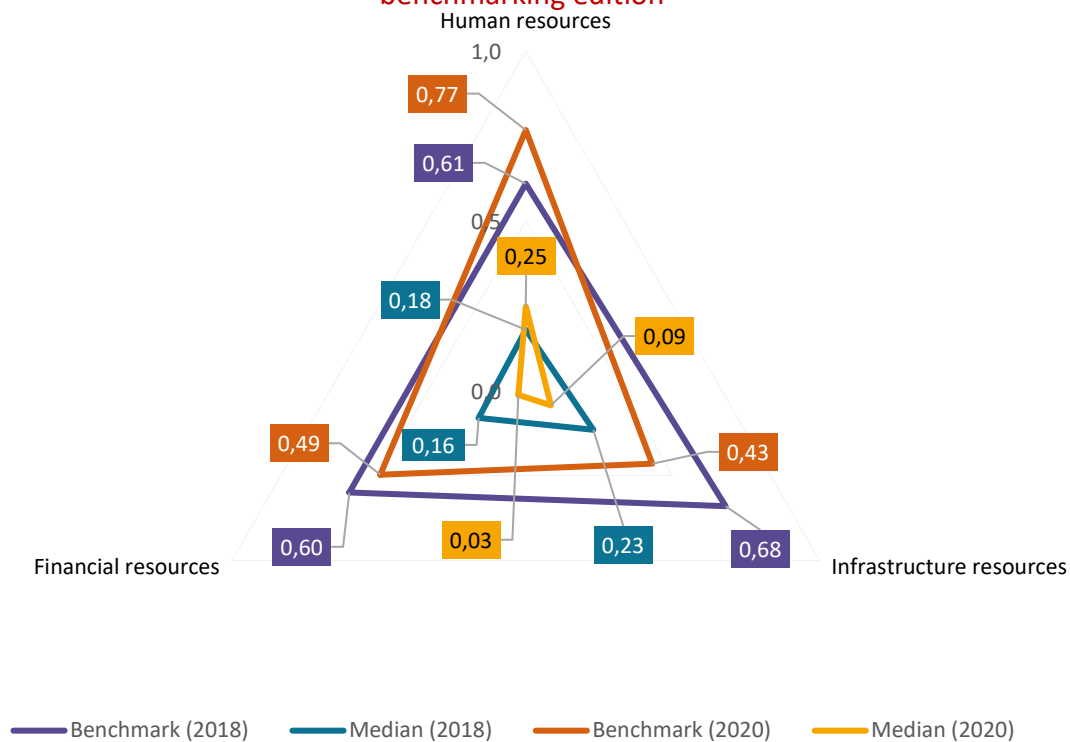
## 5.1. Cluster resources

For the study, "Cluster Resources" were evaluated in three sub-areas:

- **Human resources** – employment has been studied in all cluster member entities, including the number of people working in cluster enterprises and the number of researchers involved in cluster work and the coordinator staff seconded to the cluster.
- **Infrastructure resources** – this sub-site assessed the availability of and adapting to the needs of members of administrative infrastructure clusters and training, research, production and IT.
- **Financial resources** – this sub-area examined the cluster's budget, including its self-financing and external financing, as well as the availability of financial instruments for cluster members.

Under "Cluster Resources", the best overall score for all three areas (benchmark) was 0.43 and the median was 0.13. In terms of both median and benchmark, the cluster's human resources area (0.25 and 0.77, respectively) was the best rated. This represented an increase from the values obtained in the 2018 edition of the survey (the median increased by 0.6 and the benchmark by 0.19). For other subsynthetic indicators, there was a decrease in value, particularly noticeable in the infrastructure resources sub-range (the median decreased by 0.20 and the benchmark by 0.25).

Graph 17. Subsynchronous indicators values in the area of cluster resources for 2018 and 2020 benchmarking edition

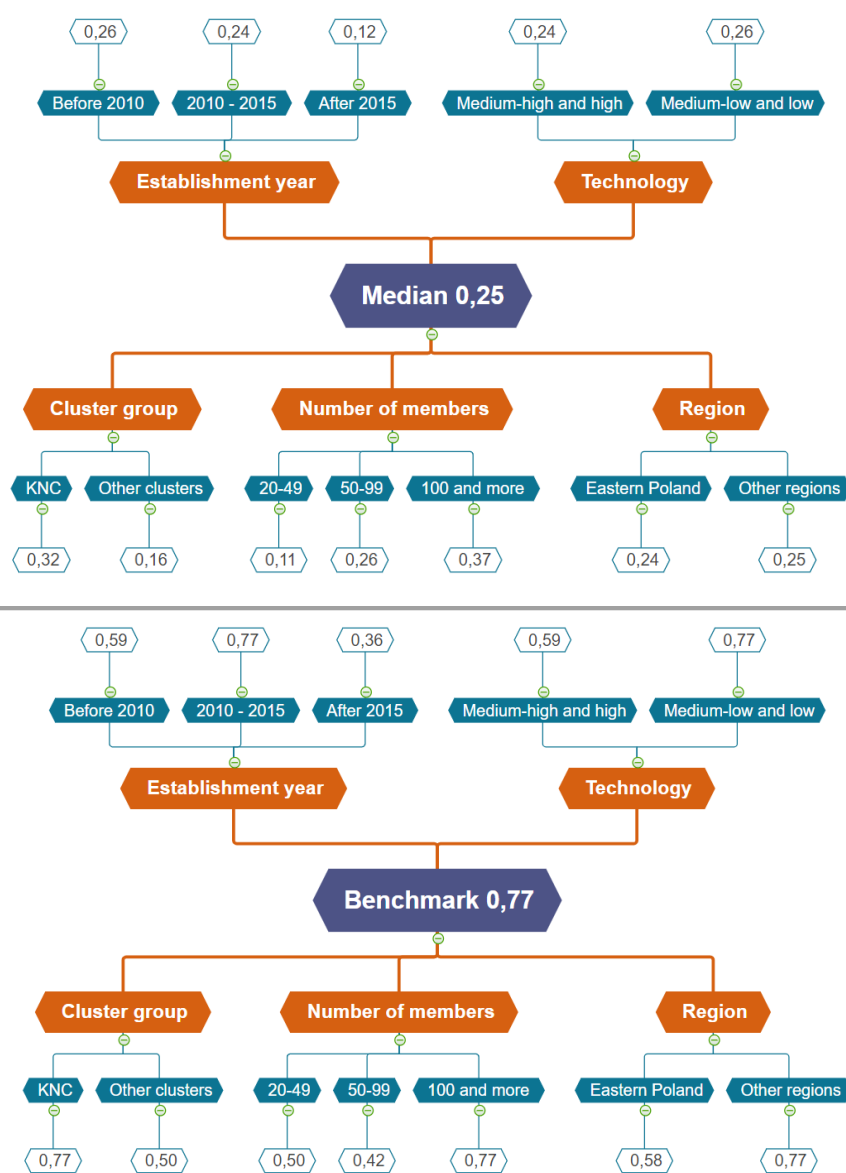


Source: Authors' analysis based on the cluster coordinator survey (N=41).

### 5.1.1. Human resources

For each sub-area of the study, median and benchmark values are presented, taking into account the most important criteria specific to clusters. In the case of human resources assessment, the resulting values for large clusters (0.37) and KNC (0.32) are much better. Young clusters have not yet built sufficient human resources, as evidenced by the relatively low median level for clusters established after 2015. The benchmark shows that the best results were achieved by clusters established in the period 2010-2015, operating in the area of medium-low and low technologies, having a critical mass in the province outside Eastern Poland, having the status of KNC and 100 and more members.

Graph 18. Median and benchmark for sub-areas human resources taking into account cluster characteristics

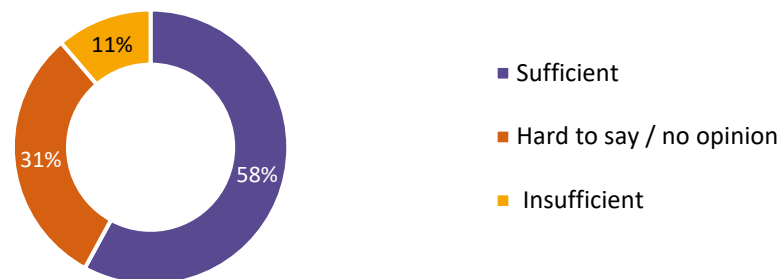


Source: Authors' analysis based on the cluster coordinator survey (N=41).

When analysing benchmark values, it can be seen that the best rating for a cluster within human resources was 0.77. It was a medium-low and low-tech cluster, founded between 2010 and 2015, with KNC status and more than 100 members. Its location belonged to an area outside Eastern Poland.

Cluster members assessed cluster coordinators as sufficient staff employed to support clusters (58% of indications) and approximately 11% disagreed. It is important that cluster coordinators in the member opinion survey include this aspect in the analysis.

Graph 19. Assessment of coordinator staff dedicated to the operation of cluster entities



Source: Research on cluster members (N=435).

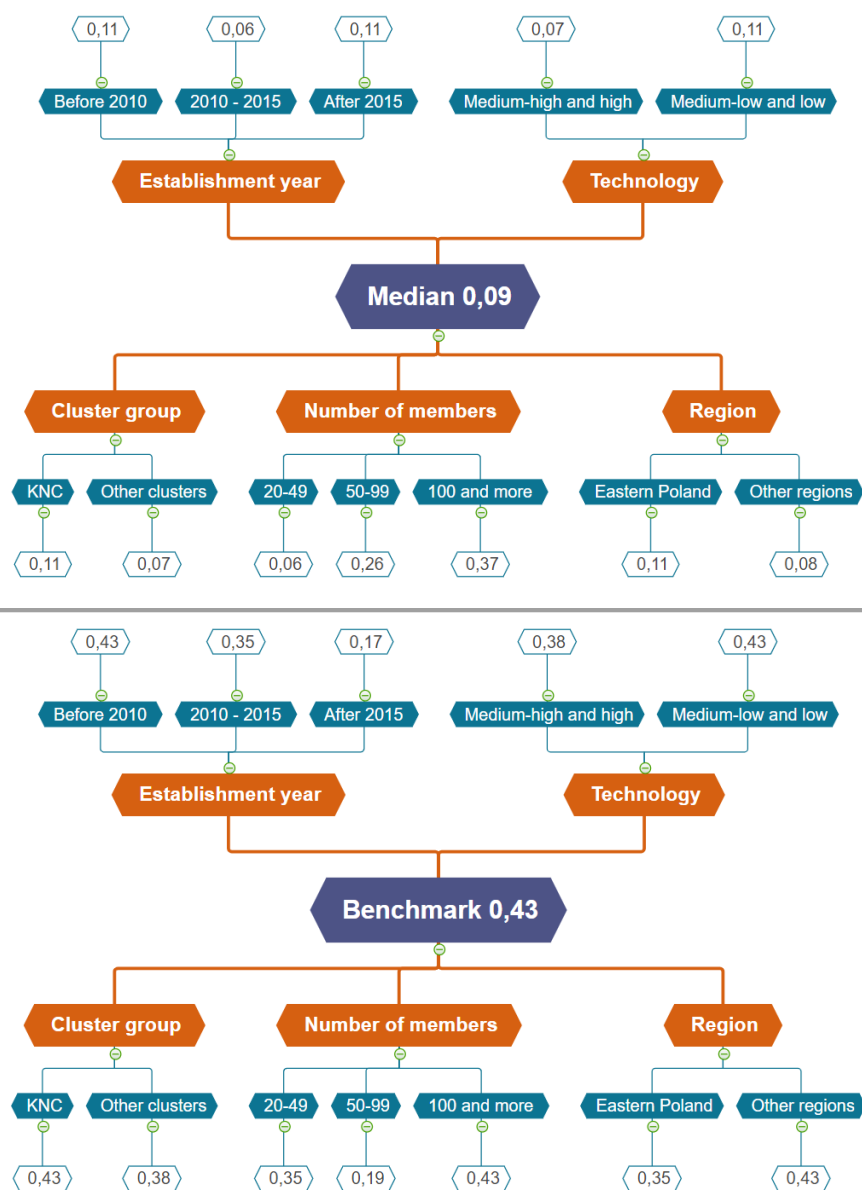
#### Detailed information for sub-area

- The study coordinators indicated the number of team members. For 31 clusters, this number did not exceed 10 people. In total, in the studied clusters, coordinators employed a total of 135 employees.
- The average number of the coordinator's employees was 6. On the other hand, the number of coordinator employees delegated to operate the cluster continuously for at least 2 years was on average 3 people.
- Almost half of the clusters were served by 1-2 people.
- 58% of cluster members believe that there are sufficient staff employed in the cluster coordinator's office. Another 31% have no opinion. Only 11% believe that the number of people serving the cluster is insufficient.
- Among the clusters studied were those where no persons seconded to the cluster and working continuously for a minimum of 2 years were shown.
- Among the members of the clusters, a certain group is scientific units. Their academics engage in cluster activities at a very diverse level. 4 clusters indicated a lack of involvement of researchers. For a further 21, the total involvement shall not exceed 10 persons. Eleven clusters identified a number of researchers involved at 11 to 50. Their total number amounted to approx. 550 people.

### 5.1.2. Infrastructure resources

For infrastructure resources, note the very low median rate values. This means that for infrastructure resources there was a fairly large group of clusters with very low levels of development in this area. In terms of median, only the group of medium (0.26) and large clusters (0.37) compared to the total (0.09) performed favourably. In the case of median, there was no greater differentiation between cluster characteristics such as lifetime, region or technology areas. In the case of benchmark analysis, the best ratings were obtained by a large cluster (more than 100 members), with the KNC status, established before 2010, operating in the area of medium-low and low technology and located outside Eastern Poland.

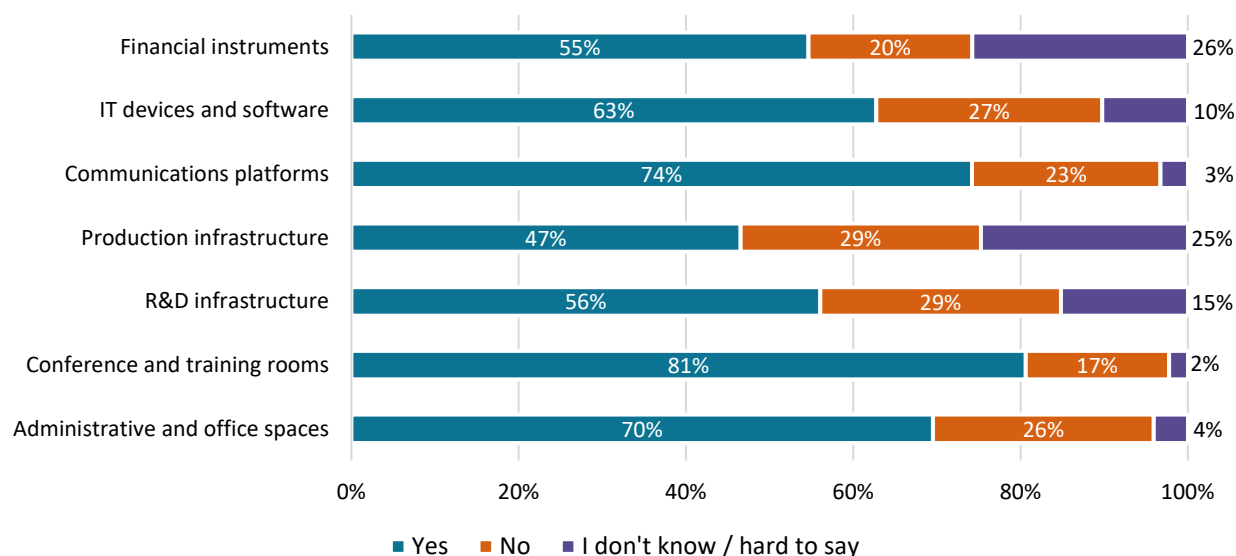
Graph 20. Median and benchmark for sub-areas infrastructure resources taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

In addition to the coordinators' surveys, surveys of the opinions of cluster members were carried out. In assessing the availability of cluster resources, respondents best assessed the availability of conference and training rooms (more than 80% of affirmative responses) and the communication platform (close to 75%). By contrast, the largest proportion of negative evaluators included the availability of production and research infrastructures (approx. 29%) and IT devices and software (27%).

Graph 21. Evaluate cluster resource availability by organization surveyed



Source: Research on cluster members (N=435).

### Detailed information for sub-area

- The average office and administrative area available to clusters was around 68 m<sup>2</sup>. Among the clusters studied, three were identified for which the area was 200 m<sup>2</sup> or more.
- Coordinators of 34 clusters also provided conference and training space. The average area was approx. 150 m<sup>2</sup>.
- 21 coordinators declared that cluster members used the available research infrastructure, with such a service being rather low-popularity among cluster members. It was about 12% of all members for all clusters and 22% for clusters providing this type of infrastructure. Nearly 60% of the surveyed cluster members highly rated the level of matching research infrastructure, and 11% low.
- Provisioning production infrastructure was a rarely pointed service among the clusters studied. 9 clusters offered this kind of support. The proportion of entities benefiting from this type of support was also low (around 4% of all cluster members). 45% of the surveyed cluster members highly rated the level of matching the production infrastructure, and nearly 18% low.
- Five of the surveyed clusters did not use any IT platforms. By contrast, among clusters using this type of solution, the platform was most often used for

communication (84% among clusters using the platform), storage of databases (42%), as a repository of knowledge (39%) and cooperation (39%). Several clusters pointed to additional platform features used for group purchases.

- Only 6 clusters declared to have incurred research infrastructure expenditure, with the value of expenditure in this area in the case of one cluster in the amount of expenditure in this area in addition to PLN 52 million. In the case of production infrastructure, there were it was only 4 clusters that declared to incur expenses in this regard.
- Cluster coordinators were much more likely to spend on IT infrastructure. A total of 22 clusters declared to be incurred in this respect, with the vast majority of them (20) spending between PLN 5,000 and 70,000 over the two-year period 2018-2019. One cluster declared to have incurred expenses of PLN 200,000. The record holder declared the in this area in excess of PLN 52 million<sup>28</sup>.

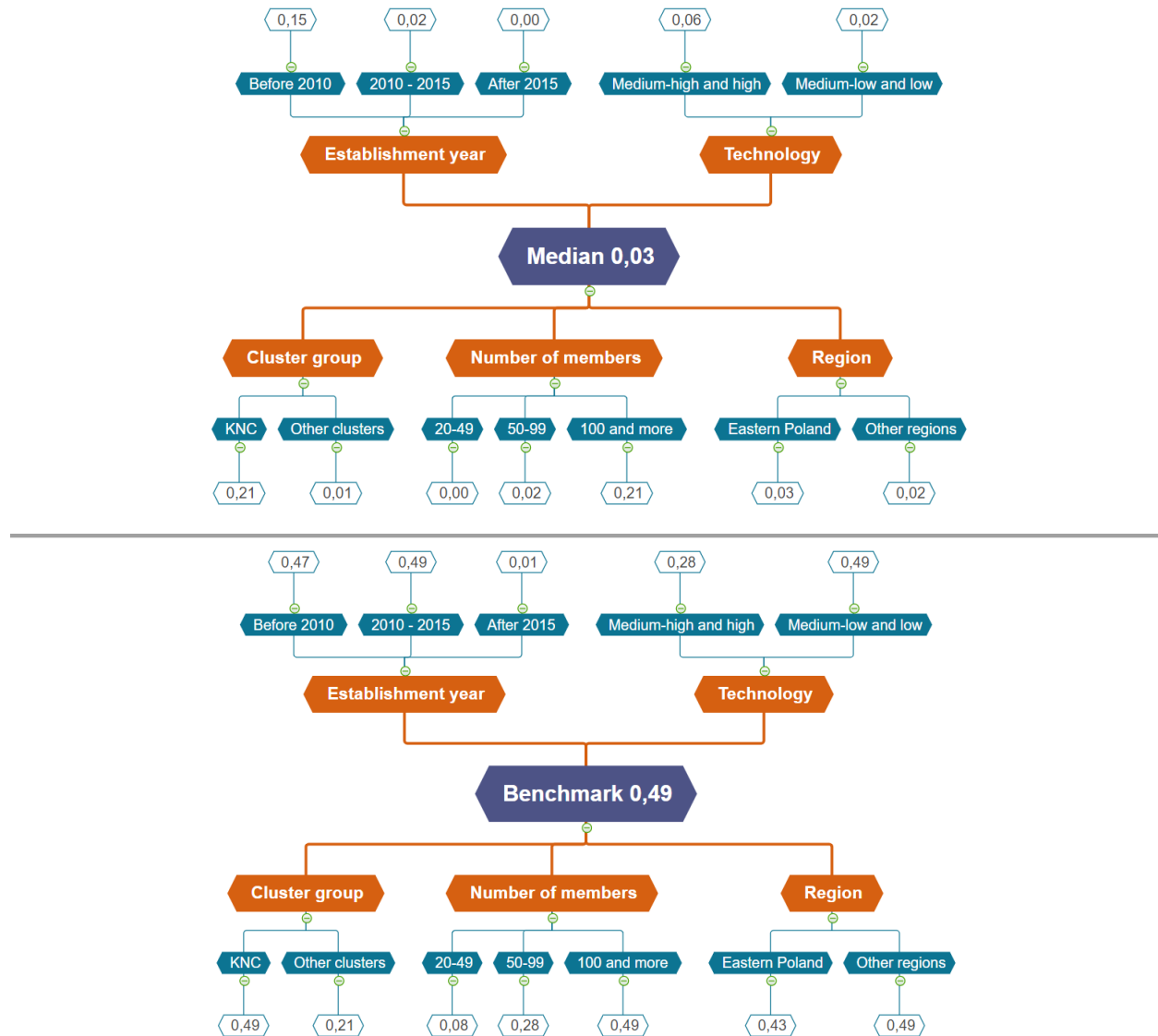
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<sup>28</sup>This is a clear example of the presence of extreme values in the collected dataset. These types of situations can reduce the information value of the data after unitaryization (the extreme value is 1 and the others are close to 0). To prevent such situations, an analysis of the occurrence of extreme values was carried out (the average criterion + three times the standard deviation value was adopted). Extreme values are quite often found in a dataset for financial indicators. For the purpose of making the analyses more readable, extreme values were omitted by looking for the maximum of the indicator for unitaryisation.

### 5.1.3. Financial resources

When switching to financial resources, it is worth noting the very low median value of the total (0,03) and for most categories of clusters. The low value of this measure means that among the clusters surveyed there was a significant group (at least half) that performed poorly against the top dozen clusters. In terms of financial resources, the clusters operating min. 10 years (median at 0.15), KNC (0.21) and clusters of more than 100 members (0.21). Analysis of benchmark values provides similar conclusions. The benchmark reached a relatively low level of 0.49. This means that among the clusters surveyed, it is difficult to find a clear leader in terms of most or all sub-indicators. The best grades were obtained by a large cluster (over 100 members), having the status of KNC, established before 2010, operating in the area of medium-low and low technology and located outside Eastern Poland.

Graph 22. Median and benchmark for sub-areas financial resources taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).



### Detailed information for sub-area

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- The budget of the clusters surveyed in the period 2018-2019 was very diverse. 15 clusters had a budget exceeding PLN 1 million during this period. For the top two, these were values in excess of PLN 50 million. In both cases, these were funds from external sources (including public sources, e.g. co-financed projects under the European Funds).
- One of the sources of budget is contributions from members and the coordinator's own revenues for the operation of the cluster. Only 5 clusters exceeded PLN 1 million in this case on a two-year basis (2018-2019). For the next 16 clusters, these amounts were in the range of PLN 100,000 – PLN 1 million.
- An important source of financing for clusters were external funds (both from public and private sources). A total of 27 clusters obtained approx. PLN 295 million from external sources, of which approx. PLN 215 million were public sources (including domestic and foreign projects, domestic and foreign grants and targeted subsidies).
- The coordinators examined provide little access to additional external financial instruments (e.g. in the form of partnerships with financial institutions). The most frequently indicated access within the cluster to the loan fund and seed capital (7 clusters each).
- Several clusters indicated support for their members in the form of advice related to obtaining grants from EU funds.
- Cluster members assessed the availability of financial instruments in the cluster. A positive answer was given by 55% of the surveyed respondents. Details on the graph 21 in chapter 6.1.2.
- On average, the number of people who benefited from all external financing services available within the cluster was about 9% of cluster members.

### Summary of the area

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- Within the area, cluster resources were analysed for human, infrastructure and financial resources. The situation in human resources and the weakest in the area of financial resources can be assessed relatively best.
- The human resources assessment shall consist m.in. number of staff of the coordinator team, including persons permanently seconded to the cluster. A significant proportion of clusters are served by virtually 1-2 people. Cluster members would rather have a good assessment of this aspect. Only 11% of them believe that the number of people involved in clustering is insufficient.
- More than three-quarter of clusters have declared the involvement of researchers. This can be considered a positive manifestation of the activity of these structures. Clusters can play an important role in establishing R&D cooperation between companies and representatives of the scientific sector.
- Cluster members assess the availability of infrastructure resources relatively well, particularly in conference, training and administrative and office premises as well as the communication platform.

- In each of the sub-areas surveyed, large clusters (at least 100 members), with KNC status and operating for at least 10 years, gain an advantage. This applies in particular to financial resources.
- Cluster coordinators are little active in ensuring access to additional external sources of funding. At the same time, a small percentage of cluster members use this type of service (approx. 9%).

## 5.2. Cluster processes

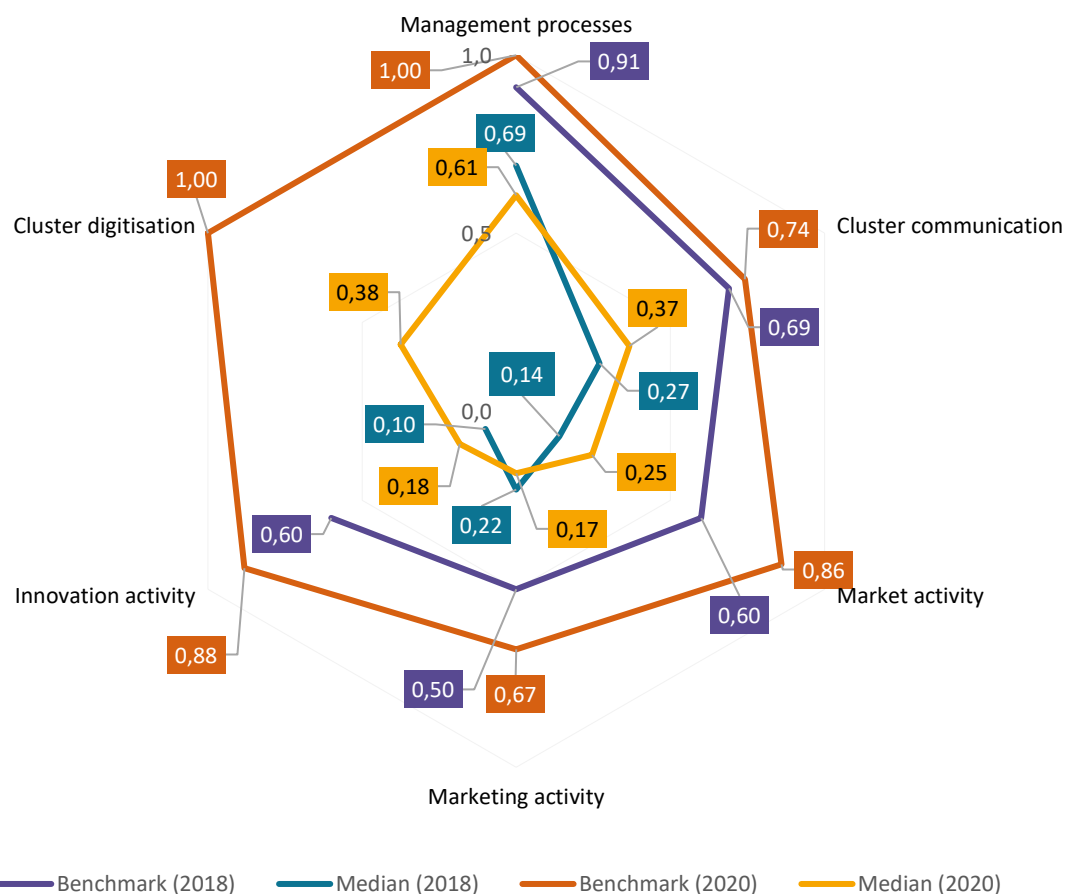
The "Cluster processes" area applies to both internal and external activity within the cluster. In this area, the following were studied:

- **Management processes** - the degree of achievement of cluster objectives in the last two years, having strategic and operational documents, having specialized management bodies, testing the needs and satisfaction of cluster members and quality standards.
- **Cluster communication - direct** contacts in clusters (meetings) and communication tools and how often they are used.
- **Market activity** - market information and cooperation within the value chain (joint procurement and distribution).
- **Marketing activity** - media presence, cluster brand use, joint promotional and marketing activities, including joint activities in fair and exhibition.
- **Innovation activity** - availability and use of pro-innovation services clusters and the diagnosis of the technological potential of cluster companies.
- **Digitisation of the cluster** – degree of digitisation of cluster members (use of Industry 4.0 management systems and technological solutions).

The last sub-area is new to the 2018 edition of the survey. The processes in the cluster were tested using a set of 32 indicators.

Analysing the median value in the current edition of the study, it was observed to increase in three areas compared to the previous edition: cluster communication (from 0.27 to 0.37), market activity (0.14 to 0.25) and innovation activity (0.10 to 0.18). The best rated sub-area was management processes (0.61). In the case of the benchmark, it is worth noting very high values, equal to 1 (cluster digitization, management processes) or close to 1 (innovation activity, market activity). This means that there were several clusters in the study group that received maximum or almost maximum ratings for the indicators in the sub-area. At the same time, comparing the situation to that of 2018, you can see an increase for each of the sub-areas. The new cluster digitization sub-area has a fairly high median value (0.38) with a maximum benchmark value (1.00). This means that among the clusters studied, their level of digitisation is fairly uniform. At the same time, there is a group of clusters (mainly from the ICT area) in the study group that obtain maximum or almost maximum values for sub-incises. There are virtually no clusters in the digitisation sub-areas that could be considered very weak.

**Graph 23. Subsynthetic indicators values in the area of processes in the cluster for 2018 and 2020 benchmarking edition**

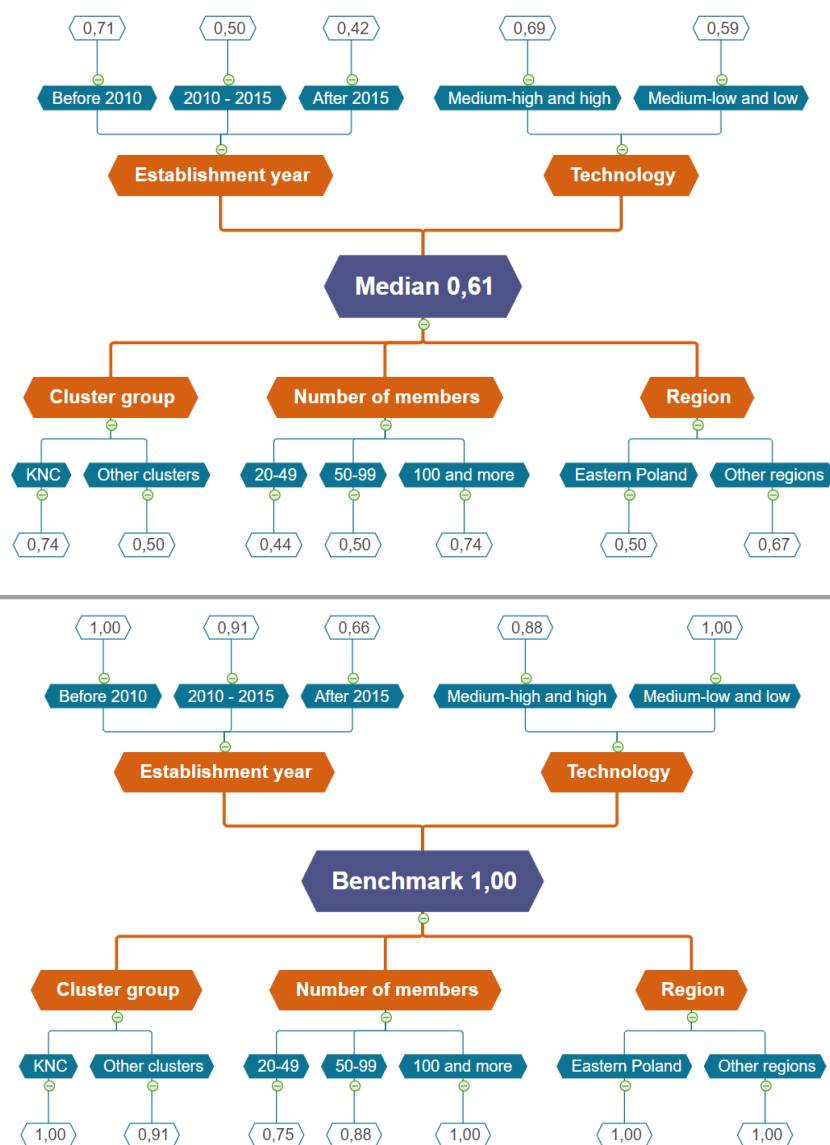


Source: Authors' analysis based on the cluster coordinator survey (N=41).

### 5.2.1. Management processes

For the sub-area, management processes, the total median ratio and by cluster type adopted relatively high values. This means that there was not such a difference between the best and other clusters. The advantage gained clusters operating min. 10 years (median at the level of 0.71), having the KNC status (0.74), operating in the area of medium-high and high technology (0.69) and having at least 100 members (0.74). Clusters located outside Eastern Poland fared better in this respect. In the case of the benchmark analysis, the best scores were obtained by a large cluster (over 100 members) with the KNC status, established before 2010 and operating in the area of medium-low and low technology. The benchmark value of 1.00 for both Eastern Poland and other regions means that there were at least two clusters that obtained the maximum scores within this sub-area.

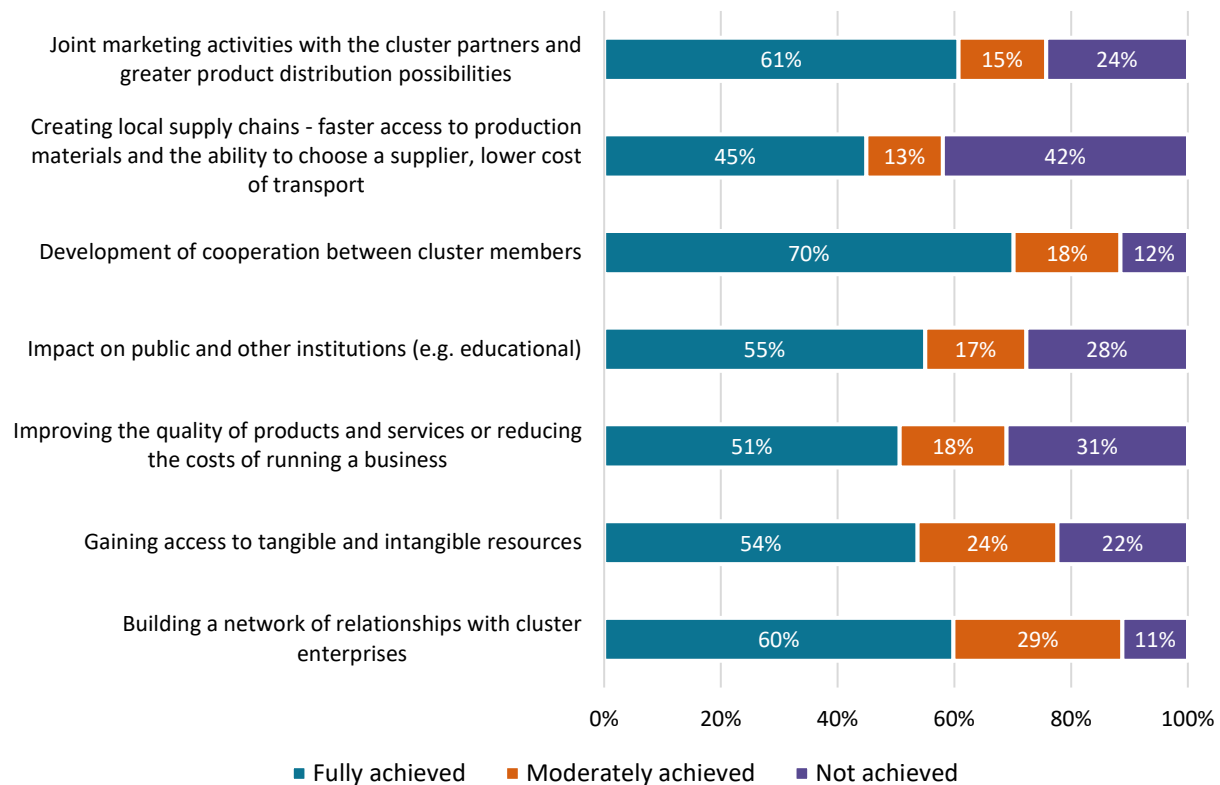
Graph 24. Median and benchmark for sub-areas management processes taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Management processes were also evaluated by cluster members. The representatives of this group rated the achievement of the objectives in areas such as: development of cooperation between cluster members (70 positive evaluations), joint marketing activities with cluster partners and greater possibilities for product distribution (61%) and building a network of relationships with cluster enterprises (positive ratings 60%). The objectives of creating local supply chains (positive assessments 45% and 42% negatively and highest negative value) and increasing the quality of products and services or reducing business costs (51%) were the least assessed.

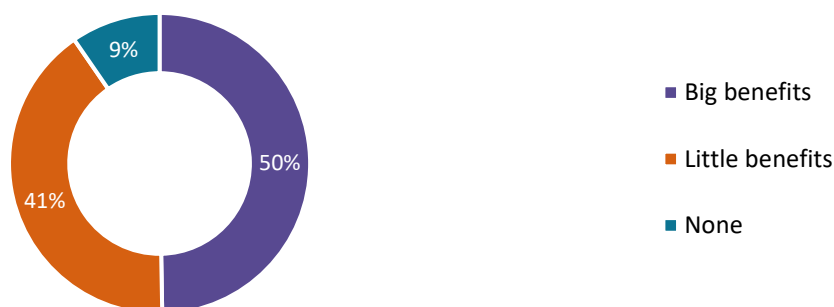
**Graph 25. The extent to which the development objectives in the cluster have been achieved from the point of view of the organization examined**



Source: Research on cluster members (N=435).

For almost half of respondents (50%) participation in the cluster was associated with great benefits. The opposite was the case in 41% of those surveyed for whom these benefits were small, and for 9% none.

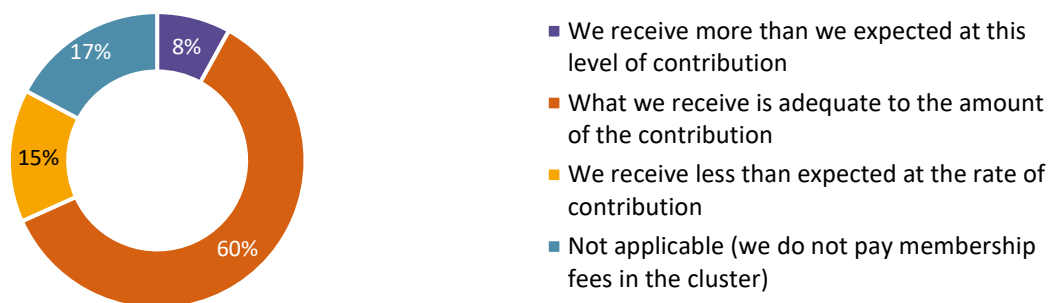
Graph 26. Scale of the benefits of participating in the cluster



Source: Research on cluster members (N=435).

In the opinion of more than 60% of cluster members, the contribution amount was adequate to the benefits of participating in the cluster. 15% of respondents disagreed. As an interesting fact, it can be pointed out that for 8% of respondents, the benefits obtained for membership in the cluster were perceived as significantly higher than the contribution paid.

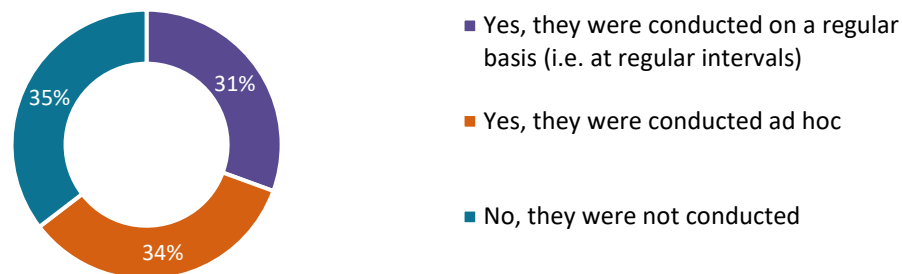
Graph 27. Adequacy of the contribution to the benefits obtained



Source: Research on cluster members (N=435).

Objective information on the level of cluster service by the coordinator is provided by the opinions of cluster members. 2/3 of the surveyed clusters conduct research needs or satisfaction among members. More than 30% of cluster members surveyed said that in the last two years their cluster regularly surveyed the needs or satisfaction of cluster participants. 34% of the clusters surveyed were *ad hoc*.

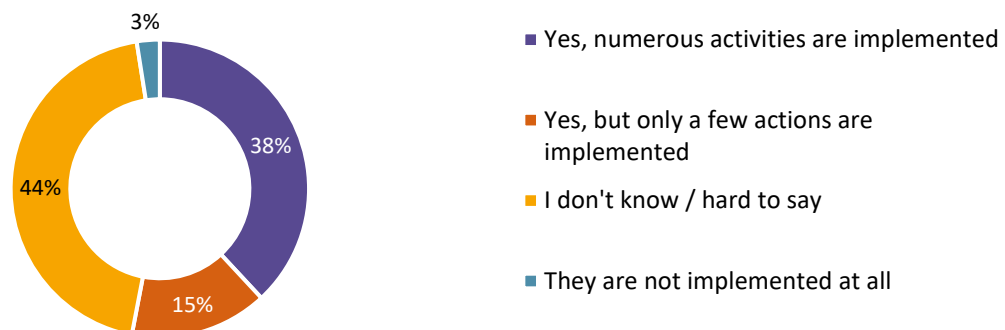
Graph 28. Surveys of cluster participants' needs or satisfaction



Source: Research on cluster members (N=435).

More than 44% of respondents indicated that they did not know or it was difficult for them to tell that, on the basis of the results obtained, improvement measures were implemented (to better meet the needs and increase the satisfaction of cluster participants), while 38% said that numerous actions were being implemented. Only 3% of members believe that coordinators do not implement improvement measures, while the opposite opinion is more than 50%.

Graph 29. Implementation of improvement activities



Source: Research on cluster members (N=435).

#### Detailed information for sub-area

- 70% of clusters had a written strategy that is upgradable. Another 24% of clusters have a written strategy that is not regularly updated. Only two clusters declared that they did not have a strategy. Over 55% of the surveyed cluster members participated in its development (on the basis of co-authorship or consultation). Almost all clusters had operational documents on how they functioned, with 23 with documents with a fairly high level of generality.

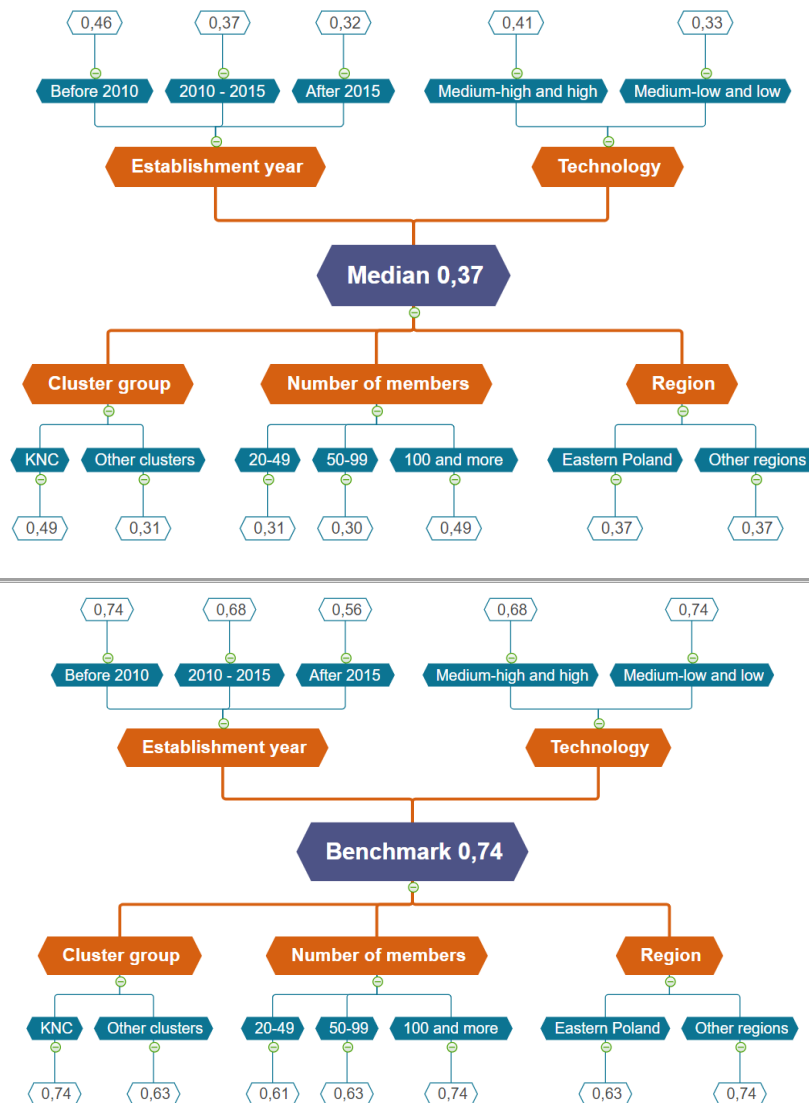


- The clusters studied mostly had complex management structures. The most frequently designated bodies include the President/Board, cluster board/programme board, members' assembly, audit committee and cluster secretariat/office. In some clusters, you can observe bodies performing substantive functions (m.in. working groups/thematic groups).
- 81% of the surveyed entities are cluster members, without participation in the work of specialized bodies (e.g. cluster management, cluster council, scientific council, audit committee, working group, etc.). About 19% of members delegate at least one employee to participate in the work of the bodies.
- Nearly two-thirds of clusters conducted needs/satisfaction surveys of cluster members, but only in case of 6 clusters were cyclical. The studies were most often conducted in the form of a survey, less often through personal/online conversation. The study was in most cases individual in nature (the interview was conducted with one member and not in the form of e.g. group interview).
- 58% of surveyed cluster members confirmed participation in cluster meetings once a month or more often.
- There is considerable polarization as to the benefits of cluster participation. Around half of cluster members consider participation in the cluster to be beneficial, while the other half see no benefit or small. More than 60% of members believe that the benefits of participation are adequate to the contributions paid.
- 5 clusters implemented common quality standards in the period 2018-2019.

### 5.2.2. Cluster communication

Given the communication in the cluster, the median overall and for each type of cluster has adopted a fairly high level. There were some differences between the different cluster categories, but they were not as large as most other sub-areas. However, long-running clusters (median 0.46), operating in the field of medium-low and low technology, with KNC status (0.49) and at least 100 members (0.49) were still the most favourable. Clusters in Eastern Poland and other regions of the country achieved the same score (0.37). The benchmark of 0.74 was obtained by a cluster registered before 2010 and operating in the area of medium-low and low technology, with KNC status, with more than 100 members and operating in a region other than Eastern Poland.

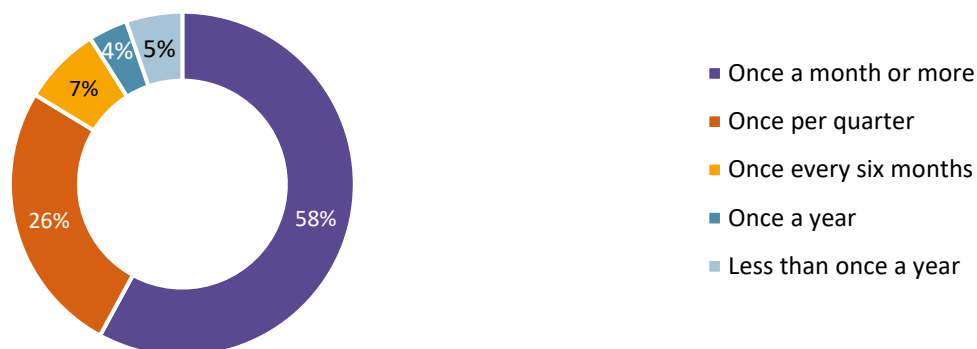
Graph 30. Median and benchmark for sub-areas cluster communication taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

In the survey of cluster members, the frequency of contact from coordinators was verified. Most often, cluster coordinators contacted their members at least once a month. Only 9% of respondents indicated that this contact was once a year or less.

Graph 31. Frequency of contacts between coordinator and cluster members



Source: Research on cluster members (N=435)

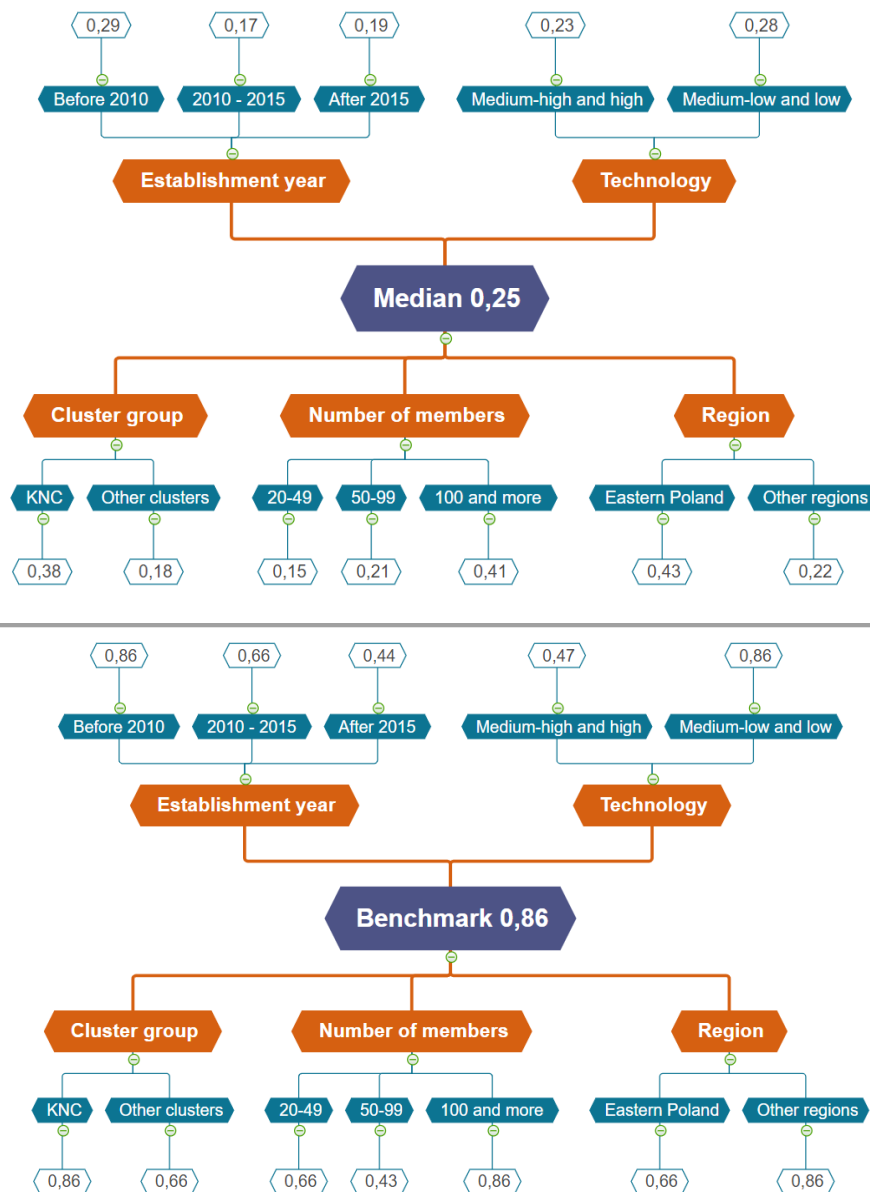
#### Detailed information for sub-area

- The average number of meetings in the clusters surveyed in the period 2018-2019 was close to 20 (approx. 10 meetings per year). Turnout data were weaker in this case. On average, the number of people attended the meeting was about 40% of cluster members.
- For communication purposes, all clusters tested declared that they had a web page. Almost all of them communicated with mailing and social media platforms. Two-thirds of clusters offered their members a newsletter subscription.
- The largest frequency of publication of information on cluster activities concerned social networks (mainly LinkedIn and Facebook).

### 5.2.3. Market activity

For market activity, there is a fairly clear difference between the median and the benchmark, with the median still at a relatively high level of 0.25 overall. Clusters established before 2010 (0.29), with KNC status (0.38) and at least 100 members (0.41) reached the highest level. It is interesting that clusters from Eastern Poland achieved a significantly higher level. In the case of benchmark analysis, the best scores were obtained by a large cluster (over 100 members) with the KNC status, established before 2010, operating in the area of medium-low and low technology and located outside Eastern Poland.

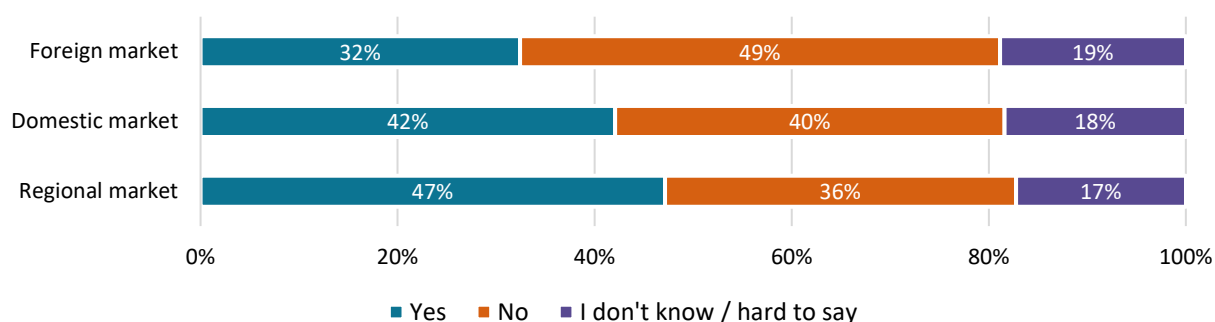
Graph 32. Median and benchmark for sub-areas market activity taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

When analysing the results of the opinions of cluster members, participation in clusters resulted primarily in an increase in their activity in regional markets (yes from nearly half of respondents) as well as national (42%). Activity in foreign markets is slightly weaker, with the indicator still quite high (32%).

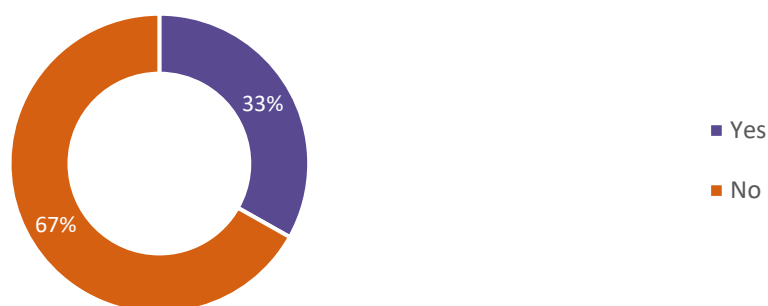
**Graph 33. Assessment of an organisation's market activity in the context of its participation in a cluster**



Source: Research on cluster members (N=435).

More than 33% of respondents said that by participating in the cluster, their organization established business relations with foreign partners.

**Graph 34. Participation in the cluster and establishing business relations with foreign partners**



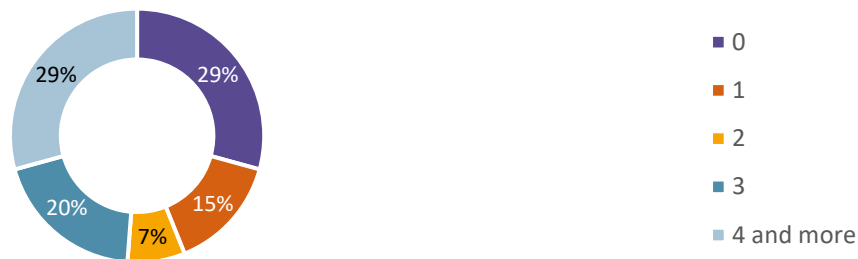
Source: Research on cluster members (N=435).

Clusters can play an important role in supporting the cooperation of their members along the value chain. The value chain, as defined by M. E. Porter, is: *a structured sequence of activities aimed at providing the end user with the product that he expects and the accompanying management and advisory activities. The purpose of this division is to enable an analysis that allows to identify the sources of costs, profits and potential competitive advantages*<sup>29</sup>.

<sup>29</sup> Porter M.E., Przewaga konkurencyjna. Osiągnięcie i utrzymanie lepszych wyników, Helion, Gliwice 2006.

The value chain can be broken down into elements that make up 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. It is worth mentioning that each of these elements can be the subject of cooperation as part of the operation of a given cluster. It is worth noting that the 12 surveyed clusters did not declare any jointly implemented stage of the value chain. This is an improvement compared to the 2018 benchmarking, when there were 19 such clusters. Most often, cooperation focused on 3 stages of the value chain (8 clusters) and 4 and more stages (12 clusters). All 7 stages of the value chain were implemented within one cluster. Then, you can identify 3 clusters that have implemented six stages of the value chain.

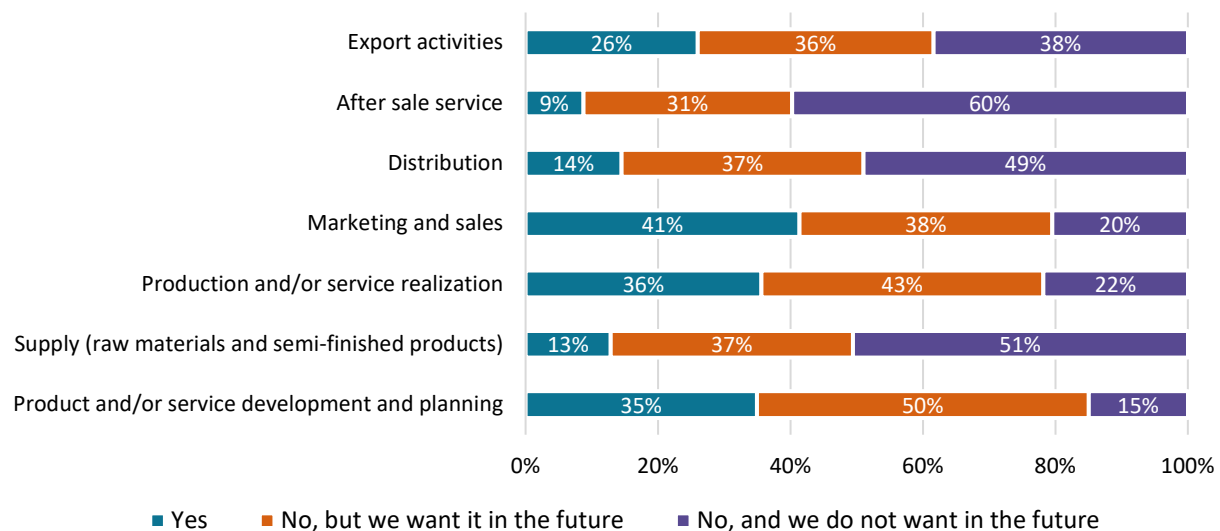
**Graph 35. Number of jointly implemented stages of the value chain in clusters**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The most frequently indicated common market activities in clusters, in which participated members of the cluster were "Marketing and sales" (41%), "Production and/or provision of services" (36%), "Development and planning of products and/or services" (35%) and "Export activities" (26%), and the least popular "After-sales service" (9%).

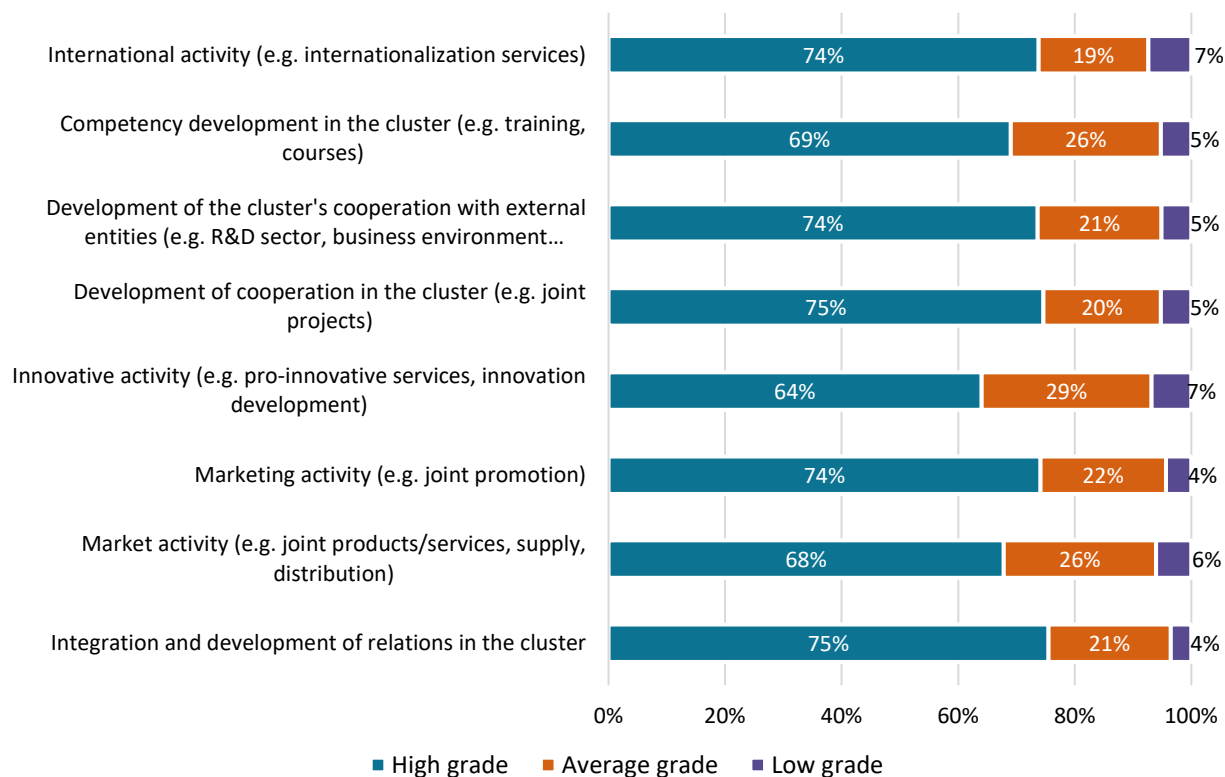
**Graph 36. Cluster members' participation in jointly implemented stages of the value chain**



Source: Research on cluster members (N=435).

In assessing the activities of cluster coordinators, 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 assessed most favourably (75% of high scores), development of cooperation in the cluster (75%) and marketing activity (74%).

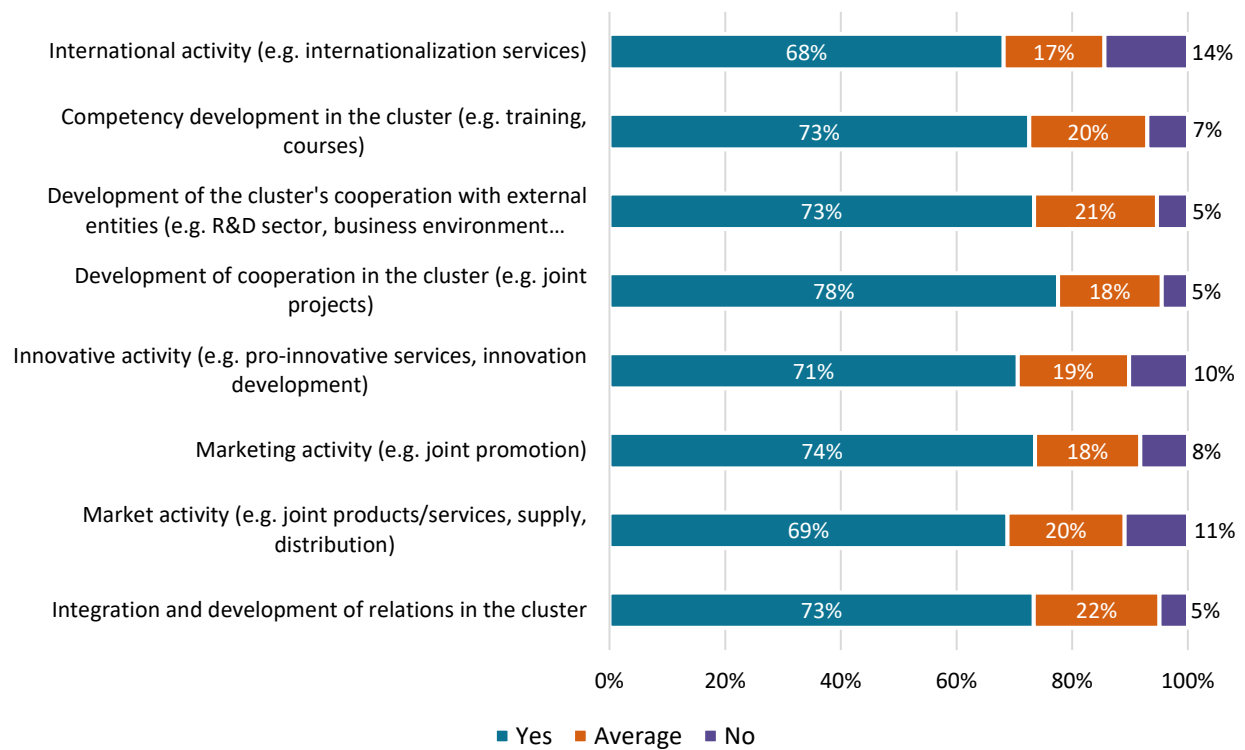
**Graph 37. Evaluation of cluster coordinators' activities in selected areas**



Source: Research on cluster members (N=435).

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 (78%), marketing activity (74%), the development of cluster cooperation with external actors and the integration and development of relationships in the cluster (78%). These results can be interpreted as high expectations of cluster members about the role and activity of coordinators. The answers "I don't know"/"hard to say" were omitted in the analysis as they did not bring any particular added value (for each category they were at the level of approx. 11%).

**Graph 38. Relevance of areas in the next two years (by cluster members)**

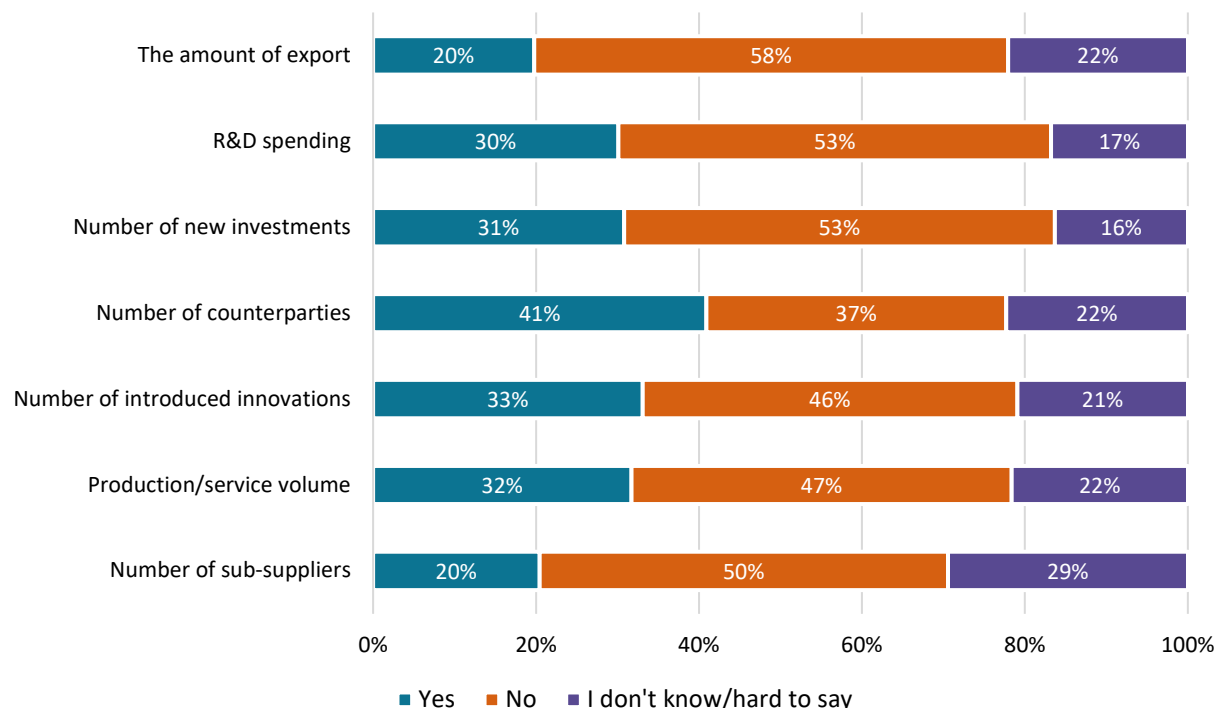


Source: Research on cluster members (N=435).

In the opinion of the respondents, the participation in the cluster improved the functioning of mainly areas such as the number of counterparties (41% of indications), the number of innovations introduced (33%) and production volume/volume of services (32%). In addition, cluster presence stimulates members to make new investments (31%) and increased R&D expenditure (30%).



Graph 39. Improving the functioning of the organisation in selected areas



Source: Research on cluster members (N=435).

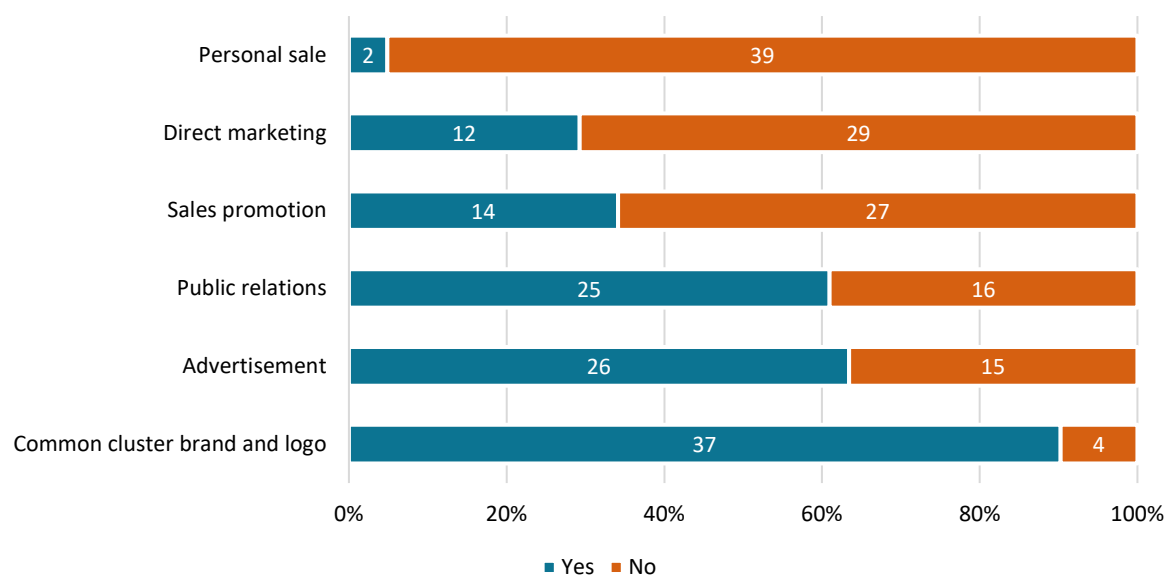
#### Detailed information for sub-area

- Only 11 clusters have declared the development or purchase of market reports. A total of 59 such documents were developed or purchased.
- There are relatively few clusters (13) that obtain products or services through joint group purchases. Most often this applies to the purchase of expert, advisory and training services (10 clusters) and consumables (5). An average of 19% of cluster members who are active in this area use group purchasing capabilities.
- Clusters are more active in the area of common distribution channels (30 clusters in total). This applies in particular to the organisation of joint stands, e.g. at trade fairs (30 clusters). In the following places, joint tendering (9) and joint hiring of an agent, exporter on international markets (6) can be indicated.
- Nearly a third of the members declared to establish relations with foreign partners thanks to their presence in the cluster.



One of the questions about cluster marketing activity was to conduct joint activities to promote the cluster and its members. The most commonly used activities include the creation of a common cluster brand and logo (37 clusters studied), followed by advertising activities (26) and public relations. Sales support measures were less frequently used.

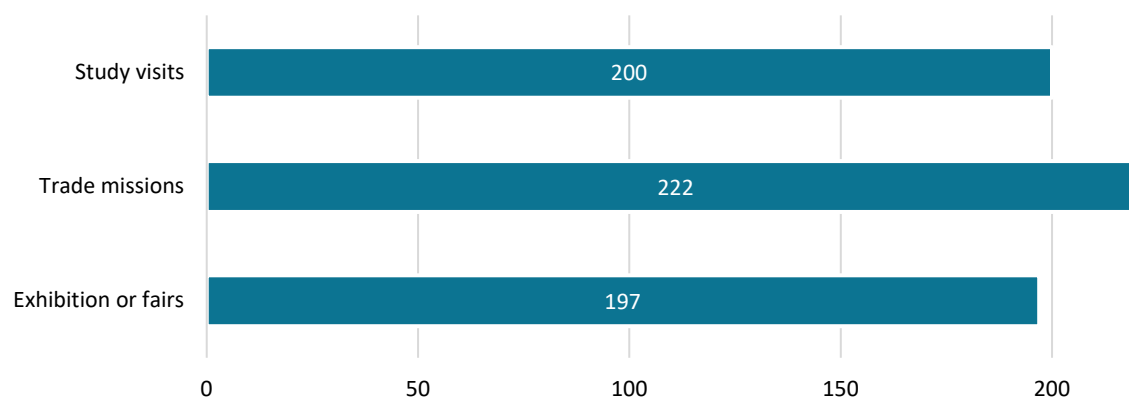
**Graph 41. Number of clusters with joint activities in the scope of promotion of cluster and its members**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Cluster coordinators actively worked to organize joint trips within country for study visits, trade missions and exhibitions or fairs. The total number of organized trips by all clusters studied was similar for each indicated type (approx. 200 – 220).

**Graph 42. Joint actions in the scope of promotion of cluster and its members**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

### Detailed information for sub-area

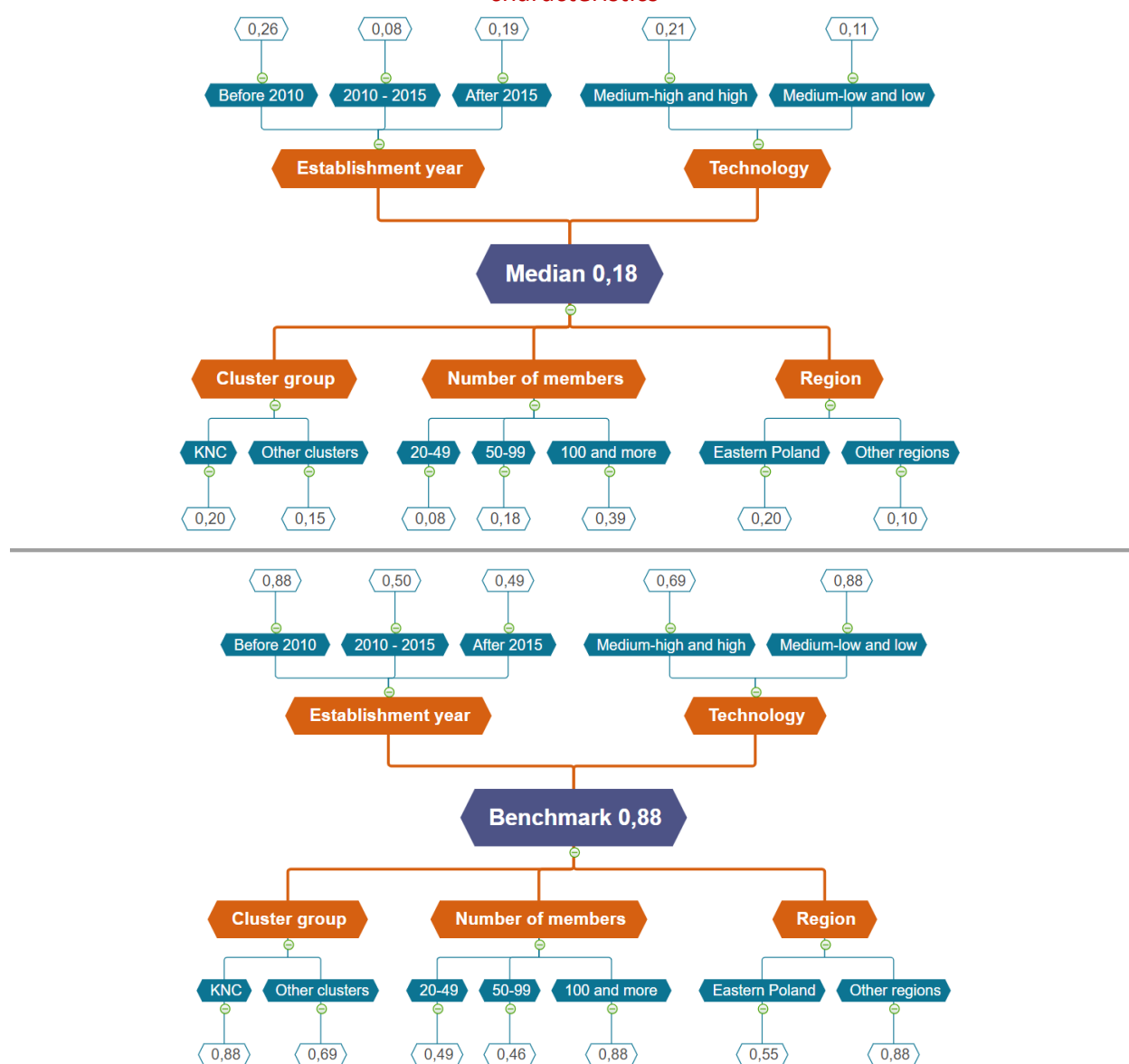
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- Cluster members have been fairly positive about the activity of coordinators in terms of marketing activities. The achievement of the targets indicated around 61% of the members surveyed. On the other hand, more than 24% of members indicated a negative assessment in this regard. This may be a cause for concern and, at the same time, it is an argument for internal evaluation of this aspect in the context of cluster member opinion surveys.
- The sub-field investigated the number of results of the phrase "cluster name" in popular search engines (Google, Bing, Yahoo). The average score for all clusters was approximately 5,000 appeals. For the best clusters, this was 18.0 and 17.6 thousand appeals, respectively. For three clusters only, the number of results did not exceed 1,000 appeals.
- Nearly three-quarter of clusters have become active in participating in exhibitions or fairs in the country. The average number of such activities in the period 2018-2019 examined was 5 (a record cluster declared the organisation of 45 such activities). The share of cluster members in these activities was relatively small. On average, 19% of members participated.

### 5.2.5. Innovation activity

In terms of innovation activity, there is a very high difference between the median (0.17) and the benchmark (0.88). This represents a significant variation in the population of the clusters studied in this sub-area. In terms of median, the KNC gained only a slight advantage (0.20) over the other clusters (0.15). It is quite understandable that medium-high and high-tech clusters in this area (0.21) have gained an advantage. It is interesting that clusters from the Eastern Region were more favourable in this Polish view. The benchmark has adopted a very high level, which means that among the clusters surveyed, a leader can be identified, i.e. a large cluster established before 2010, operating in the area of medium-low and low technologies, having the status of KNC and operating outside the area of Eastern Poland.

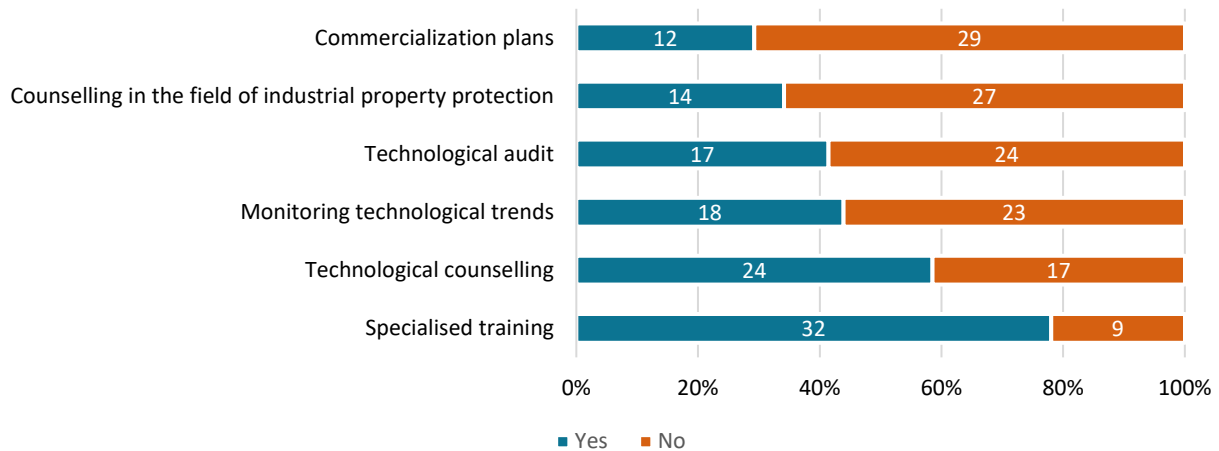
**Graph 43. Median and benchmark for sub-areas innovation activity taking into account cluster characteristics**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The clusters studied take a number of actions to provide access to pro-innovation services in the cluster. The way these services are offered can vary significantly between clusters. They can be provided directly by the cluster coordinator, by selected cluster members (e.g. business environment institutions) or can be outsourced to external entities. Specialist training services (32 clusters), technological advice (24) and monitoring and auditing of technological trends (18 and 17 clusters respectively) are most often offered.

**Graph 44. Access assured to the pro-innovative services in the cluster**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Between 2018 and 2019, the highest proportion of cluster members surveyed used such pro-innovation services provided in the cluster by or through the cluster, as specialised training (45%) and monitoring of technological trends (36%). In the future, 41% of respondents would benefit from technological advice.

**Graph 45. The use of pro-innovation services provided in a cluster or through a cluster**



Source: Research on cluster members (N=435).

The surveyed coordinators could also indicate other categories of pro-innovative services provided in the cluster. In the four clusters covered by the study, it is possible to additionally indicate:

- Consulting in the area of innovative business models.
- Transfer of knowledge and technology.
- Optimization of technology.
- Laboratory tests.
- Pre-incubation of products and services.
- Organization of joint events such as workshops, seminars, webinars.
- Selection of innovative ideas.
- Intellectual property management.

#### Detailed information for sub-area

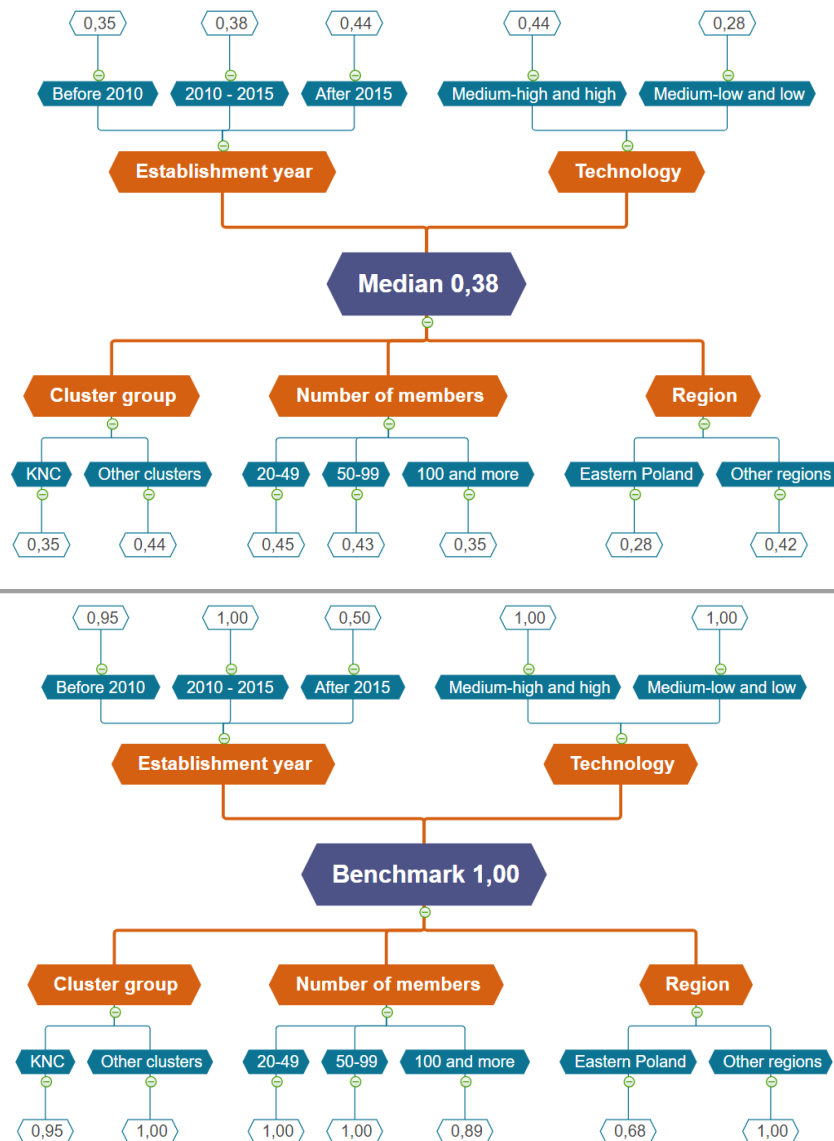
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- 12 clusters have pledged to set up an organisation to support technology transfer between cluster members in the period 2018-2019.
- 15 cluster coordinators initiated cooperation with an external entity on technology transfer during the period considered.
- Only 5 cluster coordinators were intermediaries in purchasing knowledge or technology (e.g. licences, know-how) for their members.
- 10 cluster coordinators offered their members a technological audit. The total number of audits carried out exceeded 200.

### 5.2.6. Cluster digitisation

Cluster digitization is a new sub-area in benchmarking. Only two indicators were used for the measurement, so the results are quite small in differentiation. In this criterion, you may notice the opposite of results than most other criteria. For example, young clusters without KNC status and with 20-49 members achieved the best results in terms of median. This may be due to the fact that young clusters have a greater dynamic and follow the trends in process digitisation in a more flexible and decisive way. However, the industry diversity of young clusters is very large (the m.in are high-tech, logistics, health, food and environmental). So it is difficult to point out the important regularities here. A benchmark of 1.00 recorded in two cross-sections of the analysis (including the area of technology and the number of members), means that there were at least two clusters that obtained the maximum scores in each of the examined criteria.

Graph 46. Median and benchmark for sub-areas cluster digitization taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).



Digitization of clusters for several years, at least partially, combined with the industry 4.0<sup>30</sup>. Industry 4.0 technology suppliers are to a large extent ICT companies *high tech* and entities in the R+D sector. They can become key partners in the scope of supply of Industry 4.0 solutions to other cluster members. In addition, clusters with a dominant group of entities in the ICT area can create an offer addressed to both individual enterprises and other clusters, especially those operating in the field of industrial processing. Clusters of this type can contribute to the sustainable stimulation of technological change, greater customer-to-manufacturer integration, the smooth use of Artificial Intelligence, the emergence of new business areas and new occupations on the labour market, and thus to the strengthening of innovation and regional, national and European economy<sup>31</sup>.

Almost a quarter of cluster members used Industry 4.0 technology solutions. These include m.in. Internet of Things, Big Data, Intelligent Industrial Robots, Data Cloud, Simulations, 3D Printing, Automated, Robotic and Digitized Production Systems.

Graph 47. Participation in a cluster and the use of technological solutions of Industry 4.0



Source: Research on cluster members (N=435).

#### Detailed information for sub-area

- The leaders of the cluster digitization (m.in. through the use of ERP, CRM, MRP, DMS, SCM, WMS, RCP, DMS, BI management systems) were IT clusters. In their case, the penetration rate of these systems among the members was almost 100% with an average for all clusters of around 47%.
- The same was the case with regard to the application of Industry 4.0 solutions. It was even if it was not *very* common with industrial processing. Nevertheless, this criterion assessed the penetration of solutions/technologies such as the Internet of Things, 3D printing, artificial intelligence, the data cloud or big data.

<sup>30</sup>Clusters 4.0: Shaping Smart Industries, European Cluster Conference 2016; Jankowska B., Goetz M., Clusters and Industry 4.0, <sup>43rd</sup> EIBA Annual Conference, Milan 2017.

<sup>31</sup>Bembenek B., Industrial Clusters 4.0 in a sustainable knowledge-based economy, Scientific Work of the University of Wrocław, Wrocław 2017.

## Summary of the area

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- Within the cluster resources area, management processes, cluster communication, market, marketing and innovation activity, and cluster digitization were analysed. The last area was new to the 2018 benchmarking edition.
- The relatively high median values for sub-areas indicate the relatively good situation of clusters in this area (this is particularly true for management processes). On the other hand, the high benchmark values for management processes, cluster digitisation and innovation activity also show that there are clusters in these areas that have achieved maximum or almost maximum scores within individual sub-indicators. The best clusters in this area have gained a significant advantage over the others.
- Taking into account the views of cluster members, areas such as supply chain formation, joint actions to improve the quality of products and services/reduce operating costs and impact on public authorities and other institutions have been relatively poorly assessed.
- In the survey of the opinions of cluster members, there is a significant polarization of opinion. Nearly 50% of members consider the benefits of cluster membership to be large. At the same time, almost 10% do not see any benefit of being in the cluster, and another 40% consider them small.
- 8% of cluster members think they get more from cluster membership in relation to the contribution paid. A further 60% of members believe that the benefits of membership are adequate to the contribution paid. Approximately 15% of members believe that the benefits are less than expected, taking into account the level of contributions. It is worth noting that 17% of members are not obliged to pay membership fees at all.
- Large clusters with KNC status and operating for at least 10 years gained some advantage. The exception is the sub-area of cluster digitisation, where young and relatively small clusters dominated, without KNC status.

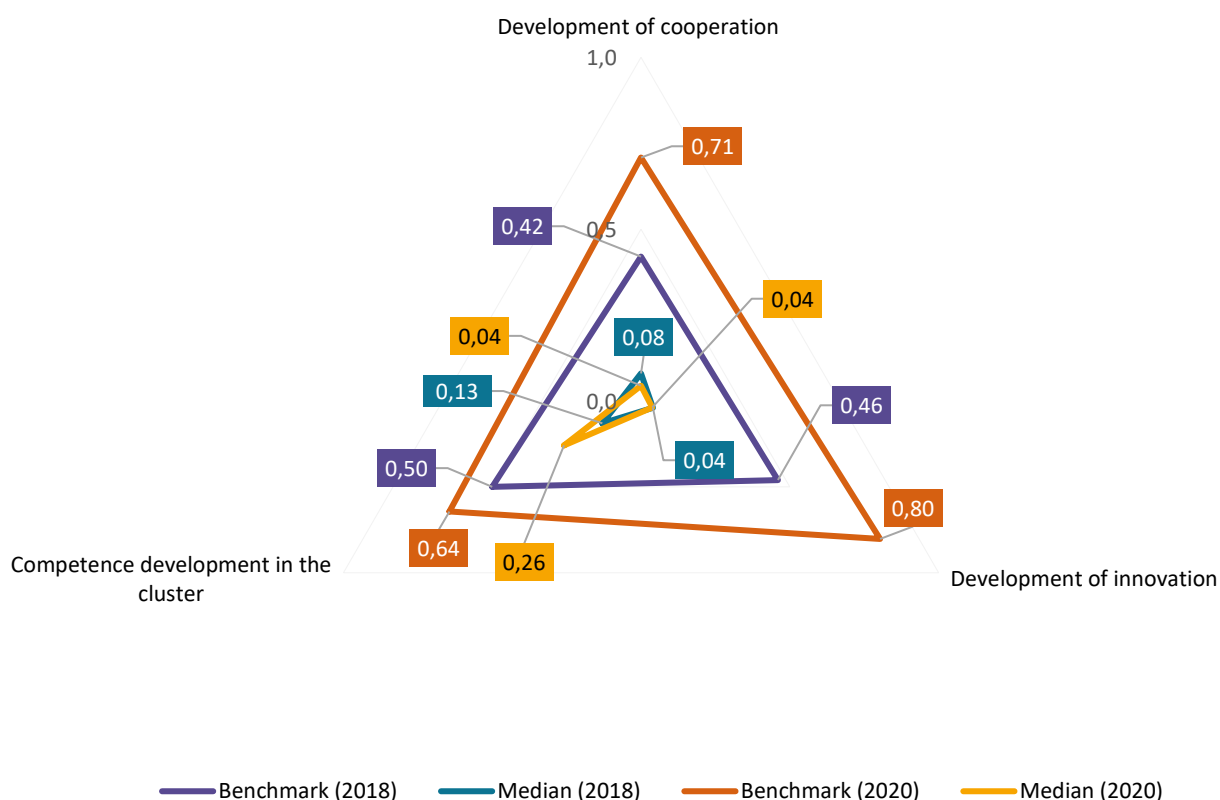
### 5.3. Cluster results

Another area examined "Cluster results" focused on assessing cluster developments in 2018-2019 in sub-areas such as:

- **Development of cooperation** in the cluster – incubation of new business activities (start-ups, spin-offs/ spin-outs and special purpose vehicles), joint implementation of projects, building a common market offer, acquisition of new co-operators (acquisition of joint procurement), strengthening of public-private partnerships.
- **Development of innovation** – joint R&D&I activities, knowledge transfers in clusters, protection of industrial property.
- **Development of competences in the cluster** – keeping records of resources and competences held by the members of the cluster, developing the professional competence of the members and the coordinator of the cluster.

In terms of cluster results, the results of the current benchmarking edition in terms of median and benchmark are more favourable than the 2018 edition. Nevertheless, the situation of clusters in the area of innovation development and cooperation development should be assessed quite poorly. The median value reached 0.04 in both criteria, which means that in the study grouping approx. half of the clusters showed minimal activity in this area.

**Graph 48. Subsynthetic indicators values in the area of cluster results for 2018 and 2020 benchmarking edition**

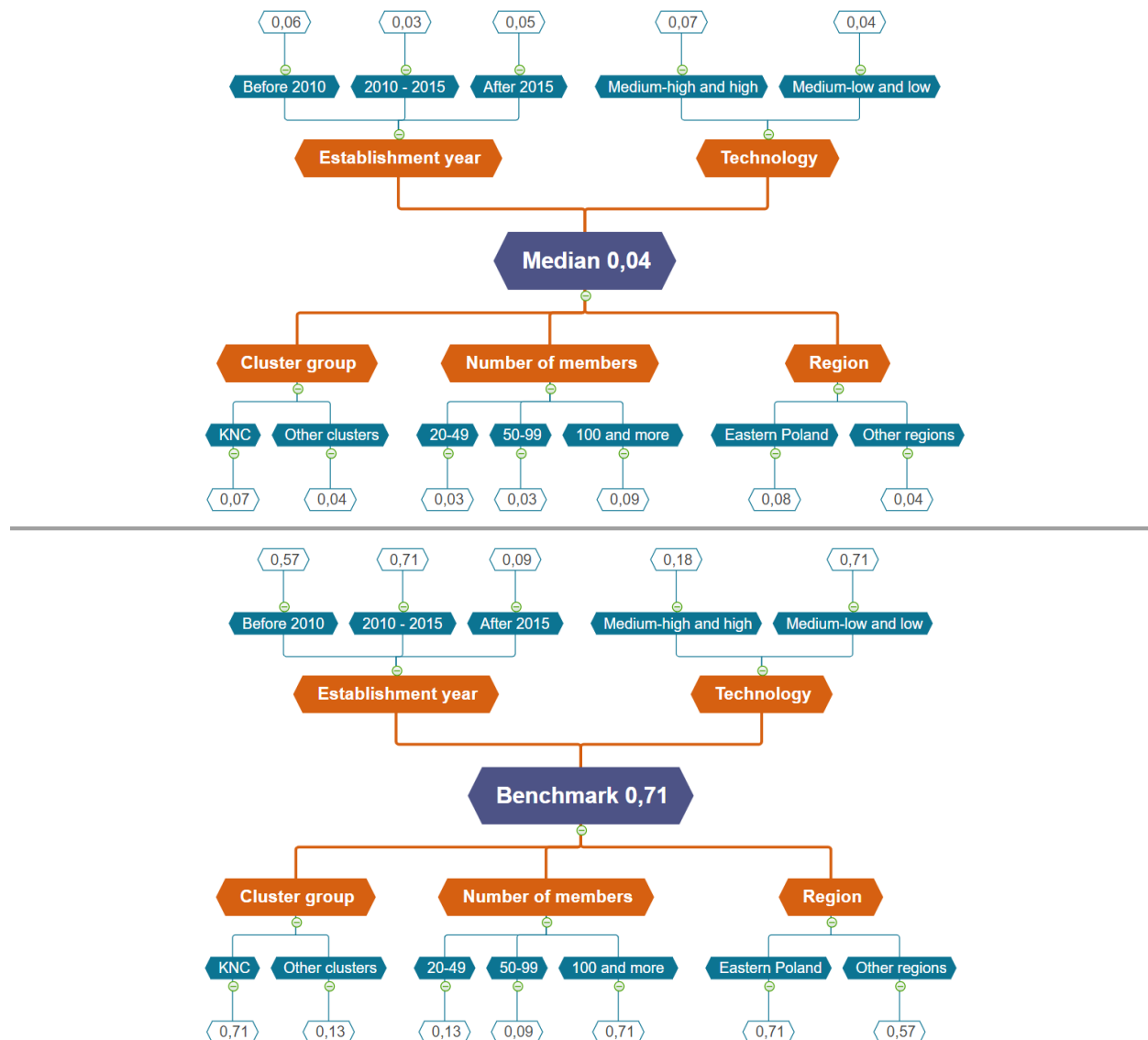


Source: Authors' analysis based on the cluster coordinator survey (N=41).

### 5.3.1. Development of cooperation in the cluster

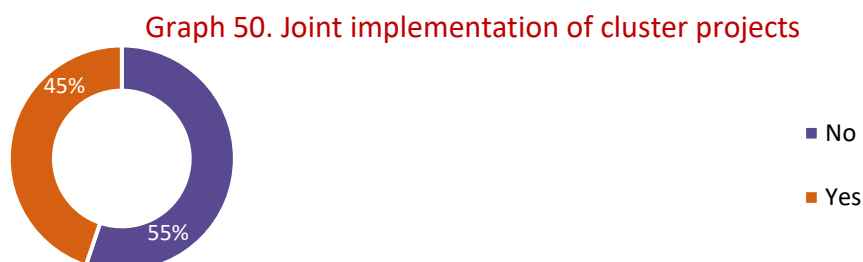
The median value for the development of cooperation in the cluster has reached a very low level relative to the benchmark value. This means that a fairly large group of clusters showed negli little activity in the sub-examined sub-cluster for the top few clusters. In this case, the year of the cluster's creation was of no particular importance. Cluster status was moderate (KNC had a slight advantage, median at 0.07 over the other 0.04 clusters). The number of members played the most important role. In large clusters, the median was 0.09, while in the smallest clusters it was three times lower. The benchmark value illustrates the situation where a large cluster founded in the period 2010-2015, operating in the area of medium-low/low technology, having KNC status and operating in Eastern Poland, was the best rated.

Graph 49. Median and benchmark for sub-areas development of cooperation in the cluster taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

One manifestation of the development of cooperation in the cluster is joint implementation of cluster projects (with the participation of a coordinator and at least 2 members or with the participation of at least 3 members of the cluster without a coordinator). 45% of cluster members surveyed declared this activity and 55% of respondents did not participate. The understanding of the projects is broad in this case. It can be both projects co-financed by the EU, and others.



Source: Research on cluster members (N=435).

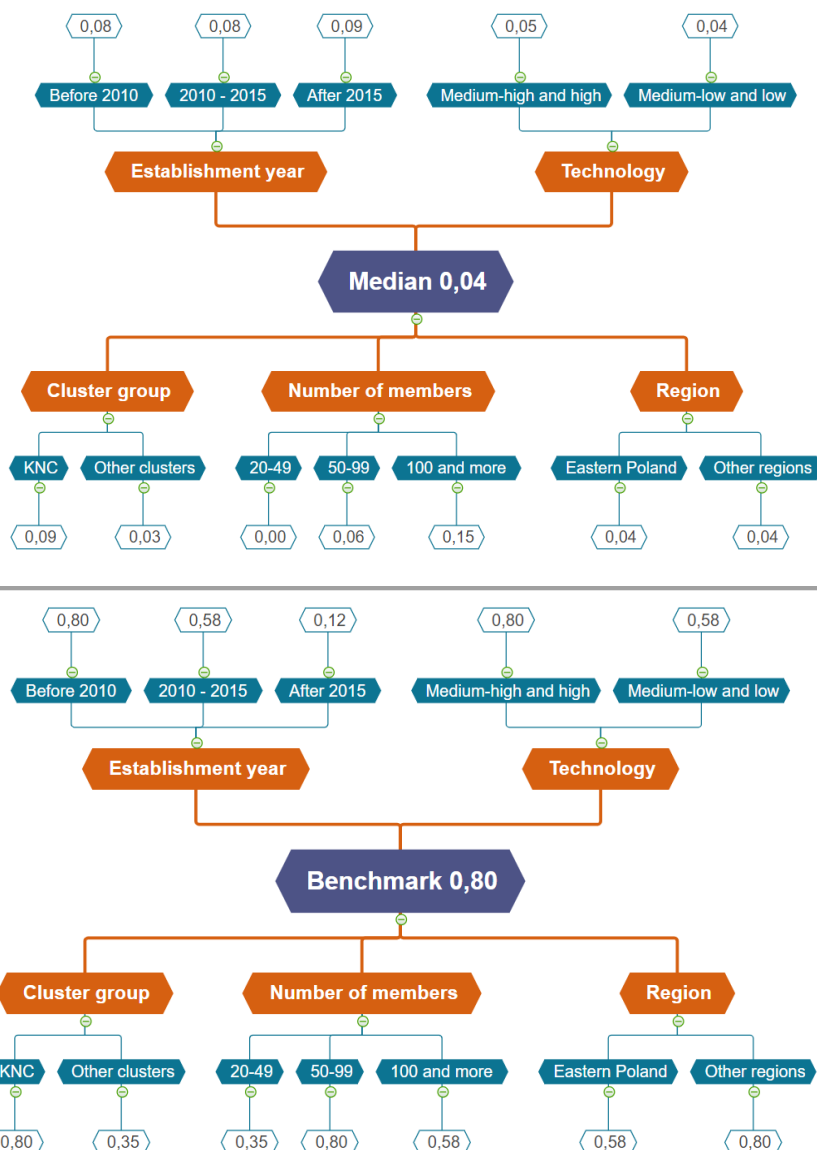
#### Detailed information for sub-area

- As part of cluster activity in this sub-area, 12 of them contributed to the creation of startup/spin-off/spin-out enterprises and special purpose vehicles. The total number of entities appointed was 37 in the period 2018-2019.
- In the case of 10 clusters, we can talk about cooperation start-ups of technological nature of large companies (total 41).
- For 19 clusters, we can talk about jointly implemented projects in a cluster co-financed by the EU. Research and innovation projects (17 clusters each) were equally concerned, with less implementation (10 clusters). On average, in these projects participated around 24% of cluster members.
- Huge differences can be observed in the value of joint projects. For 17 clusters, the total value of the projects was less than PLN 10 million. For the next 7 clusters it was between PLN 10 million and PLN 100 million. For one cluster, the total value of the projects amounted to more than PLN 200 million. The record holder declared the value of jointly implemented projects in the amount of PLN 1.4 billion. Apart from the last (extreme) amount, the average project value per cluster was approximately 20 million PLN.
- Almost half of the clusters were involved in creating a common offer. As a result, more than 100 products and services were introduced by cluster members. The joint production/implementation of joint services was involved on average around 10% of cluster members.
- 6 clusters showed success in obtaining joint execution contracts by the coordinator or cluster members. Their value varied greatly. For 3 clusters it did not exceed PLN 1 million, for the next two it was PLN 3 and PLN 15 million respectively. One of the clusters declared the acquisition of contracts for joint execution at the level of PLN 500 million.
- Only 4 clusters declared undertaking initiatives in the field of public-private partnerships in the total number of 6. Their value amounted to approx. PLN 6.5 million. The total value for 4 of these initiatives was approx. PLN 6.5 million (for the remaining two, the value was not given).

### 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 0.04. This means that at least half of the clusters surveyed showed negligible results in this area against a background of several/a dozen top organisations. For this criterion, the year of establishment of the cluster, the location and the level of technology used had virtually no significance. Clusters with KNC status (median 0.09) and clusters of at least 100 members (0.15) performed better. The best cluster reached the benchmark of 0.80, which means that in almost all criteria it achieved maximum values. It was a cluster founded before 2010, operating in the area of medium-high and high technology, having the status of the KNC and with 50-99 members and operating outside Eastern Poland.

Graph 51. Median and benchmark for sub-areas development of innovation taking into account cluster characteristics

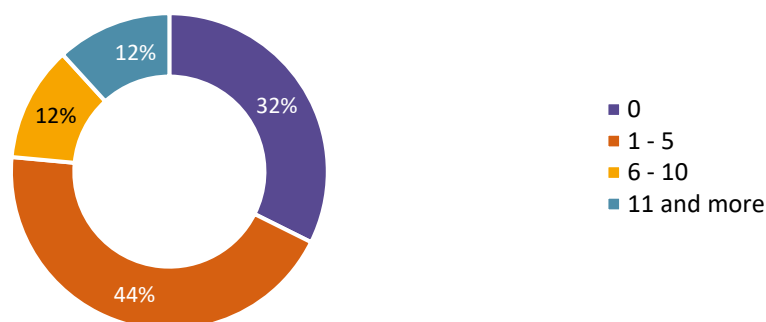


Source: Authors' analysis based on the cluster coordinator survey (N=41).

Clusters have been seen for many years as an important element of innovation systems and innovation stimulators. Such a role was already perceived and described in detail in the publication of OECD of 1999<sup>32</sup>. By the European Commission the clusters are perceived as a significant actor for raising innovativeness and competitiveness of regional economies<sup>33</sup>. This was reflected in Message from the Commission of 22.1.2014<sup>34</sup>, in which it is emphasised that a potential of clusters favourable for the innovation should be used better as the manner to support the development of innovativeness of enterprises. In numerous European Commission presentations, the main axes of European cluster policy are cited, the first of which treats clusters as accelerators of innovation and industrial change. An example of an initiative supported by the European Union to strengthen clusters in this area is the CLUSTERIX2.0<sup>35</sup>. The European Commission also notes the legitimacy of integrating clusters as participants in Digital Innovation Hubs by providing innovative services and trainings<sup>36</sup>. The project examined ways to make better use of clusters in the region for innovative regional development. On a national level, it is worth looking at the provisions in the document of the Ministry of Development, under the title: “Directions of development of cluster policy in Poland after 2020”, according to which in the coming years clusters should play an important role as innovation centres, supporting their members, especially enterprises in the implementation of innovation.

One of the key indicators on coordinators' activity in this area was the number of jointly implemented innovation and R&D projects in the cluster. A third of the clusters surveyed did not show any activity in this area. The 23 clusters were carried out R & D projects and innovative Their total number was 131 (on average 5.6 projects per clusters that implemented this type of initiatives). On average, 15% of cluster members participated in such projects. This can be considered a very favourable situation.

Graph 52. Number of implemented innovative and R&D projects in the cluster



Source: Authors' analysis based on the cluster coordinator survey (N=41).

<sup>32</sup>Boosting Innovation. The Cluster Approach, OECD, 1999.

<sup>33</sup>[https://www.interregeurope.eu/policylearning/news/8772/clusters-an-established-innovation-policy-for-regional-specialisation/?no\\_cache=1&cHash=1a12a0c21c7cb61ff2ddd8620d908dca](https://www.interregeurope.eu/policylearning/news/8772/clusters-an-established-innovation-policy-for-regional-specialisation/?no_cache=1&cHash=1a12a0c21c7cb61ff2ddd8620d908dca).

<sup>34</sup>Efforts to re-rebirth European industry, Brussels 2014.

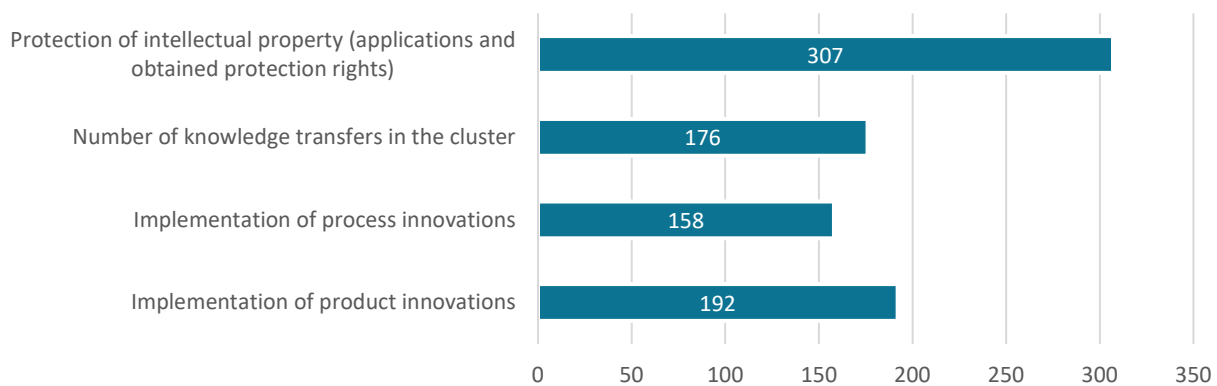
<sup>35</sup><https://www.interregeurope.eu/clusterix2/>.

<sup>36</sup>European Digital Innovation Hubs in Digital Europe Programme, European Commission, Brussels 2020.

The immediate effect of innovative and R&D projects in the cluster is the implementation of innovation, knowledge transfers and intellectual property activity. 16 clusters (39%) implemented product innovations, and a small number, i.e. 14 (34%) process innovation. The total number of declared product and process innovations implemented in the clusters tested is 350. Nearly half of the clusters involved knowledge transfer (e.g. between higher education and science actors and businesses). The total number of such initiatives was close to 180.

An important manifestation of the development of innovation is the 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 companies with the participation of the cluster was examined. 15 clusters (37% of respondents) declared this activity. The total number of protection rights notified/obtained was 307. The three clusters clearly distanced the others, declaring 61, 55 and 40 declared/obtained conservation rights respectively.

**Graph 53. Results of innovative and R&D project**



Source: Authors' analysis based on the cluster coordinator survey (N=41).



It is worth mentioning that within this sub-field half of the cluster members surveyed (50%) positively assessed the impact of participation in the cluster on the level of technological advancement of their companies. This illustrates an important aspect of cluster activity in popularising technological solutions among its members.

**Graph 54. Impact of cluster participation on technological sophistication**



Source: Research on cluster members (N=435).

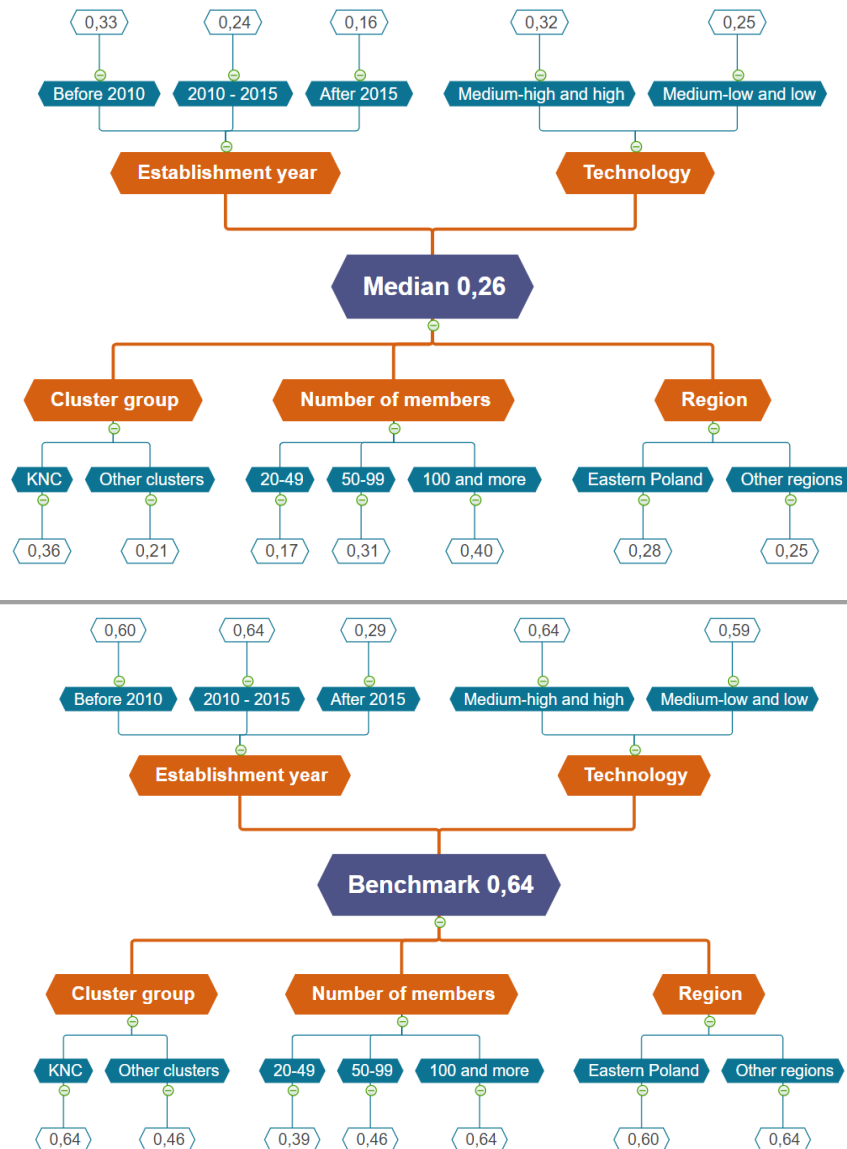
#### Detailed information for sub-area

- The value of these projects ranged from several hundred thousand PLN to several hundred million PLN. For 3 clusters, the value of the projects exceeded PLN 100 million. For subsequent 6 clusters the value was between PLN 10 million and PLN 100 million.

### 5.3.3. Competence development in the cluster

In the case of competence development in the cluster, the median reached a fairly high level of 0.26, which means that most clusters have taken any activity in this area. Clusters over 10 years (median 0.33), with KNC status (0.36) and at least 100 members (0.40) achieved the advantage. Cluster localization or technology was less important for the high rating of this area (only a slight advantage of clusters with a leading medium-high and high-tech area). The benchmark at a moderate level of 0.64 means that there was not a single cluster that stood out from the rest. The best grades were obtained by a large cluster (over 100 members) with the KNC status, established in 2010-2015, operating in the area of medium-high and high technology and located outside Eastern Poland.

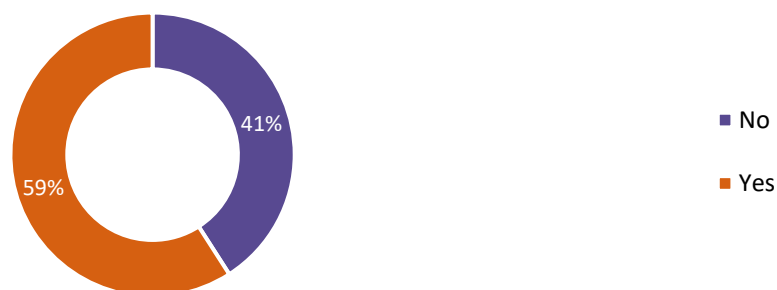
Graph 55. Median and benchmark for sub-areas competence development in the cluster taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The survey of cluster members shows that more than 59% of them participated in cluster-initiated common forms of competence improvement.

**Graph 56. Percentage of cluster entities participating in cluster-initiated common forms of competence improvement**



Source: Research on cluster members (N=435).

The most common form of competence improvement in clusters was training, workshops, courses, conferences and seminars. More than 85% of clusters used these forms. The rarest initiative was postgraduate studies (only 17% of clusters).

#### Detailed information for sub-area

- Nearly a third of clusters did not keep records of resources. A similar number, in turn, kept such records, but updated this information very rarely or not at all.
- The value of funds allocated to improving the competences of members in 2018-2019 ranged between several thousand zlotys and 1 million PLN. On average, this was PLN 114,000 for clusters that incurred any expenditure in this area.
- Training and workshops aimed at improving the competences of cluster members were carried out within 34 clusters studied. In total, more than 440 such initiatives were organised by both the cluster coordinator and other actors within the cluster. Such initiatives have been quite popular. On average, 35% of cluster members participated in individual events.
- More than 300 training & seminars aimed at improving the competences of its members were also organised as part of the cluster's activities. Interest in their case was even greater, with around 40% of cluster members participating in the event.
- About half of the clusters declared that they would carry out actions to improve the competences of the coordinator's staff. The average value of expenditure in this area was relatively small (approx. PLN 5,000 per cluster). A total of 68 of employees were trained.

## Summary of the area

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- Within the cluster results area, the development of collaboration, innovation and competencies in the cluster was analysed. The very low median values for the development of cooperation and innovation mean that around half of the clusters performed very poorly compared to the others. For these areas, it is also possible to identify leaders who have clearly distanced most clusters. These were clusters from the area of aviation, construction and chemical industry.
- In the case of the development of cooperation, the characteristics of the clusters did not have as much impact on the results obtained. In the remaining sub-areas, large clusters with KNC status and operating for at least 10 years stood out. High scores in this criterion were obtained, among others, by clusters from the area of industrial processing and ICT.
- Cluster coordinators remain very active in taking action to improve competences in the cluster (e.g. training, workshops). The subject of training was very varied. It is worth noting that in most clusters the trainings conducted were specialized and industry-specific. Interesting topics of training, in line with the current industrial and technological trends, include: industry 4.0, 3d printing, smart city, virtual reality or blockchain. A number of clusters also organized training, the subject of which is related to the improvement of environmental protection (e.g. implementation of renewable energy solutions, energy efficiency, waste reduction).

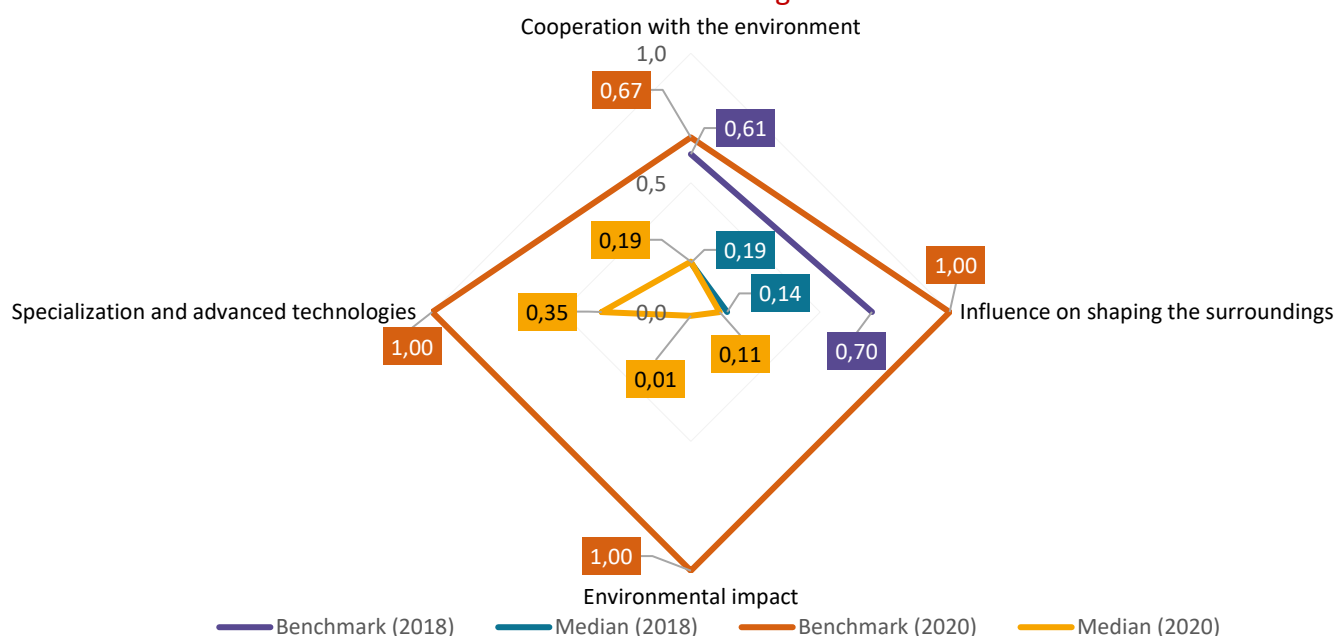
## 5.4. Impact on the environment

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

- **Cooperation with the environment** - cluster cooperation with external actors such as public authorities, with business environment institutions and with the R&D and education sectors.
- **Influence on shaping the surroundings** – participation in consultation bodies at national and regional level.
- **Environmental impact** – number of measures taken to improve the natural environment.
- **Specialization and advanced technologies**– interest of the enterprises conducting business activity dominating for the cluster of the National Intelligent Specialization and Regional Intelligent Specialization, industrial in the scope of medium-high technologies or service activity in knowledge-absorptive services <sup>37</sup> and with the use of technologies conditioning future development of EU.

In the area of environmental impact, only two sub-areas covered the 2018 study (cooperation with the environment and influence on shaping the surroundings). In both areas, the current edition has slightly better benchmark values and similar median values. In the current edition of the study, the new sub-area of specialization and advanced technologies (0.35) was rated highest in terms of median. The second new sub-area is environmental impact. The median in this case was very low (0.01).

**Graph 57. Subsynthetic indicators values in the area of impact on the environment for 2018 and 2020 benchmarking edition**



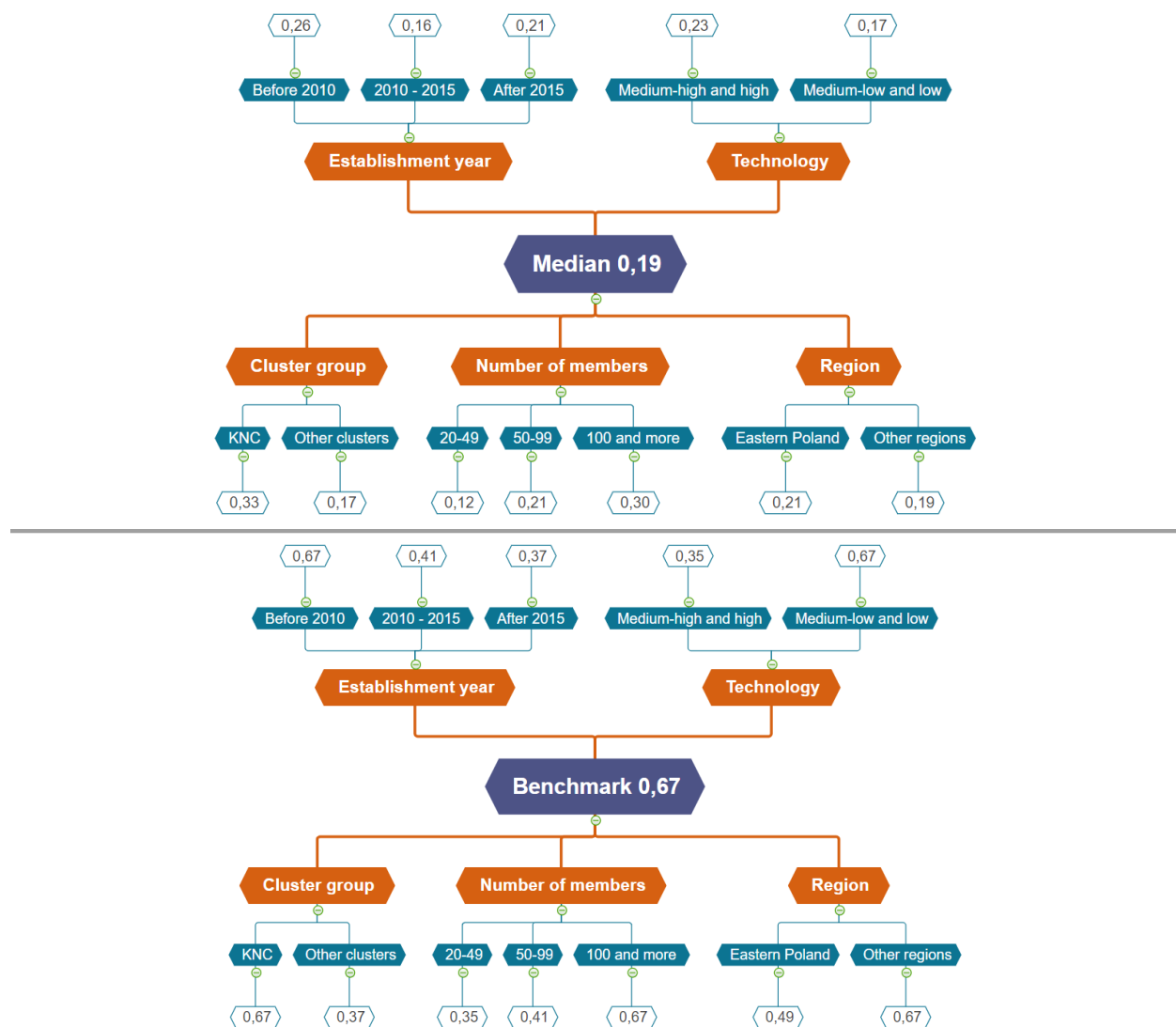
Source: Authors' analysis based on the cluster coordinator survey (N=41).

<sup>37</sup>In order to make further analysis and graphs more readable whenever the report mentions high and medium-high technologies, knowledge-intensive services are also understood.

### 5.4.1. Cooperation with the environment

For the area of cooperation with the environment, the median adopted a moderate level of 0.19. Moderate differences were observed between clusters taking into account such criteria as technology level and cluster activity region<sup>38</sup>. Clusters with KNC status (median 0.33) and more than 100 members (0.30) achieved significantly better values. The benchmark of 0.67 indicates that there was not a single cluster in this criterion that clearly dominated the others. The best-rated cluster was established before 2010, had the status of KNC, was located outside Eastern Poland and had more than 100 members (mostly operating in the medium-low and low-tech areas).

Graph 58. Median and benchmark for sub-areas cooperation with the environment taking into account cluster characteristics



Source: Authors' analysis based on the cluster coordinator survey (N=41).

<sup>38</sup>A state in which the critical mass of the cluster is concentrated (the location of the predominant number of members).

### Detailed information for sub-area

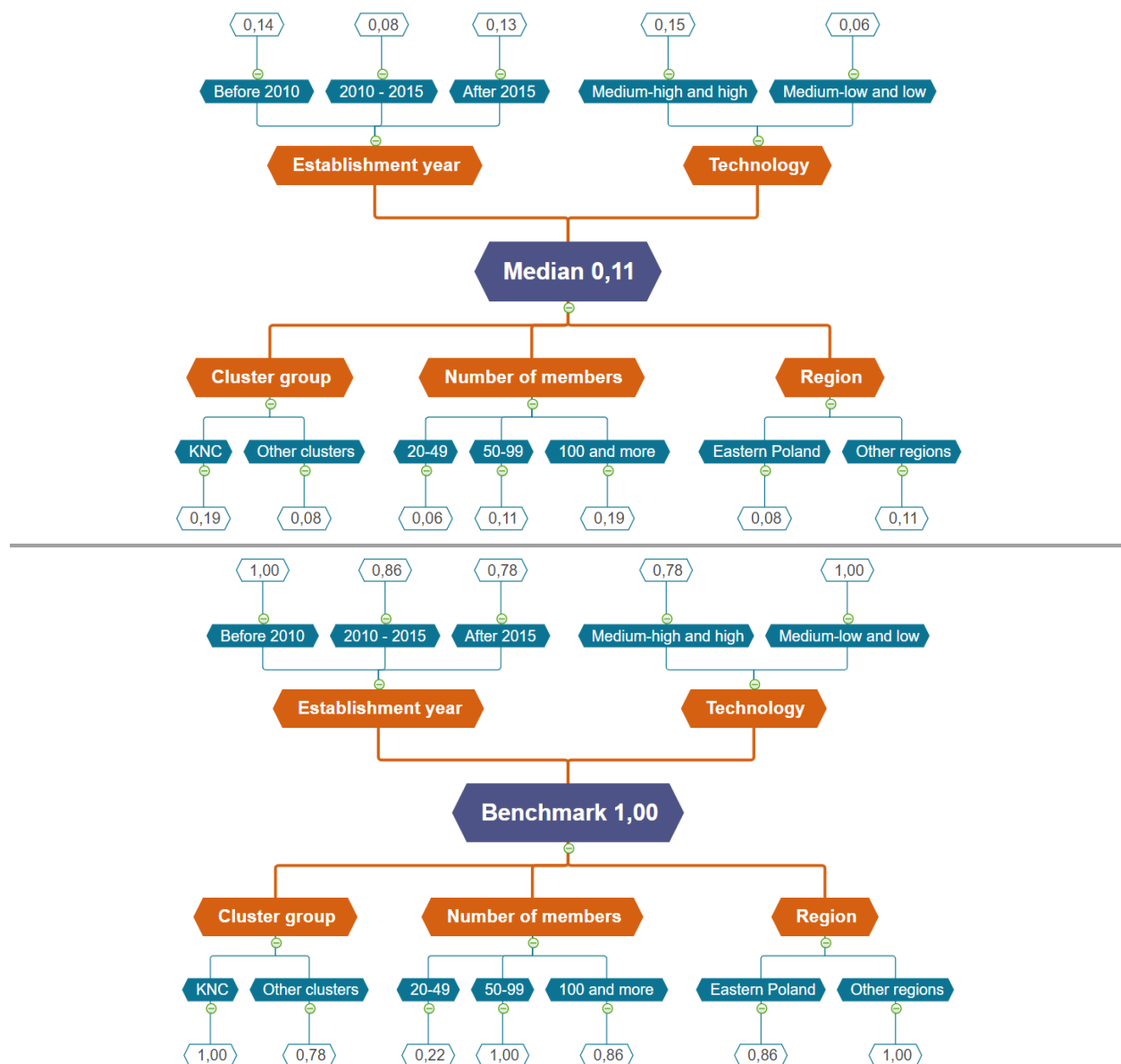
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- One of the elements assessed within this sub-field was the number of contracts signed with different categories of entities and organisations. In this area, 16 clusters had signed agreements with public authorities (a total of 46 contracts, not including support contracts). In turn, 24 clusters had agreements with institutions of the business environment (total number of signed agreements with this group of entities amounted to 47).
- Clusters also entered into partnerships with educational institutions (73 contracts signed in total), other national clusters (27) and foreign clusters (104).
- Another criterion assessed was support received from public authorities. The support from these entities was mostly financial (15 clusters with support) and promotional (also 15). To a lesser extent, it included educational (8) and organisational support (5). The value of the support provided on a scale of all clusters in the above areas amounted to around PLN 5 million, with an average of PLN 167,5 thous. (clusters that received this type of support). The list was dominated by two clusters, for which support exceeded PLN 1 million.
- Cooperation with the R&D sector was both individual (32 clusters declared cooperation with the selected researcher) and institutional (31 clusters jointly carried out R&D projects with scientific units).
- Clusters were involved in the creation and implementation of education courses related to area of activity. A total of 12 courses at professional level, 15 medium and 18 higher levels were declared. There were 16 postgraduate courses also launched.
- The number of completed internships and traineeships with the help of the cluster coordinator exceeded 1400.
- Clusters saw a need to work with researchers as part of their work. As a result, there were 33 implementation doctorates developed in cooperation between clusters and young science workers in the period 2018-2019.

### 5.4.1. Influence on shaping the surroundings

The median influence on shaping the surroundings for the sub-field was 0.11. In this case, the year of the cluster's creation and its location were of little importance. Medium-high and high-tech clusters (median 0.15), KNC (0.19) and at least 100 members (0.19) gained the upper hand. A benchmark of 1.00 means that there was at least one cluster in the list that received maximum ratings in each sub-index. It is a KNC-status cluster, founded before 2010 with 50-99 members, operating in the area of medium-low and low technologies and located outside Eastern Poland. Given the benchmark values, the small cluster category of 20-49 members performed quite poorly. The best cluster in this group achieved a benchmark of 0.22.

Graph 59. Median and benchmark for the sub-area influence on shaping the surroundings taking into account characteristics of clusters



Source: Authors' analysis based on the cluster coordinator survey (N=41).



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**Detailed information for sub-area**

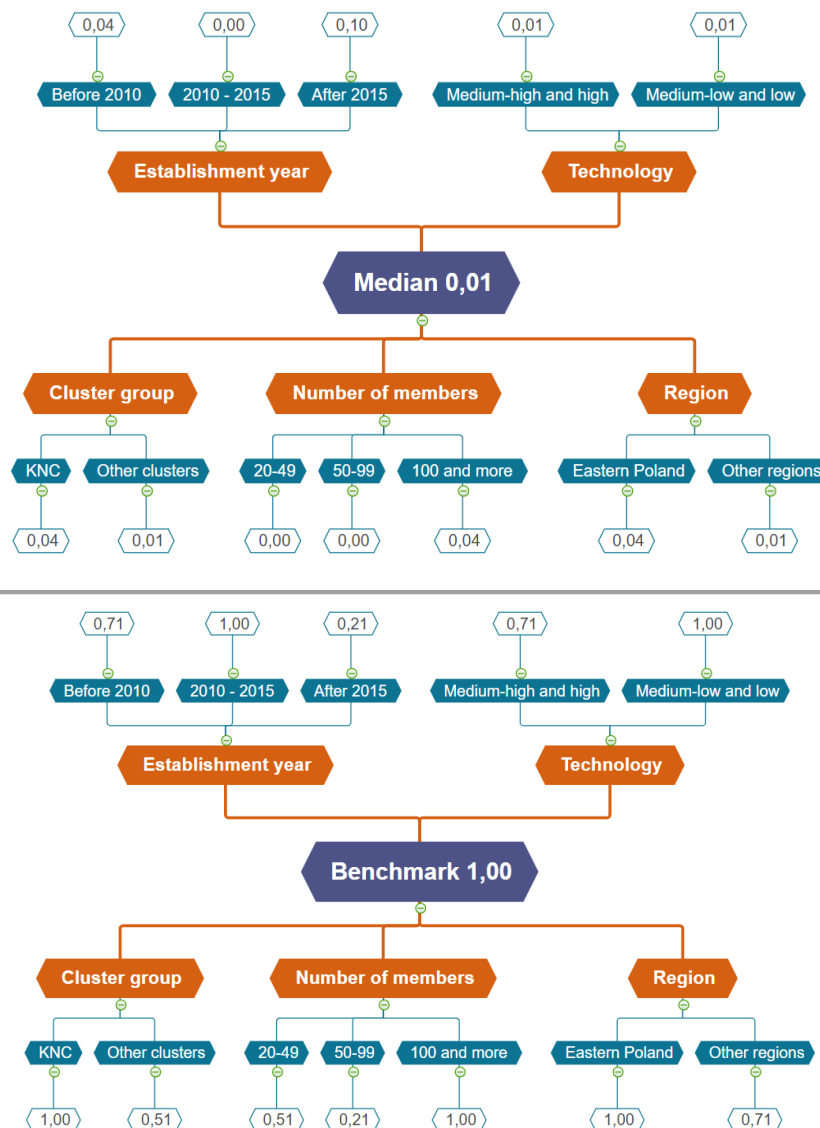
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- The sub-areas used three indicators to measure the impact of clusters on the regional and national environment. The first was participation in national consultation bodies with representatives of the cluster. A total of 72 different national bodies have declared their participation in 21 clusters. The next indicator was similar, only for the regional level. 28 clusters and a total of 78 committees declared their activity in this area. This confirms the important role of clusters in shaping the socio-economic environment.
- The third indicator focused on the number of initiatives aimed at improving the external conditions of business. The clusters have engaged in around 150 initiatives to influence the business conditions of their members.

### 5.4.2. Environmental impact

In the area of environmental impact, the median value has reached a level close to zero. This means that at least half of the clusters surveyed did not show more activity in this area. Interestingly, clusters created after 2015 performed best in terms of this criterion (median 0.10). However, it is difficult to find any regularity in this area, as this group is represented by a relatively small group of clusters with quite different specializations (m.in. logistics, material technologies, food, environmental protection). The best result in this sub-area was achieved by a KNC-status cluster of more than 100 members, operating in the Polish East, operating in the area of medium-low and low technologies and established between 2010 and 2015 (benchmark at 1.00).

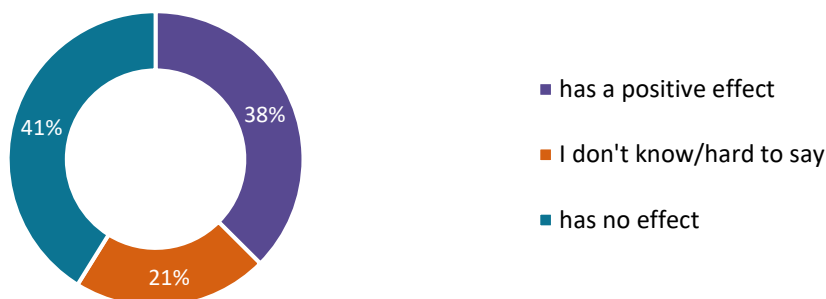
Graph 60. Median and benchmark for the sub-area environmental impact taking into account characteristics of clusters



Source: Authors' analysis based on the cluster coordinator survey (N=41).

One of the questions addressed to cluster members concerned the assessment of the impact of participation in the cluster on taking action to improve the natural environment. For 38% of cluster members surveyed, participation in the cluster had a positive impact in this area.

**Graph 61. Assessment of the impact of participation in the cluster on the undertaking's action to improve the natural environment**



Source: Research on cluster members (N=435).

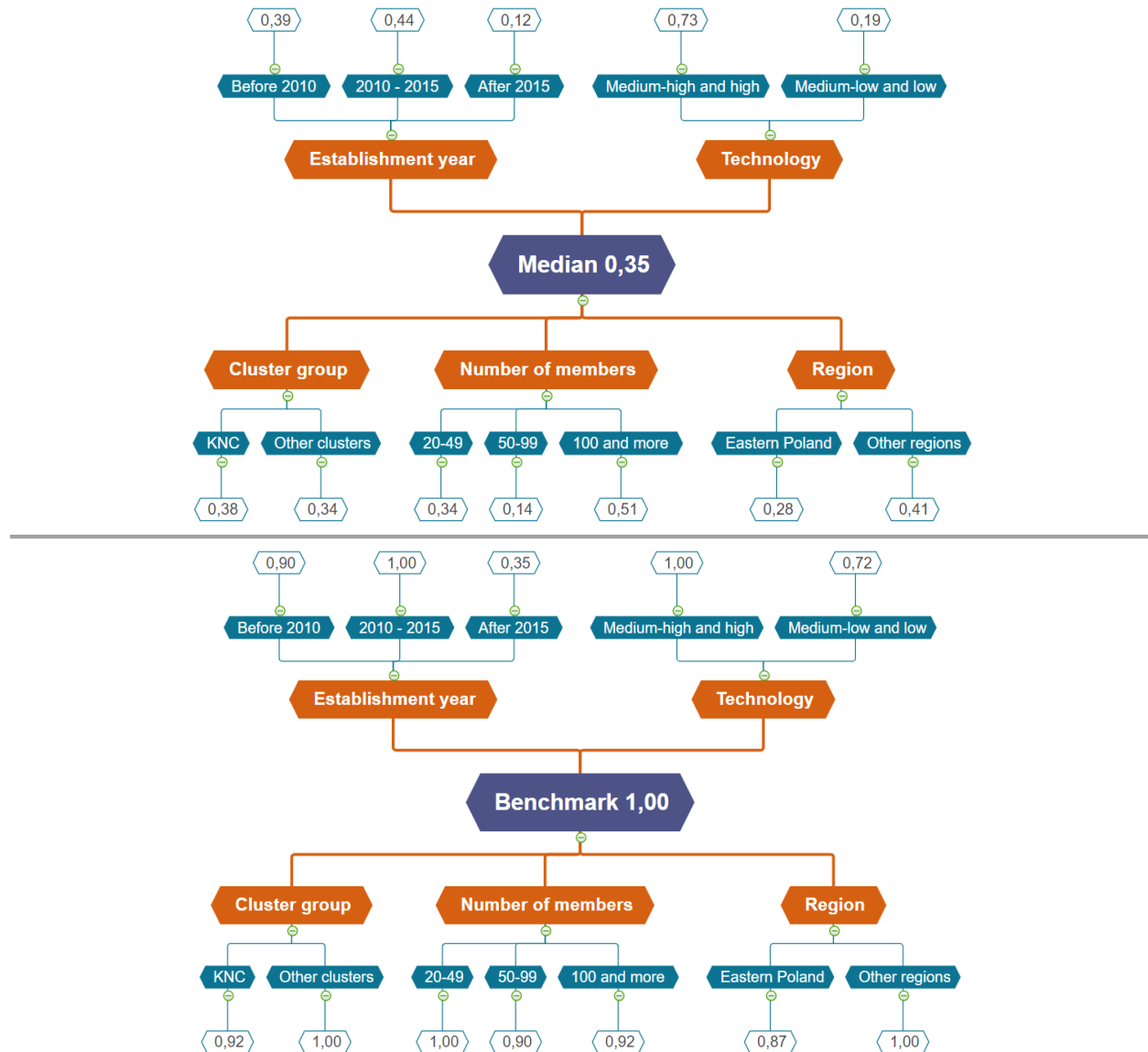
#### Detailed information for sub-area

- 16 clusters have not declared any activity for activities aimed at improving the natural environment.
- Among the remaining clusters, eco-innovation activities (a total of 116 actions carried out by 16 clusters) and circular economy cooperation (112 actions, 15 clusters) were the most frequently implemented. Renewable energy (26) and alternative ways of obtaining and exploiting raw materials were much less frequently undertaken (22).
- Only 9 clusters declared their activity in terms of cooperation for the production of organic food. One of these clusters declared 5 actions in this area. For the remaining clusters, these were individual initiatives.
- 15 clusters pledged to support circular economy cooperation. It is worth highlighting the significant number of projects carried out in this area (112 in total). Four clusters have declared the implementation of at least 10 cooperation projects in this area.

### 5.4.3. Specialization and advanced technologies

The median specialization and advanced technologies for the sub-area was 0.35, which confirms the fairly even involvement of clusters. In this area, the KNC status (median 0.38) over the other clusters (0.34) did not represent an advantage. Medium-high and high-tech clusters (0.73) fared much better than the others (0.19). The benchmark at 1.00 indicates a where at least one cluster has received maximum ratings within each sub-area. There was also a group of clusters that also received very high ratings (benchmarks within different cluster groups of 0.92, 0.90, 0.87 , and 0.72). The best grades were obtained by a small cluster (20-49 members), without the KNC status, established in 2010-2015, operating in the area of medium-high and high technology and located outside Eastern Poland.

**Graph 62. Median and benchmark for the sub-area specialization and advanced technologies taking into account characteristics of clusters**



Source: Authors’ analysis based on the cluster coordinator survey (N=41).

### Detailed information for sub-area

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- Within the sub-area, specialisation and technological advancement assessed the proportion of enterprises that were members of clusters that met the criteria for national and regional smart specialisations operating in the field of high or medium-high technologies or service activities of a knowledge-intensive nature. In addition, an analysis of the proportion of cluster companies doing business using technologies that determine the future economic development of the EU (KETs: nanotechnology, micro- and nanoelectronics, photonics, biotechnology, advanced materials, artificial intelligence and security and connectivity) is analysed.
- The clusters surveyed declared membership of one or more National Smart Specialisations (NSS). The analysis was based on the list of 14 NSS in force for the period from 1 January to 31 December 2020. Taking into account the division, the largest number of clusters identified Automation and robotics of technological processes (10) and Intelligent networks and information and communication and geoinformation technologies (9).
- It is worth noting that, under this criterion, clusters representing different sectors have received high ratings. These were clusters from the ICT, aviation, automotive and health and medical sectors.
- Around 52% of the companies operating in the clusters surveyed were part of one of the national smart specialisations specific to the cluster's activities. At the level of regional smart specialisations, this was in turn around 55% of companies.
- About 39% of companies operated in the area of medium-high or high technology.
- The percentage of cluster members operating in the KETs area was approx. 36%. For two clusters, their activity profile is directly part of the key KET (photonics, advanced materials) areas of technologies. Other clusters that have identified a high share of KETs include aerospace, automotive and ICT clusters. In addition, there is one cluster in the field of life sciences. In this cluster group, this percentage exceeds 30% (in total, such clusters are 15). For the top 5 clusters in this criterion, the rate was 80 percent or more.

### Summary of the area

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- Within the area of environmental impact, the cooperation with the environment, the impact on environmental shaping, environmental impact and the level of specialization and advancement of technology among members were analysed.
- A novelty is the introduction of a sub-area of environmental impact. At the same time, this sub-area was very poorly rated, taking into account the median value. This means that around half of the clusters did not show much activity in this area.
- Given the characteristics of the clusters, a certain advantage has been found for a group of large clusters, with KNC status, and operating for at least 10 years. However, this did not apply to the full environmental sub-area. In this case, young clusters, established after 2015, gained the upper hand.
- The level of specialisation and technological advancement can be best assessed in this area. There are no significant differences between clusters.

- The most frequently identified NSS among the clusters studied were Automation and Robotics of Technological Processes and Intelligent Networks and Information and Communication Technologies and Geoinformation.

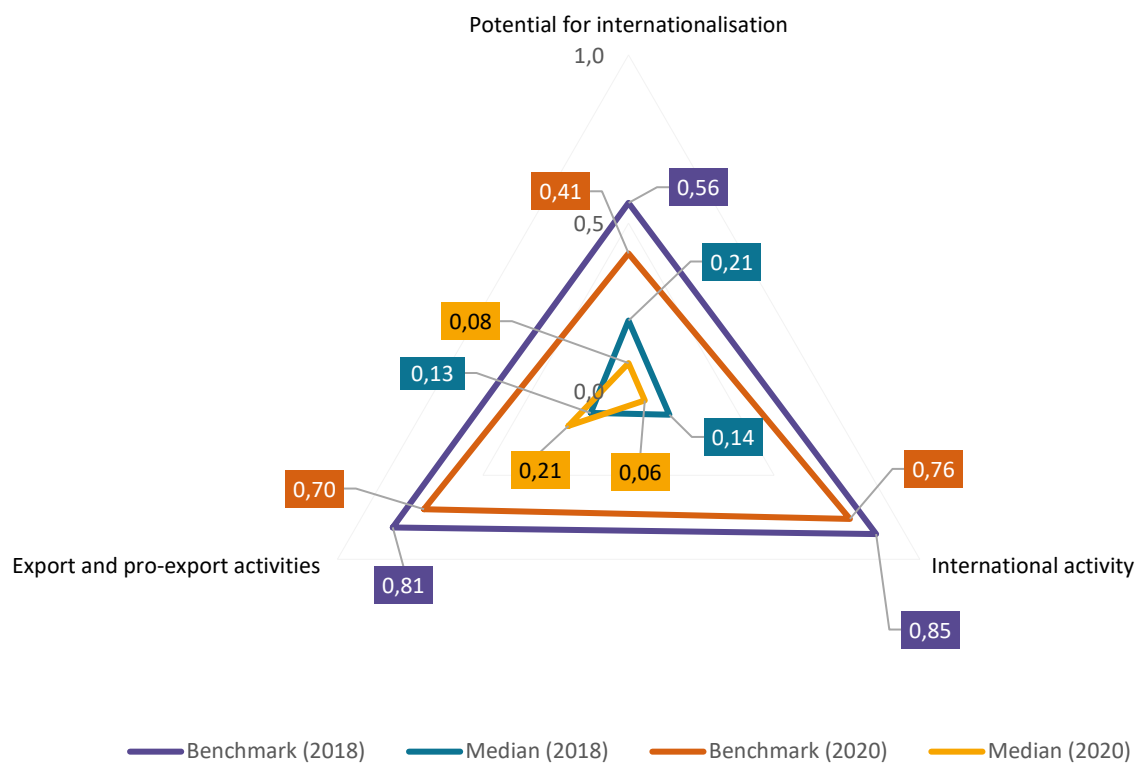
## 5.5. Cluster internationalisation

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

- **Potential for internationalisation** - services for cluster internationalisation, representation of clusters outside the country, multilingualism of the website and cluster publishing houses.
- **International activity** – strategic cooperation with foreign entities, international projects and industry events, recognition of clusters abroad and foreign direct investment.
- **Export and export activities - export** performance, cluster activity foreign trade fairs and foreign trips and accepted visits from foreign clusters.

The area of cluster internationalisation was one of those that received good benchmark and median ratings in the previous benchmarking edition. Currently, taking into account the median, a decrease in value has been observed for areas of potential for internationalisation and international activity. The low values of these indicators illustrate a situation where at least half of the clusters are poorly presented against the background of the leading group of clusters. The benchmark fell by 0.09 for exports and pro-export activities to 0.15 for internationalisation potential compared to 2018. This should not be treated in unfavourable terms. This means equalizing the level between the majority of the studied clusters and the leaders who would clearly outperform the other clusters.

**Graph 63. Subsynthetic indicators values in the area of cluster internationalisation for 2018 and 2020 benchmarking edition**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Cluster internationalisation is seen as a new stage in cluster development. This is evidenced by the intensification of analytical and implementation activities in this area in recent years. In the Report under the title „Internationalisation of clusters” in 2014<sup>39</sup> the significant role of these structures was noticed in the scope of the activities on the international markets, which allows to achieve a number of benefits for the coordinator and members of clusters (especially the enterprises from the group of micro, small and medium enterprises):

- access to knowledge that can be used in new products and services;
- access to new markets;
- access to key infrastructure;
- access to new partners for cooperation;
- raising the profile of the company;
- foreign direct investment.

In the opinion of the speakers of the Conference "Clusters 4.0 – Shaping Smart Industries" in Brussels in 2016, national cluster policies need to be redefined in order to better support internationalisation.

The role of clusters in this area has been recognized by public authorities, which has resulted in the creation of an instrument to support the activity of leading clusters (with KNC status) on international markets under the action "Internationalisation of National Key Clusters" (Sub-action 2.3.3 Of the Intelligent Development Operational Programme).

As part of the document "Directions of development of cluster policy in Poland after 2020" by a team of experts appointed by the Ministry of Development, there is repeated reference to the role of clusters in supporting the activity of their members in international markets. One of the proposals identified the creation of an instrument m.in the strengthening of the internationalisation of clusters and the export activities of their members.

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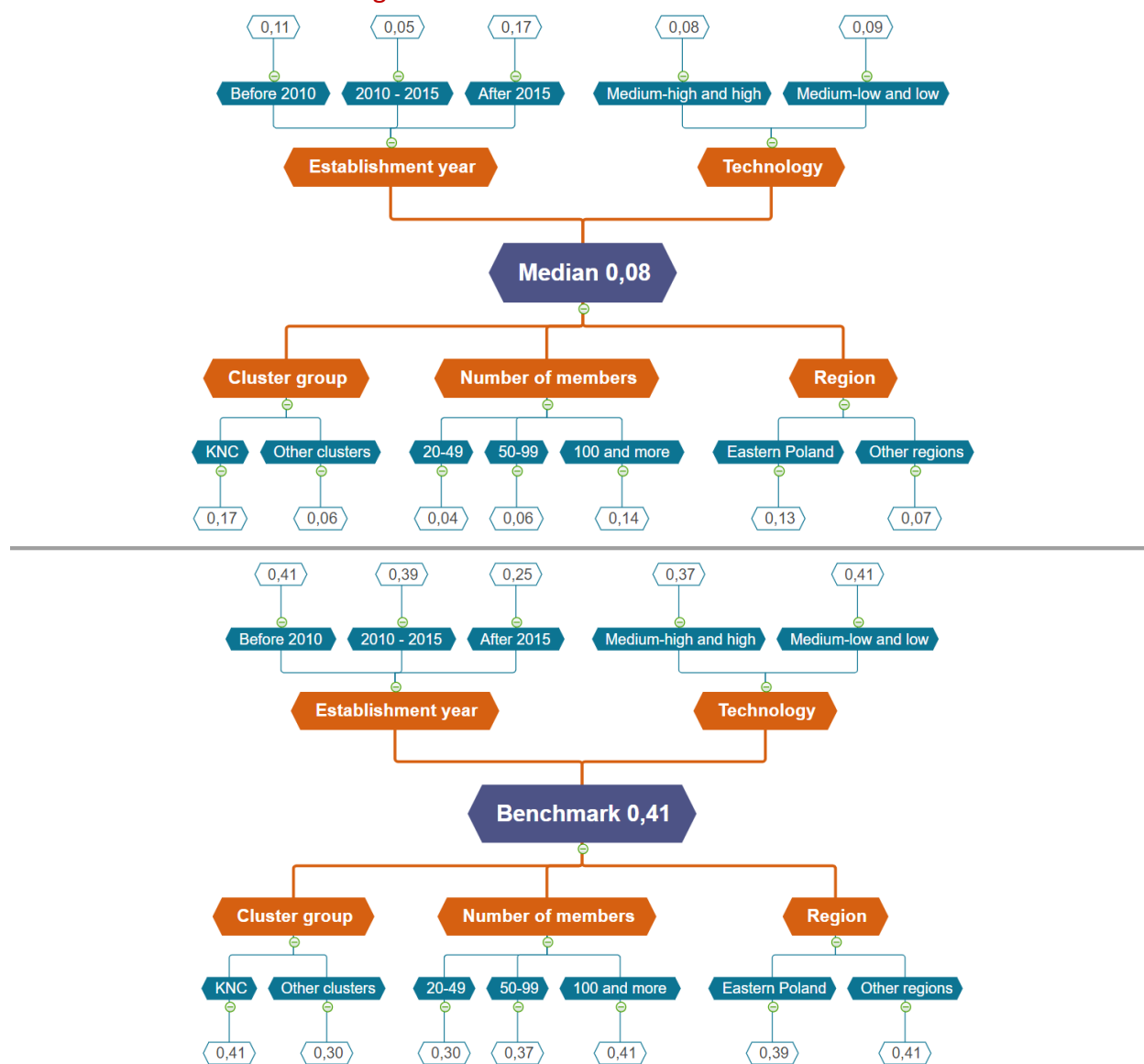
<sup>39</sup>Cluster internationalisation, ed. Greenhalgh B., Polish Agency for Enterprise Development, Warsaw 2014.



### 5.5.1. Potential for internationalisation

The median potential for internationalisation in the sub-area reached a fairly low level, which means that there was a large group of clusters with moderate activities in this area. KNC (0.17) and large clusters (0.14) were high. In addition, clusters located in Eastern Poland (0.13) compared to the rest of the country (0.07) were better assessed in this respect. Given the benchmark values in each cluster group, you may notice relatively low values compared to other sub-areas. This indicates a situation in which there was no cluster in any of the criteria that would be a clear leader over the others. The best grades were obtained by a large cluster (over 100 members), with the status of KNC, established before 2010, operating in the area of medium-low and low technology and located outside Eastern Poland.

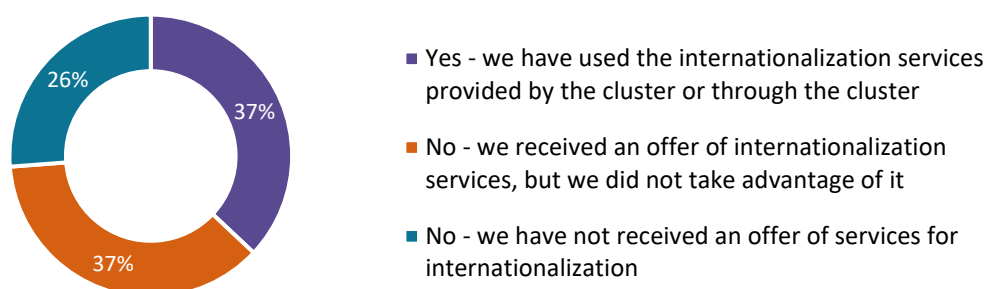
**Graph 64. Median and benchmark for the sub-area potential for internationalisation taking into account characteristics of clusters**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

It is worth noting that a significant group of clusters provided services for the internationalisation of activities for their members. Among cluster members surveyed, 37% used these services through or through the cluster in the last 2 years, and 37% had the opportunity to do so (received an offer of services for internationalisation), but chose not to use it.

Graph 65. Services for internationalisation



Source: Research on cluster members (N=435).

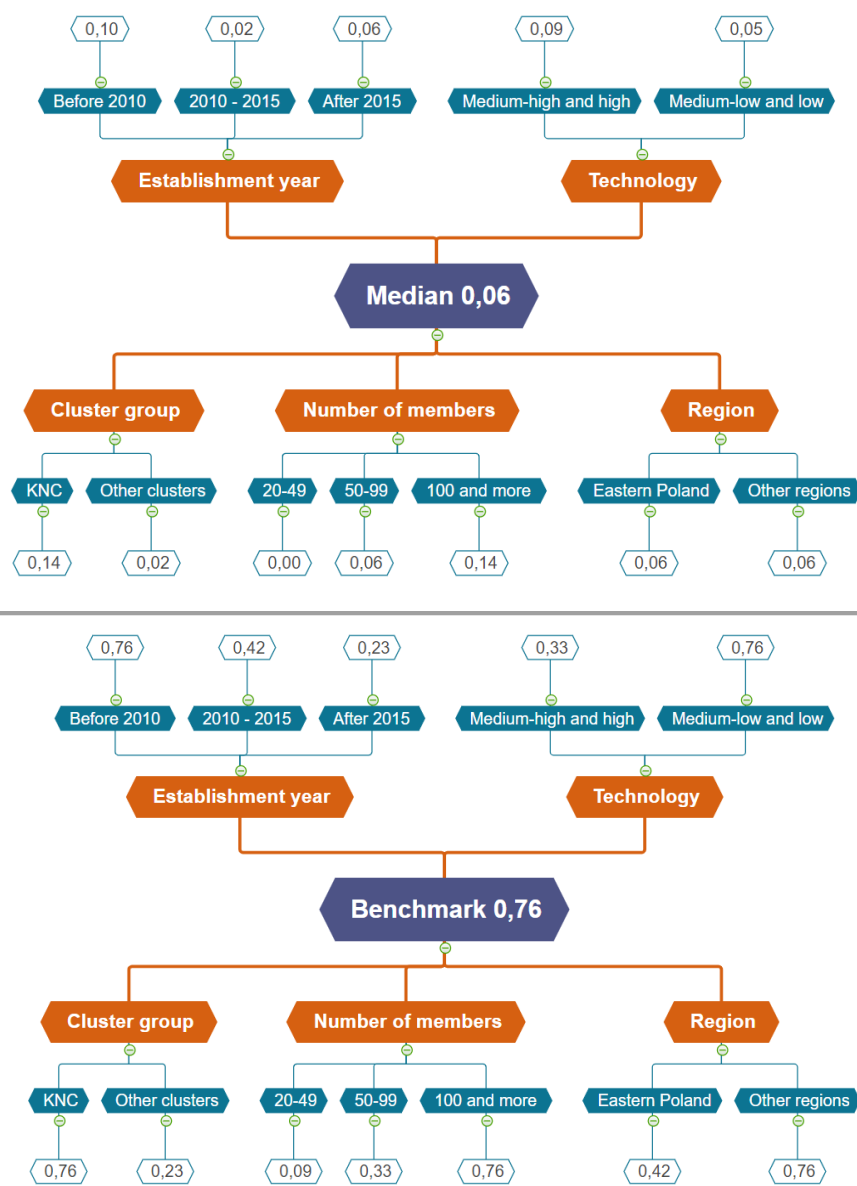
#### Detailed information for sub-area

- More than 70% of clusters offered support to their members in the area of internationalisation. Within a given cluster, the number of services provided ranged from one type to up to a dozen. The total number of services for all clusters amounted to 119. The most frequently offered support concerned preparatory actions (e.g. development of an export plan, consultancy, training) and those carried out in selected foreign markets (m.in. organization of joint trips to trade fairs and economic missions or promotional activities). On average, 28% of cluster members used this type of service (they offered at least one service in this area).
- Only 4 clusters declared that they had foreign representations of the cluster (13 delegations in total).
- Almost 66% of clusters were active in the development of publications in foreign languages, i.e. materials on the functioning of the cluster (e.g. information, promotional, commercial). Nearly 370 such different publications have been developed.
- 76% of clusters had a page that contained at least one language version (except the Polish version). The leader was the cluster, which indicated 14 foreign-language versions, this number was due to the implementation of the Google module to automatically translate pages on a given site, which can translate into moderate quality of translations (especially in the case of translations from Polish to foreign languages).

### 5.5.2. International activity

For the sub-activism of the international, the median adopted a very low level (0.06). A significant group of clusters did not take any activity in this area or it was negligible. Small clusters (0.00), established between 2010 and 2015 (0.02) and operating in the medium-low and low technology (0.05) areas, performed the least. For median, there is no difference between clusters in Polish east and other regions of the country (0.06). A benchmark of 0.76 means there was a cluster that received high ratings in most criteria. It is a cluster founded before 2010, with the status of KNC, with more than 100 members, originating from outside Eastern Poland and operating in the area of medium-low and low technology.

Graph 66. Median and benchmark for the sub-area international activity taking into account the characteristics of the clusters

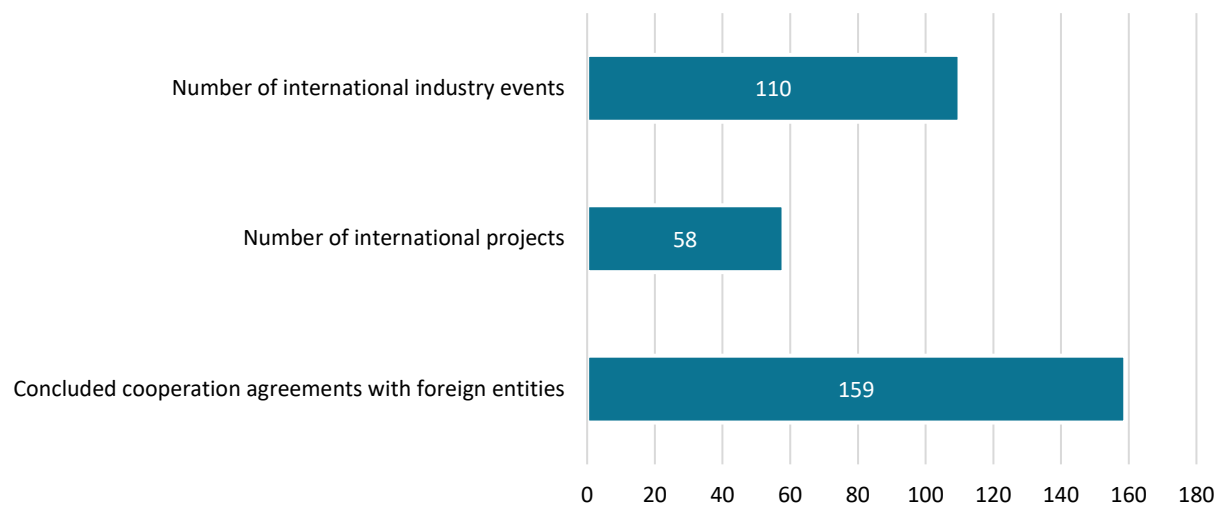


Source: Authors' analysis based on the cluster coordinator survey (N=41).

The international activity of clusters was measured using m.in. indicators relating to established foreign cooperation (signed agreements), the number of international projects carried out in the cluster and the number of internationally organized industry events. International projects are particularly valuable for establishing foreign cooperation and knowledge exchange, which are most often carried out in consortia of several to even dozen organizations.

This type of activity showed 20 clusters, which carried out a total of 58 projects. Almost half of clusters (49%) at least one international project in the period 2018-2019. The average number of projects per cluster was around 3. The total value of the projects amounted to almost PLN 500 million, with the value statement being dominated by practically two clusters. 59% of clusters have signed at least one cooperation agreement with a foreign entity. Only three clusters have signed 10 or more agreements. The leader was one of the clusters, which concluded 84 such agreements.

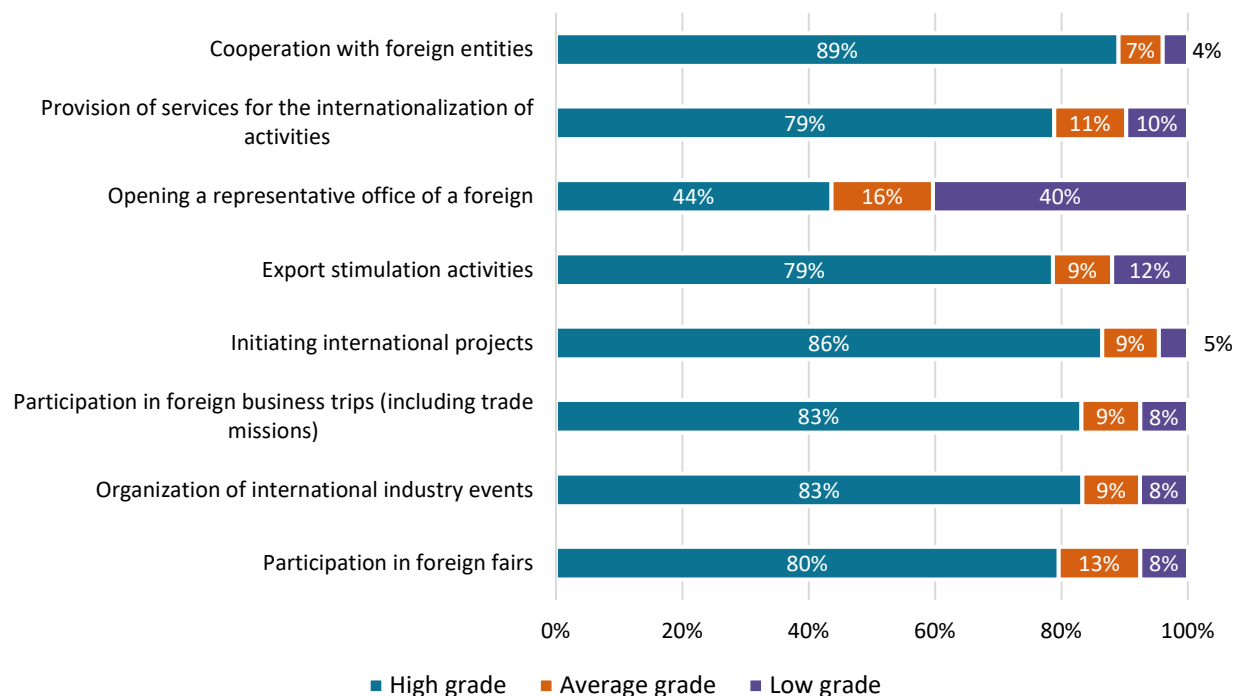
Graph 67. International activity in clusters



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The issue of the international activity of clusters has been the subject of research by cluster members. The most frequently identified activities to be carried out by the cluster for the internationalisation of cluster members in the next 2 years include cooperation with foreign entities (89% of indications), as well as the initiation of international projects (86%), the organisation of international industry events (83%) and participation in business trips (83%). By far the least popular is the opening of a foreign representation of the cluster. 44% of respondents rated preferences for such activities highly and 40% rated them very low.

**Graph 68. Preferred actions for internationalisation of cluster members**



Source: Research on cluster members (N=435).

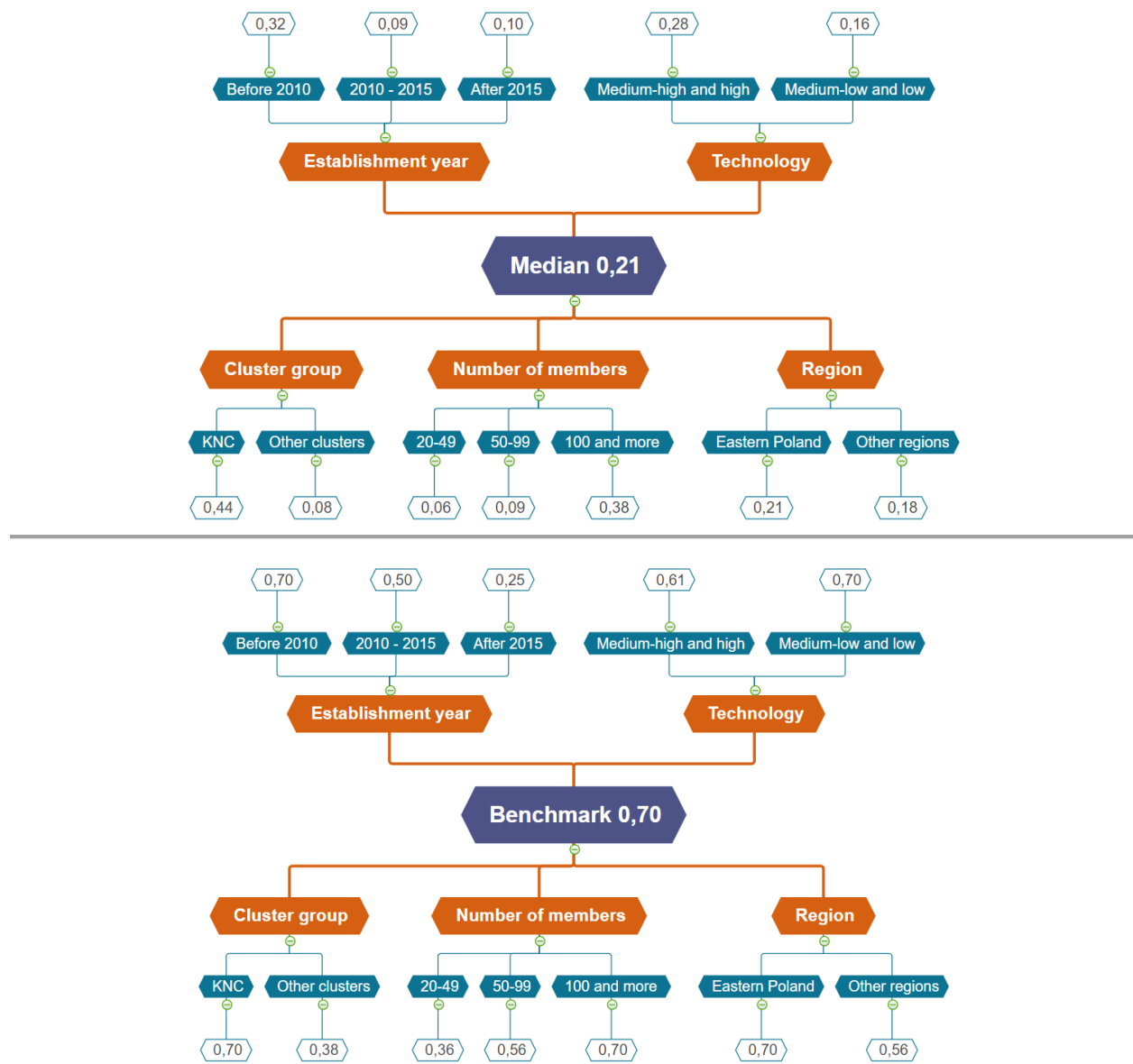
#### Detailed information for sub-area

- More than half of clusters (54%) organised international industry events. The average number of events per cluster was 5 events (for clusters that declared this activity).
- Only 3 clusters indicated that members had made outward direct investment and 2 clusters had acquired inward direct investment. This was the first benchmarking edition to examine these indicators.

### 5.5.3. Export and export activities

The last sub-area of the study analysed was export and pro-export activities. Unlike previous sub-areas that fit into the cluster's internationalisation area, in this case the situation was more aligned between clusters. Large clusters (median 0.38) with KNC status (0.44) compared to other clusters (0.08) fared significantly better. Clusters established before 2010 were by far the best. When Analysing benchmark values, you will notice that there is no single cluster that would be a strong leader in all indicators. The best cluster had KNC status, had more than 100 members, was founded before 2010, it operated in the area of medium-low and low technology and operated in Eastern Poland.

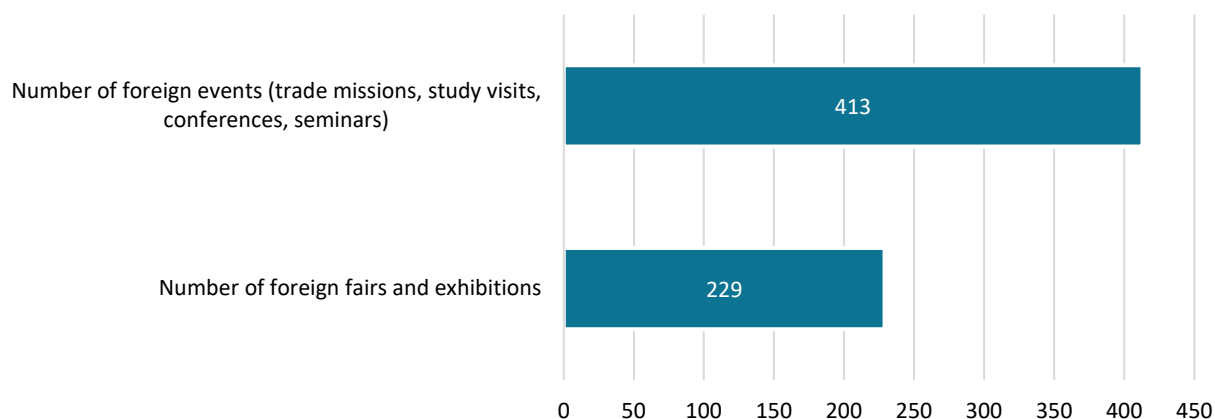
Graph 69. Median and benchmark for the sub-area export and pro-export activities taking into account characteristics of clusters



Source: Authors' analysis based on the cluster coordinator survey (N=41).

Within the sub-area of export and pro-export activities, the measurement m.in the number of foreign events and the number of foreign trade fairs and exhibitions in which the cluster participated. For these indicators, the number of m.in trips organised for economic missions, study visits, conferences or seminars amounted to 413 during the period considered. Thus, on average, there were 10 such trips per cluster. The number of trips to the fair and exhibitions was also significant, their total number was 229. This type of activity was taken by 29 clusters during the period considered. This means that each active cluster on the field type organized an average of 14 events.

**Graph 70. Number of events, fairs and foreign exhibitions involving the cluster**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

#### Detailed information for sub-area

- 27 clusters declared that its members were exporting. The seven coordinators were unable to unequivocally confirm or deny this type of activity (so the actual number of clusters in which members exported goods or services may be higher). In the cross-section of all clusters, export activities carried out around 40% of members.
- Much more difficult from the coordinator's point of view was the question of the average share of export revenues in total revenue among all members. Among those clusters that were able to estimate the value of this indicator (24 clusters), the maximum was 82% with an average of 43%. The question of the number of foreign markets in which the cluster members were present was also a major difficulty for cluster<sup>40</sup>. On average, members of a given cluster exported their products up to approx. 30 countries.
- One of the types of support often offered by the coordinator was the organization of joint trips to trade fairs and foreign exhibitions. 25 clusters confirmed their activity in this area, which over the two years of the period considered organized an average of 9 trips (a record result is 45 trips). On average, 18.6% of cluster members participated in these events.

<sup>40</sup>The answer "no data", "hard to say".

- The last indicator examined in this sub-area was the number of foreign visits accepted to the cluster. Foreign delegations hosted in 25 clusters. A total of 90 such visits were organised, which means an average of 3.6 per cluster.

### Summary of the area

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- Within the area of cluster internationalisation, the potential for internationalisation, international activity and export and pro-export activities were analysed. The best of these were actual exports (median 0.21) and least international activity (0.06) and potential for internationalisation (0.08). Within these sub-areas, a large group of clusters were identified, with very low levels of activity.
- Support from cluster coordinators was quite popular with members. More than a third of the entities in the cluster have used services. Most often these were preparatory activities (e.g. development of an export plan, consultancy, training), as well as the organization of missions and trips to the fair.
- In this area, large clusters, with KNC status and operating for at least 10 years on the market, gained a fairly clear advantage.



## 6. Good practices in the functioning of clusters

One element of cluster benchmarking research consisted in identifying good practices – model solutions that allow for outstanding effectiveness and efficiency in achieving a cluster's activities and development goals. It has been assumed that good practices must be applicable in other clusters (attribute of following, learning), and so their identification and selection were carried out with an idea of their possible implementation in other cluster structures.

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

- innovation of the used solution;
- effectiveness/efficacy of the used solution;
- systemic character and durability of the solutions used in the cluster;
- flexibility and potential for change;
- versatility, i.e. the ability for the solution to be applied used by another cluster, including from a different industry;
- performance and optimal use of available cluster resources;
- possible potential of the practice to be applied in an event of a sudden change (e.g. as in the case of the COVID-19 pandemic).

Particular attention has been paid to good practices implemented in 7 selected sub-areas, which largely determine the development of cluster structures (because they relate to a cluster's organizational maturity, the development of cluster cooperation and innovation, as well as internationalisation), i.e.:



Innovation activity



Cluster digitisation



Development of cooperation in the cluster



Cooperation with the environment



Impact on the natural environmental



International activity



Export and pro-export activities



Counteracting the effects of the COVID-19

## 6.1. Good practices of national clusters

### 6.1.1. HR Telco

Name of good practice and cluster name	HR Telco – West Pomeranian ICT Cluster	
Key area of good practice		Counteracting the effects of the COVID-19
Other areas of good practice		Development of cooperation in the cluster
		Cooperation with the environment
Purpose and circumstances of introducing good practice	<p>A number of cluster members faced new problems during the corona virus pandemic. The epidemic has had a particular impact on work organization as well as the challenges faced by HR departments. The approach to many processes has changed, including such as managing employees who have been forced to work in distributed teams in a remote work system, as well as the manner of taking advantage of new technologies, which has not always been kept up to date by, for example, legal solutions.</p> <p>Focusing on the circumstances of introducing the good practice, it is also important to mention the specifics of the IT labour market. It is a field where both the needs of the employer and the employee must be met. Companies from the IT industry, including cluster members, have a lot of trouble finding and retaining qualified employees. The demand for developers and other IT professionals is very high. For this reason, every employer must take great care of employees and take actions that aim, among other things, to strengthen the good atmosphere at work, as well as the image of the company. Employers are forced to offer employees a range of benefits to encourage them to work for them.</p> <p>All of the above aspects have highlighted a need to jointly seek HR solutions as well as to share knowledge and practices across companies. As a result, the cluster's</p>	

coordinator began organizing meetings to discuss topics important for HR and the development of IT business in this area.

#### Description of good practice

Within the cluster, in response to the problems of HR departments that became more evident after the outbreak of the pandemic, cyclical online conversations have been introduced under the name HR Telco. That way, the cluster coordinator created a forum for discussing HR topics with HR department managers. Additionally, a closed expert group named "Dobre praktyki HR w IT" (Good HR practices in IT) has been set up on Facebook, where cluster members can count on ongoing support in these terms.

So far, HR Telco meetings addressed such issues as: how to communicate remotely with employees, how to take care of relations, how to create the terms and conditions for remote work, and how to account for costs related to remote work. The expert group also discussed the issue of providing "feedback" in the context of building an organisation culture, exchanging information and ways to integrate remotely, communicating with remote workers, the role of HR in business development, or stimulating the involvement of participants of online training.

#### The effect of introducing good practice

Cyclical meetings (every two weeks) allow sharing expert knowledge, inspire each other, and jointly search for solutions to pressing problems in a group of people responsible for handling day-to-day HR processes in member cluster companies. As a result, this translates into the transfer of hidden knowledge and optimizing processes that constitute one of the key factors of success, as well as contributes to developing competences and increasing the efficiency of companies.

#### Possibility to use good practice

Many businesses and organisations face similar challenges and are forced to adapt rapidly to the new realities of social and economic life. The principle of "I learn and inspire others" is so universal that it has potential both in terms of HR issues as well as any other subject – at the same time it can be used at different levels of the organization. It is also used to build trust between cluster members and create a plane for cooperation between the participants of meetings.

*Magdalena Ławicka Phd –  
Operational Director in West  
Pomeranian ICT Cluster:*

*"For the development of our cluster, it is important that the knowledge of individual members spreads within. During the meetings, the following are presented: current industry knowledge, good practices, procedures and others. Thanks to discussions, we achieve a better understanding of everyday professional problems and the chance to find an effective solution."*

### 6.1.2. Digital Innovation hub (HPC4Poland DIH)

Name of good practice and cluster name	Digital Innovation hub (HPC4Poland DIH) – Wielkopolska ICT Cluster Association	
Key area of good practice		Cooperation with the environment
Other areas of good practice		Innovation activity
		Cluster digitization
		Development of cooperation in the cluster
Purpose and circumstances of introducing good practice	<p>The aim is to increase industrial innovation by providing Polish manufacturers with access to advanced services (digital transformation tools). Thanks to connecting into a hub, it became possible to offer comprehensive services: from assessing digital maturity to practical implementations, in line with the needs of Polish production companies, which would not be available if cooperation was not established and the service offer of the members of the hub was not combined.</p>	
Description of good practice	<p>HPC4Poland DIH serves the role of a hub for exchanging values and services between research teams, suppliers, and recipients of advanced concepts, services, and solutions. The Digital Innovation Hub (HPC4Poland) is an initiative at both a regional and European level. A partnership of 20 entities, including the cluster, has been established in</p>	

three provinces of north-west Poland, offering services that could not be provided by individual entities. Similar services, available on the foreign commercial market, would face unacceptable costs for Polish companies. On the one hand, the hub increases the availability of advanced services in Poland and, on the other hand, helps in searching for funding, reducing the risk of implementing innovation. The cluster's coordinator, together with cluster members and other hub partners, focuses on the technological research and development challenges, the implementation of which in principle requires cooperation between several entities—scientific units or companies. DIH (*Digital Innovation Hub*) engages in a dialogue with partners and customers, constantly updating the needs of key customers in the region, i.e. automotive, transport, wood, furniture, agricultural-food, medical, and chemical (including pharmaceutical and health services of public entities).

The effect of introducing good practice




The result of the hub's operation consists in an increase in the **availability of advanced technologies and digital competences** (HPC, cloud, AI, AR/VR, IoT, robotics) for the manufacturing industry in Poland. The hub currently provides 170 Industry 4.0 digital transformation services. It combines the infrastructure and competences of partners to build advanced digital service, so far not available on the commercial market. Thanks to its membership in the hub, the cluster has a direct impact on shaping the hub's offer and activities.

Possibility to use good practice

The transformation to Industry 4.0 is a long-term process that requires a change on many levels, which cannot be achieved without a stable ecosystem of innovation development. Moving in this direction, it should be considered a good example for the clusters to follow trends of the economy and their very rapid response to developments in this area.

The systemic character of the solution allows offering comprehensive services in line with the needs of Polish production companies.

### 6.1.3. Development of the "0 residue" pesticide technology as an example of effective project coordination and management.

Name of good practice and cluster name	Development of the "0 residue" pesticide technology as an example of effective project coordination and management – Polish Nature Cluster	
Key area of good practice		Development of cooperation in the cluster
Other areas of good practice		Innovation activity
		Impact on the natural environmental
		Export and pro-export activities
Purpose and circumstances of introducing good practice	<p>The basic need, which contributed to the introduction of the good practice, was the desire to increase the competitiveness of fruit farms and a striving for the cluster to distinguish itself from both producers as well as other such entities bringing together fruit-farmers (other clusters, producer groups). The cluster needed a product with which it could consciously interact with the environment and promote it. At the initiative of one of the cluster's members - with a strong involvement of the coordinator as the animator of the entire project - joint works have been initiated to create a technology that allows to produce apples without the residue of plant protection products.</p>	
	<p>The production of apples without chemical residues constitutes also a response to the threat of the existence of fruit-farmers due to the fact that the production of apples is the main source of income in the Błędów municipality and throughout southern Mazovia, and its profitability is declining. The reasons for this consists for example in an improper use of plant protection products by some producers, which has a negative impact on the manner</p>	

in which consumers perceive the quality and health benefits of the offered fruits.

The initiative itself was also intended to integrate the environment, taking advantage of its resources and serving the sustainable development of local actors.

#### Description of good practice

The "0 residues" action, which was successfully achieved thanks to the involvement of the coordinator and cluster members, as well as the developed innovative technology implemented by the farmers, constitute examples of effective integration of bottom-up ideas, activities, coordination, and project management. The aim consists in a coordinated production and sales of high-quality fruits and vegetables while reducing residues of plant protection products.

As part of the cluster's activities, a technology has been developed and implemented allowing for the production of an innovative type of fruits called "amela". The "amela" brand stands for fruits produced with the use of the innovative "0 residues" of chemical compounds technology, controlled in certified laboratories. The technology produces clean fruits, and at the same time it is neither BIO production nor conventional production. The fruits are harvested during specific phases and then stored in modern facilities of controlled anaerobic atmospheres. The sorting and packaging is carried out on sorting lines using the latest technologies in accordance with consumer demand. Apples, pears, blueberries, plums, and strawberries are currently grown in the cluster according to this technology, but according to the principle, it can be implemented in the production of all fruits and vegetables.

Actions undertaken by the cluster's coordinator focus also on the next stage, meaning an innovative fruit sales system that allows reducing the supply chain and bypassing intermediaries (sales directly to customers, based on residential groups operating in Warsaw). This product can be purchased in Poland in two retail chains and an online store. Sales of survey quantities have also been launched in foreign markets, which will allow the cluster to develop more advanced export activities.

#### The effect of introducing good practice

The activities undertaken by the coordinator and the cluster's members contributed to better cluster collaboration and integrating its members around a shared



technology. It had also an impact on succeeding in **improving the competitiveness of fruit farms by producing, and then selling fruits of unique quality.**

By bringing together individual fruit-farmers and their groups in the production process and the following sales of fruit under one brand, the "Polska Natura" (Polish Nature) cluster has strengthened its position and acts as **a significant partner** on the market, which gives it a stronger negotiating position in determining the terms of sale with various links of distribution channels.

Taking advantage of the "czysty owoc" (clean fruit) technology affects the natural environment, improves **the ecological conditions** of the population in the Błęków municipality, and **indirectly improves the health of consumers.**

Products branded **with the cluster's common brand "amela"** are premium or extra class products (calibre, colouring, firmness for specific varieties in accordance with EU quality standards). The "amela" brand is the cluster's trademark for fruits with special nutritional and taste properties, and its **recognition** on the market increases the demand for these fruits and strengthens the leading position of fruit growers in the region among fruit producers. In this situation, fruit growers and their groups cooperating within the cluster become important players in the market game and avoid pressure from intermediaries and price coils of large fruit customers.

The good practice of the "Polska Natura" Cluster illustrates the fact that actions taken to fight for sustainable development and environmental protection stimulate innovation and allow to stand out from the competition.

#### Possibility to use good practice

One of the strengths of the identified good practice as well as a factor that had a big impact on the success of the undertaking consists in the role played by the cluster's coordinator who managed the process as a whole. Thanks to the coordinator's efforts, but also the trust of the cluster's members in terms of these actions, it became possible to establish effective cooperation between a number of competing entities (the partners of the cluster are: a horticultural cooperative, three producer groups, a municipality, and private fruit growers), the use of

innovative solutions, and the development of technology, resulted in increased competitiveness.

In addition to the coordinator's courage to build joint initiatives, present them on a general forum, and undertake active steps to seek the best solutions for cluster members to maximise added value within the cluster value chain, an inspiration may also consist in the development and offering of common services/products as well as building coalitions for this purpose.

*Andrzej Stępniewski – Chairman of the Council of the Polish Nature Cluster*

*"We were aware of the increasing competition of organic fruit growing as well as a number of threats to the existence of fruit-farmers. That is why we have started to carry out experiments in orchards aimed at producing apples without residual plant protection products, which would increase our competitiveness. We have achieved good results and the certainty that it is possible to produce such apples on a larger scale.*

*At the beginning of 2018, we've decided to define these activities as the "zero residue" project and registered our product with the Polish Patent Office under the "amela" brand. As a result, after 2-3 years of practice, we already had commodity production."*

#### 6.1.4. Systematic character of supporting digital transformation processes

Name of good practice and cluster name

Systematic character of supporting digital transformation processes – Silesia Automotive & Advanced Manufacturing

Key area of good practice



Cooperation with the environment

Other areas of good practice



Innovation activity



Cluster digitization



Development of cooperation in the cluster



## International activity

### Purpose and circumstances of introducing good practice

Many manufacturing companies are urgently seeking guidance and support in the field of transforming towards Industry 4.0. Actions undertaken by the cluster's coordinator respond to the identified demand for services in this area.

The aim is to comprehensively support entities in the process of this transformation, to show the possibility of taking into account integrated IT systems, advanced production techniques, or new business models, corresponding to market trends in the activities of enterprises.

The initiative also responds to the excessively slow uptake of digital technologies, which threatens the ability of entrepreneurs to compete in the global economy, economic growth, and job creation, and also is a source of inequality. It aims to increase awareness that digital transformation activities are necessary for companies to be able to grow and compete effectively on the market.

### Description of good practice

The cluster's coordinator organised a system of actions, so that the digital transformation processes in the cluster took place in a multi-track manner and in many areas. The created system support consists in:

- organizing seminars promoting new technologies,
- functioning of thematic groups,
- operation of DIH–Silesia Smart Systems.

#### **Seminars promoting new technologies:**

The cluster's coordinator organizes seminars under the name "Akademia - Transformacja Cyfrowa" (Academy – Digital Transformation), raising awareness of the need for transformation and showing how new technologies support efficiency and increase the competitiveness of enterprises.

#### **Thematic groups:**

The "Industry 4.0" and "Industry 4.0 Suppliers" thematic groups have been operating in terms of the cluster for years.

In terms of the first one, a platform for cooperation between technology suppliers and the automotive industry has been created, enabling for example to transfer knowledge, exchange experience, and networking.

The latter group, which operates within the cluster, meaning "Industry 4.0 Suppliers" brings together technology suppliers. The aim of its activity is to go beyond the cluster to support other SMEs in the Silesian Region, including those operating in other industries, in the field of digital transformation.

#### **DIH–Silesia Smart Systems:**

In 2018, together with external partners, the cluster's coordinator established an initiative – Silesian Competence Centre for Industry 4.0, which currently operates under the name DIH–Silesia Smart Systems – certified Silesian Digital Innovation Hub. DIH–Silesia Smart Systems is a platform for cooperation between business environment institutions, scientific units and universities, providing comprehensive services to support transformation processes in the "one- stop-shop" formula. DIH–Silesia Smart Systems identifies the challenges that a company faces, develops, demonstrates, and tests potential solutions as well as provides support in the processes of implementing new solutions. By providing access to technological knowledge and possibility of conducting laboratory testing and research, as well as "test-before-invest" possibilities, the cluster's coordinator helps companies improve and develop business and production processes as well as products and services taking advantage of digital technologies.

As part of this initiative, audits of the technological advancement of SME companies in Silesia are carried out for several years now, which are conducted by experts from the cluster. The result of the auditors' work consists in a business-specific digital transformation roadmap developed, in cooperation with suppliers of new technologies from the SA&AM Cluster, which guides the company in the process of implementing new Industry 4.0 technologies or changing the business model.

The coordinator provides companies with a database of suppliers of a given technology, leaving it to them to decide with which entity they wish to cooperate at a later stage.

The field of operation of DIH-Silesia Smart Systems also includes developing the competences of employees and managers, which are necessary in digital transformation processes, providing adequate knowledge and organizing specialized training.

The role of the cluster's coordinator is primarily to initiate cooperation and networking, i.e. raising **the awareness of companies** in terms of digital transformation, **conducting audits, and connecting companies and technology providers.**

The effect of introducing good practice

The result of introducing the good practice, meaning a systemic character and comprehensiveness of solutions from the field of Industry 4.0 offered by the cluster and its partners, consists in providing companies with the opportunity to take more effective action in real time and react faster to changes taking place, which translates directly into **an increase** in their **competitive advantage.**

The experience of the Silesian Competence Centre for Industry 4.0 made it possible to remodel and extend the initiative with new partners. As a result, **the DIH-Silesia Smart Systems has been launched**, which takes efforts to obtain the status of a European DIH - is after the pre-selection phase, allowing to apply for funds for its further development.

As a result of the actions undertaken by the cluster's coordinator, **new external fundraising opportunities** emerge before the cluster (the Digital Europe Programme, Just Transition Fund), the proper use of which will allow for implementing the assumptions of a regional policy as well as European strategies.

Possibility to use good practice

Other clusters, especially non-IT clusters, and their members, can benefit from the good practice and services offered by Silesia Automotive & Advanced Manufacturing to verify the legitimacy of digital transformation solutions, which would surely allow them to digitize certain processes or technologies.

Furthermore, clusters can draw a number of inspirations from a comprehensive, systemic approach and focusing actions on a selected area, which for Silesia Automotive & Advanced Manufacturing is Industry 4.0. In this context, it should be considered valuable to identify market gaps

and to observe trends closely in order to offer new services or products on this basis.

*Łukasz Górecki – manager of the Silesia Automotive & Advanced Manufacturing Cluster:*

*"We're trying to initiate the digital transformation process and show businesses how new technologies can affect their functioning and reality, because today digital transformation is not an option but a must. Many companies that are contracted today do not see this need and do not perceive these activities as priorities, which may affect their competitiveness and market position in the future. As the cluster's coordinator, we see the need to raise awareness of the need for digital transformation, to show the opportunities and effects of implementing new solutions, and sometimes the need to change the business model of an organization's operation. With the support of SA&AM's new technology providers, the cluster's experts are able to prepare a kind of transformation roadmap and link an interested entrepreneur with the providers of new technologies."*

### 6.1.5. Promotion of 5G piloting

Name of good practice and cluster name

Promotion of 5G piloting – ITC Central Poland Cluster

Key area of good practice



Innovation activity

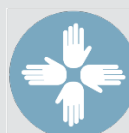
Other areas of good practice



Cluster digitization



Development of cooperation in the cluster



Cooperation with the environment

Purpose and circumstances of introducing good practice

In today's economy, a progressive computerisation process is noticeable, and information-communication technologies are present in virtually every sector. However, the 5G technology sets new standards

in controlling and managing production processes, but also contributes to the development of Industry 4.0.

The cluster's coordinator, together with members, recognizing this potential, including ensuring greater wireless capacity, reliability and efficiency, as well as exceptionally high data rates and low transmission delays, considered it essential to take lobbying efforts to prioritise the implementation of 5G networks in the city of Łódź.

#### Description of good practice

The cluster works actively to promote Łódź as a city of technological solutions of the future with a particular focus on 5G, for example through organizing and co-organizing meetings, debates, and panels concerning this technology, which translates into raising awareness and allows to interact with the socio-economic environment.

The activities of the cluster and its individual participants, cooperation both within the cluster as well as with its surroundings and the involvement under the "Porozumienie na rzecz Strategii 5G dla Polski" (5G Strategy Agreement for Poland) were ultimately successful – in the "Strategia 5G dla Polski" (5G Strategy for Poland) published in 2018, Łódź was included as the first city to pilot and implement 5G networks in Poland.

At the same time, the cluster is involved in cooperation with academic centre, as seen by the involvement in the functioning of the 5G Competence Centre of the Łódź University of Technology, which aims to increase accessibility, knowledge, and competence in the field of modern technologies centred around 5G implementations.

As part of the actions undertaken by the cluster's coordinator an **Information and Communication Portal** has also been created, which disseminates knowledge in the field of: 5G technology, the benefits of its implementation in relation to Economy 4.0, social and environmental conditions, active support for education, and cyber security.

#### The effect of introducing good practice

As part of the 5G Digital Innovation Hub, an innovative and pilot network financed by the Ministry of Economic Development, Labour and Technology has been established on the premises of the Łódź University of Technology, which allows companies to perform an initial verification and implementation of tests concerning new services and prototype devices. Łódź entrepreneurs, including cluster members, have thus been given the opportunity to **test 5G-**

**based solutions**, so that they can already develop new technologies and build a competitive advantage, which at the same time translates into the degree of their digitisation. Reliable and fast communication allows for example to efficiently take advantage of 5G networks for controlling and managing production processes, but also contributes to Industry 4.0 and digital transformation.

Possibility to use good practice

The COVID-19 pandemic has clearly demonstrated that entering the field of new technologies and taking advantage of them creatively in business models determine the fate of companies. **Thus, it may be an important task of cluster coordinators** to open up new channels of cooperation between science and industry, which is essential for effective change in this area. One activity should also be striving for identifying innovations beneficial for the ecosystems in which clusters operate and involve members in their implementation. The role of a coordinator should also be to integrate members around specific issues, such as digitisation, which could result in increased cooperation - both within and around the cluster.




The identified good practice constitutes an example of effective actions of the cluster's coordinator and members for successful cooperation of administration, science and business, and focused on the primary goal, which in this case was promoting the city, but also the development of companies, and ultimately jobs. Behind the success of the projects there is a group of cooperating cluster members, with specialists and access to unique technical resources and tools supporting the designing.

*dr hab. inż. Sławomir Hausman,  
prof. PŁ*

*"Currently, the 5G pilot system at the Campus of the Łódź University of Technology is already used by many companies for testing their innovative solutions, including controlling autonomous vehicles and remote monitoring of devices."*



### 6.1.6. Action aimed at improving the quality of education

Name of good practice and cluster name	Action aimed at improving the quality of education– Lubuski Metal Cluster
Key area of good practice	 Cooperation with the environment
Other areas of good practice	 Development of cooperation in the cluster
	 International activity
Purpose and circumstances of introducing good practice	<p>The aim is to enrich the educational offer and increase the employment of school graduates, of both vocational schools as well as universities, by improving the quality of education adapted to the needs of the labour market.</p> <p>The good practice responds to the identified, noticeable problems of companies concerning finding adequately qualified employees. Companies from the metal industry report shortages in employee qualifications, i.e. lack of professional experience, low level of expert knowledge, and lack of technical skills.</p> <p>The cluster's activities in this area also respond to the needs of universities and industry schools in terms of acquiring knowledge of what kind of skills potential employers need and what professions will be sought on the labour market in the future.</p>
Description of good practice	<p>The cluster's coordinator undertakes a number of comprehensive actions aiming at improving the quality of education, enhancing the competences and skills of staff entering the labour market, including actions aimed at dual education at various levels of the education process, and promoting such solutions among entrepreneurs who are members of the cluster.</p> <p>By involving the ViVA 4.0. international project under the INTERREG VA Brandenburg – Polska 2014-2020 programme, the cluster undertook the development of a cross-border dual vocational training model ViVA 4.0. This</p>

model combines school education with a company and includes mainly dual vocational training in the metal, electromechanical, and electrical system industries, especially with regard to Industry 4.0. The project included such actions as: study visits at workplaces, internships, new technology workshops, CAD-CAM teacher training, specialist CNC training for students, or learning German industry language in the form of e-learning. In terms of the project, modules concerning material testing and driver programming has been developed and implemented in selected companies (which are members of the cluster), which were then used during practices and courses.

The established international cooperation results in following undertakings such as organizing joint conferences or study visits to German research laboratories.

Furthermore, thanks to the involvement of the Lubuski Klaster Metalowy and partners, in 2018 at the Technical Faculty of the Jacob of Paradies University in Gorzów Wielkopolski, a pilot program of dual studies has been launched in all fields of master's and engineering studies. According to the assumptions, internships in specific workplaces take place during the studies. The system of organizing the study course assumed 6 months of study spent at the university and 6 months at the workplace. Currently, the organization of internships has been adapted to the needs of entrepreneurs, and therefore students spend Mondays and Fridays at the university, while Tuesdays, Wednesdays, and Thursdays are spent at the workplaces. After 6 months of internship, students are offered an employment contract. The role of the cluster's coordinator was to recruit companies to carry out the practical part of the study. Such a solution guarantees a thorough practical training. It allows students not only to acquire key qualifications and competences, but also to gain experience and work already at the stage of studies as well as establish professional contacts for the future.

The effect of introducing good practice

The activities undertaken by the coordinator and the members of the cluster allow for **better efficiency of the training process**, contribute to improving the quality of vocational education adapted to the needs of the labour market and **to increase the competences and skills of staff** entering the labour market, thanks to which the cluster's members have a better chance of acquiring desired

specialists, already equipped with the necessary professional competences.

Cooperation with the cluster's environment in terms of a cross-border dual vocational training model combining school education with an enterprise and involving small and medium-sized metal enterprises in the ViVA 4.0 project allowed **to develop 10 modules** for vocational training in Polish and German and reflected the needs of the Lubuskie-Brandenburg regions in this regard. At the same time, **it became possible to develop solutions and adapt the education system to the needs of the metal industry.** The developed modules can also be used by people who want to improve their qualifications in terms of skills required by the market.

The effects of cooperation and within the cluster consist in **creating theses** corresponding to the needs of companies, as well as **constructing** technological laboratories of the Technical Faculty of the Jacob of Paradies University in Gorzów Wielkopolski corresponding to the needs of the members of the cluster and which can be used by them to carry out research or training of employees.

#### Possibility to use good practice

Cooperation between schools and employers is essential, especially where technological changes take place very quickly. The involvement of cluster coordinators in promoting technical education as well as actions in this area contribute to delivering well-prepared workers to the labour market, including for cluster members. Whereas the implemented actions allow students to verify in practice the acquired school/university theoretical knowledge, as well as enable them to acquire new knowledge and practical skills in accordance with the requirements of employers, which facilitates their professional start.

In addition to drawing inspiration and exchanging experiences, the involvement of clusters in implementing international projects constitutes a very good source of innovative approaches and developing skills in terms of identifying, disseminating, and transferring good practices.

*Włodzimierz Fleischer, Director of the Office of the Lubuskie Metal Cluster:*

*"A very important part of our efforts concerning improving the quality of education is their consistency and regularity. It is not enough to meet once, in a specific group, on a specific topic. Life has shown that in order for these actions to actually result in a change in the market*

*situation, it is necessary to meet repeatedly, in different groups, on different specific topics, in different configurations and... be patient as this is a lengthy process."*

### 6.1.7. Lublin Medicine Cluster StartUpLab – Lublin Medicine – Medical & Wellness Cluster

Name of good practice and cluster name	Lublin Medicine Cluster StartUpLab – Lublin Medicine – Medical & Wellness Cluster	
Key area of good practice		Innovation activity
Other areas of good practice		Cooperation with the environment
		International activity
Purpose and circumstances of introducing good practice	The aim of the cluster coordinator's activities is to increase the number of innovative solutions in the cluster's environment, identify end-user needs, as well as a faster commercialization of new products and services.	
Description of good practice	The Lublin Medicine Cluster StartUpLab constitutes the first contact point, which is the Cluster's coordinator, which start-ups can contact if they want to develop their ideas or learn about the conditions for implementing a solution on the market in the cluster's environment (including universities, research and development units, medical entities, entrepreneurs, business environment institutions, and local government units). The coordinator makes it possible to establishing further contacts and animates the cooperation process. The coordinator offers support in term of those solutions which, in his or her opinion, have commercialization potential. The coordinator works with investment funds and business angels, as well as startup platforms <sup>41</sup> from the region (i.e. Unicorn Hub, Wschodni	

<sup>41</sup>Startup platforms constitute a comprehensive support program for people who have an innovative idea for their own business. They are offered by partnerships of innovation centers, universities, venture capital funds, and

Akcelerator Biznesu, and Smart Foodies Accelelator), being in constant contact with them, participating in meetings and presentations of start-ups. Start-ups are offered individual, "tailor-made" support in terms of cooperating with platform innovation managers. At the same time, it is made possible for them to take advantage of the experiences of the cluster's members who have already followed the path from start-ups to companies with a mature business model. The Cluster's Coordinator, together with the cluster's members in the field of science and business, provides startups with expert knowledge during all stages: from creating the initial concept, through developing the solution's functionality, its testing in the environment, and implementation on the market. Companies also receive information concerning the possibility of financing innovation, and the planned business model is discussed. Thanks to active cooperation with the cluster's environment and participation in cluster projects, start-ups build their recognition in the region, country, and abroad.

The creation and development of start-ups are supported by cluster projects such as:

- Lublin Medicine Cluster Living Lab (Living Laboratory - international cooperation as part of a partnership network with other living laboratories from the countries of the Baltic Sea Region. Thanks to the undertaken international activity) and cooperation with Living Labs from Denmark, Sweden, Finland, Estonia, Latvia, and Poland, companies can develop and test their innovations with the support of foreign experts, also obtaining information concerning the conditions for implementing products or services on a selected foreign market.
- InnoTest (testing innovation, building common knowledge of the environment in the field of innovation) concerning medicine and health, taking into account their technical and organizational conditions as well as legal implementations for the market).

- InnoDesign (designing innovations based on the identified and mapped needs of end users).

The cluster's coordinator, by taking actions aimed at supporting start-ups, focuses on entities operating in the field of medicine and health, thus consistently taking care of maintaining the cluster's profile.

The effect of introducing good practice

So far **direct support** of the cluster's offices **has been obtained by circa 30 start-ups**, some of which can account for implementing and commercializing their ideas.

Projects implemented by the cluster, workshops, trainings, and individual meetings with start-ups allowed to increase **the efficiency of using resources** involved in the process of developing innovation and **accelerate the process of implementing solutions on the market**.

The cooperation of the cluster's environment with start-ups in the process of developing innovation means **a process of continuous learning** for all of the cluster's actors. Not only start-ups, but also representatives of entities from the scientific community and business representatives. This means **cross-linking**, building a culture of cooperation, a culture of innovation, and a new business culture.

Important partners in the process consist in knowledge and technology transfer centres of Lublin universities, clinical hospitals of the Medical University of Lublin (mainly the largest one, the Independent Public Clinical Hospital No. 4 in Lublin, which as a member of the cluster, in cooperation with the cluster's office actively supports start-ups in assessing and testing their solutions), private hospitals, other healthcare entities, as well as companies from the cluster.

Thanks to such an organized process and the cluster's experts, start-ups gain **the possibility of verifying solutions at a very early stage, with the participation of the end user**. They can avoid many mistakes, refine their solution, and develop their own business model.

Thanks to the international activity of the coordinator, start-ups also have the possibility of verifying and obtaining support in terms of developing solutions in an international environment, which is very important because solutions in the field of health and medicine have to compete globally.

Private entities and public institutions (including public hospitals) receive **information concerning global trends in the field of technological**, process, and social innovation. They are more and more open, not only to participate in the process of developing innovations offered by start-ups, but also their implementation.

Możliwość wykorzystania dobrej praktyki

The developed model of cooperation in a cluster's environment, meaning processes and experiences from implemented projects supporting the creation and development of startups, is a model that can be applied in any cluster environment as an innovation ecosystem. It is a universal model, developed on the basis of observations of global trends and the experience of international partners (clusters, innovation centres, universities and representatives of the business world).

The coordinator serves the role of a kind of accelerator with a very wide access to various types of entities, which in the process of supporting innovation cross-links both suppliers and recipients of technology, with the use of modern tools and methods.

The universality and applicability of the good practice stands also for placing the end user in the centre of attention. The cluster coordinator is working knowing that the key to success consists in answering the identified needs of the end user. Solutions in the area of health and medicine should be verified by the coordinator as soon as possible, at the earliest possible stage.

The needs of companies, healthcare entities, hospitals, and end users (including doctors, patients, seniors, and disabled people), identified in the process of cooperation, are an inspiration for new solutions that can be developed in newly created companies.

Thanks to coordinated support, start-ups achieve the expected results easier and faster.

*Marzena Strok-Sadło – member of the board of the Lublin Medicine Cluster, head of the department of economic ecosystems and business infrastructure in the City of Lublin, the coordinator of the cluster coordinator*

*“Innovations, especially in the field of medicine and health, are very often innovations of a global nature. Therefore, they have to face competing solutions from around the world. The time of the pandemic and the lessons learned from it accelerated the development of innovation, with a strong emphasis on the digitization of processes and solutions. In order to be successful in this dynamic and increasingly competitive reality, we must look for our own*

*solutions and models for more and more effective cooperation. We must map the competences of the actors of cluster innovation ecosystems and take advantage of them systematically in the process of supporting innovations and startups. In order to accelerate the emergence of new startups, it is also necessary to map the needs of the market and end users, as well as to communicate this knowledge to innovators.*

*The basic factor for success consists also in active international cooperation. It also allows not only to follow current trends, but also support start-ups in scaling their business and entering foreign markets."*

### 6.1.8. The functioning of ThinkTank groups

Name of good practice and cluster name	The functioning of ThinkTank groups– Eastern Automotive Alliance	
Key area of good practice		Development of cooperation in the cluster
Other areas of good practice		Innovation activity
		Cooperation with the environment
Purpose and circumstances of introducing good practice	<p>The structure established by the Eastern Automotive Alliance - EAA) is a place for good practices, where views clash and experiences exchange, which is held together by a network of experts and business practitioners. The goal is to stimulate creating innovative ideas and projects.</p> <p>The structure of EAA ThinkTank groups and organizing meetings was formed in 2017 and is continued to this day (due to the covid reality, the meetings adopted an online formula). In terms of the EAA ThinkTank there are 8 teams working and communicating in the following thematic areas: HR (<i>Human Resources</i>), EHS (<i>Environmental and Health Safety</i>), R&amp;D (<i>Research and Development</i>),</p>	



*maintenance*), Lean Management, external logistics, quality management, and a purchasing group.

#### Description of good practice

The uniqueness of the project consists in combining creative work during interactive workshops with visits to production lines, in laboratories and management centers. The functioning formula of the EAA Think Tank consists in implementing carefully planned day-long meetings including short mutual presentations of companies, a thematic "production visit", workshops concerning a previously agreed topic, as well as summing up and exchanging contacts. EAA Think Tank organizes such meetings twice a year in eight thematic areas. They are held at the premises of subsequent member companies, however, when the topic has a developing character, the number of meetings is increased.

In accordance with the intention of the originators, one of the most important goals of the EAA Think Tank program consists in supporting automotive companies from the SME sector through a knowledge transfer and direct contact with excellent specialists from large international corporations. These corporations, being the cluster's members, allow other members, including small and medium-sized companies, to carry out study visits to their plants and observe production, e.g. in terms of maintenance, which allows to take notes and learn from the best. Whereas, they themselves gain, for example, knowledge concerning the potential of regional companies and the possibility of subcontracting certain processes. The meetings are accompanied by professional training conducted by lecturers, lawyers, and others carefully selected from the best available specialists. Thus, it is also a field where science and business come into practical and creative contact. The place of study visits consist also in prestigious technical universities (AGH, Rzeszów University of Technology), which allows cluster members to get acquainted with their modern laboratory base and the possibilities of providing research and measurement services.

#### The effect of introducing good practice

The functioning of ThinkTank groups generates interesting added value. Apart from a **broadly understood transfer of knowledge and exchange of experiences** member companies can count on **intra-cluster assistance**. This is especially important in emergency situations, when - thanks

to mutual knowledge of specialists from different companies and quick communication - direct mutual assistance is possible. A practical example is, for example, when companies helped each other by renting or quickly reselling a unique sensor or other element, preventing losses related to downtime.

A tangible effect of collaboration within the teams consists in **creating** within the HR Group a **project initiative** concerning the development of innovative vocational education. This initiative resulted in obtaining a grant worth circa PLN 2 million as well as the implementation of a project entitled “Podkarpacka Akademia Motoryzacji – Innowacyjne Szkolnictwo Zawodowe (PAMISZ)”. Another example was taking advantage of team collaboration during the implementation of the international DRIVES project (*Development and Research on Innovative Vocational Education Skills*). The discussion initiated during the maintenance team meetings concerning predictive maintenance has been developed in the above-mentioned project and contributed to **creating curricula and studies that will be implemented in EU countries**. Currently ThinkTank teams analyse the concepts of following initiatives, which also have a chance to become the subject of applications for EU funds.

Możliwość wykorzystania dobrej praktyki

Cluster coordinators should consider creating ThinkTank groups within clusters. That is because it constitutes an opportunity to get to know each other better and build a culture of cooperation within the organization. Taking advantage of this element by clusters may contribute to stimulating technological changes in a given industry and contribute to shortening value chains. Taking advantage of reference visits, which are a very effective form of networking and the flow of knowledge, active learning from others, and looking for inspiration, should be considered valuable. At the same time, functioning in the ThinkTank formula works in favor of the emerging of project initiatives. An important advantage of team-initiated projects coordinated by the cluster's institution consists in the possibility to obtain European funds for their implementation, which are most often unavailable to the companies themselves. The results of such projects constitute an interesting added value that can be used by

companies associated in the cluster, which is also an incentive for new business entities to join the cluster.

*Witold Pycior, ThinkTank EAA coordinator:*

*„Basing on the experience from four years of operations by ThinkTank groups, it can be said that this is an initiative that significantly strengthens the basic substantive activity of clusters, providing tangible benefits for their members. This is a good place for creating and forming initiatives in the fire of substantive criticism, which have a chance to become valuable projects that provide benefits for cluster members. Based on current experience, it can be concluded that conditions necessary for success are passion, skill, and the commitment of a ThinkTank's animator, a pragmatic formula of activities, as well as support from the presidents of member companies, expressed by making plants available for internal study visits”.*

### 6.1.9. Children's Technical University

Name of good practice and cluster name

Children's Technical University– Aviation Valley Association

Key area of good practice



Cooperation with the environment

Other areas of good practice



Development of cooperation in the cluster

Purpose and circumstances of introducing good practice

The goal is to develop existing and arouse completely new interests among children. It is assumed that thanks to properly presenting exact sciences, young students will choose technical universities in their adult life in order to deepen their knowledge and gain education in this field.

Description of good practice

Establishing the Education Support Foundation at the Aviation Valley Association, the main goal of which is to develop science and technology education and promote educational programs among children and adolescents – the future generation of Polish engineers, including free popular science classes at the Dziecięcy Uniwersytet Technologiczny (Children's University of Technology). University classes are intended for primary school students. They deal with scientific issues from selected fields.

The students have the opportunity to look for answers to such questions as, for example, where do colours come from, what is electricity, how does a laser work and where it is used, or what ancient fireworks and modern space flights have in common. DUT students discover the physics of space flight as well as what Tesla transformers and the Van de Graaff generator are. Classes are conducted by scientists, lecturers and science popularisers from all over Poland, who through lectures or presentations with interesting experiments, inspire children to broaden their horizons and discover the fascinating world of science on their own.

The effect of introducing good practice

Inspiring action contributes to awakening in children a natural curiosity about science, a better understanding of the surrounding world and practical functioning within it. The number of participants in educational projects organized by the Foundation is over 40,000 people.




Possibility to use good practice

Undertaking similar initiatives in cooperating with local universities, which translates into an increase in recognizing the cluster and its activities in the field of CSR.

*Andrzej Rybka, dyrektor SGPPL „Dolina Lotnicza”:*

*"Supporting science and education was one of the most important priorities from the very beginning of our cluster's operations. The comprehensive system of supporting the education of " Aviation Valley", a part of which is the Children's Technical University, constitutes a unique solution and "benchmark" on an international scale. We willingly share our experiences in this area with numerous Polish and foreign clusters, whose representatives visit us to learn about the good practices of " Aviation Valley."*

### 6.1.10. Sector Council for the Competences of the Chemical Sector

Name of good practice and cluster name	Sector Council for the Competences of the Chemical Sector– Association of West Pomeranian Chemical Cluster Green Chemistry
Key area of good practice	 Cooperation with the environment
Other areas of good practice	 Development of cooperation in the cluster
	 International activity
Purpose and circumstances of introducing good practice	<p>Rapid technological progress works in favour of the obsolescence of employees' knowledge, and their competences require to be complemented, developed, or even completely transformed. Globalization results in that new jobs being are created. Good practice responds to the phenomenon of a dynamically changing market situation and the related need to constantly improve skills and adapt them to its needs.</p> <p>It is a necessary condition of contemporary socio-economic development based on knowledge and information. Establishing the Sector Council for the Competence of the Chemical Sector was possible thanks the Green Chemistry Cluster acquiring a project under action 2.12 "Increasing knowledge concerning the qualification and professional needs" of the Knowledge Education Development Operational Program.</p>
Description of good practice	<p>"Green Chemistry" Chemical Cluster serves the role of the project's leader and at the same time animator of the Sector Council for the Competences of the Chemical Sector. The aim of the Council's activity is supporting enterprises in developing employees' competences and market qualifications and to support enterprises in acquiring new qualified employees. At the same time, the Council is an advisory body for the authorities at a ministerial level. One of the important roles of the Council is consulting legal acts and recommending legislative</p>

changes in the field of education and adapting them to the needs of the labour market. It includes representatives of the cluster's members and those from external enterprises, as well as representatives of educational institutions, higher education, and the labour market.

The Council undertakes a number of multidirectional activities aimed at attracting and activating people to work in the chemical sector. This means, for example, cooperation in the field of educational agreements (educational entities and employers), activities related to reconstructing a part of industry education that ceased to exist during the last years of the economic transformation, in-depth analysis of the industry's needs, and developing recommendations concerning the demand for competences, as well as administration lobbying to ensure the financing necessary to improve the quality of the education industry. The Council supports actions related to the dual education system, as well as adjusting the education system to the needs of enterprises from the chemical sector and related industries, so that the qualifications acquired in schools, universities, during courses and various training sessions, respond to the real needs of employers in the sector.

The Council is also active on the international market. It is a partner of a project entitled Pact for Skills, created by the European Commission, which is intended to work in favour of joining forces and taking specific actions to improve professional skills and retraining Europeans.

The effect of introducing good practice

Identifying the sector's needs in terms of changes in the competences that are created through globalization, structuring, and development of enterprises, including defining research areas related to competences in the chemical sector. Actions taken by the Sector Council for the Competences of the Chemical Sector increase the adjustment of the educational offer to the needs of entrepreneurs. It allows cluster members to have an impact on educational services - what and how is taught by Polish schools, universities, training institutions etc.

Possibility to use good practice

In a number of industries, employers signal the need to create new market related qualifications related to implementing innovations. Clusters are environments that create the possibility of transferring knowledge and

establishing effective cooperation between the business and education environments, consisting in transferring information about the needs of a given sector in the field of competences and adjusting vocational education to the needs of entrepreneurs and the labour market.

Involvement of clusters in the work of sector councils for competences will allow to increase the efficiency of the flow of information between the labour market and education, and will constitute help in coping with the challenge of rapid changes in a given sector.

*Przemysław Wojdyła, Vice President of Association of West Pomeranian Chemical Cluster Green Chemistry:*

*We are very proud to be the only cluster in Poland, to create a Sector Council. The industry is constantly developing, thus there is a need for new competences. The element of education is one of those that should be strongly emphasized in cluster activities. If we neglect it and fail to respond to staffing needs in a timely manner, it will result in serious shortcomings in this field. Clusters are institutions that are perfect for such task, although there are a number of problems to overcome, such as creating complete financial engineering. However, we are convinced that the cluster's involvement in activities in this field constitutes one of the basic elements of its development and significantly increases the competitive advantage of the entities.*

### 6.1.11. Recycling Academy

Name of good practice and cluster name

Recycling Academy – Waste Management and Recycling Cluster

Key area of good practice



Cooperation with the environment

Other areas of good practice



Impact on the natural environment

Purpose and circumstances of introducing good practice

The good practice is a response to the needs in the field of education of the society and economic entities operating in a sensitive and specific sector of the economy, which is waste management. The aim of the activities is to create a "recycling society".

**Description of good practice**

The educational project carried out by the cluster's coordinator together with cluster members provides:

- comprehensive education of companies (including employees, management, and other interested parties) and institutions in terms of waste recovery and recycling technologies, as well as the direction of a closed circular economy;
- educating the public in this regard.

During trainings and webinars, enterprises are provided with knowledge of global trends and technologies in the field of management and neutralization of all kinds of waste, recovery, and recycling, including ferrous and non-ferrous metals, plastics, rubber, wood, glass, cellulose, multi-material waste, and also concerning financing investments taking advantage of EU funds and the latest legal solutions.

The project is aimed at cluster members, in order to use their common potential (possessed substantive resources), as well as at external entities for which initiatives are being undertaken.

Additionally, the coordinator organizes seminars, competitions, outdoor events, and workshops forming the society's pro-ecological attitudes. These activities are aimed at increasing the awareness and knowledge of residents in terms of environmental protection and waste management.

Therefore, the coordinator carries out various actions aimed at many social groups, having an impact on the cluster's economic environment and, as a result, a positive impact on the natural environment.

**The effect of introducing good practice**

The effect of the Academy's activities consists in consolidating proper waste segregation, as well as introducing optimal solutions for waste management and disposal as part of:

- educating the cluster's employees - increasing competences;
- lifelong education of employees of so-called recycling companies in the field of waste management;



- promoting and presenting innovative recycling and recovery technologies.

Additionally, one of the results of the trainings organized in terms of the Recycling Academy is innovations implemented at enterprises, for example by taking advantage of subsidies.

#### Possibility to use good practice






The identified good practice may constitute an inspiration for other clusters in terms of finding a niche even in specific sectors, but also a uniqueness of the implemented solutions focused on the market demand. Recycling Academy is the first Academy in Poland dedicated for companies in the field of waste recovery and recycling technologies. At the same time, a valuable development impulse for clusters may turn out to be the formation of conditions for cooperation in order to take advantage of the cluster's potential and development in the field of a circular economy, as well as creating a wide range of consulting services and offers of specialist training and workshops.

*Katarzyna Błachowicz, – member of the management board of the Waste Management and Recycling Cluster:*

*" Recycling Academy allows taking advantage of the potential of experts who are members of the cluster to share practical knowledge and indicate the direction of development. It is a knowledge platform that everyone is still learning to use, and in retrospect, it can be seen that it has more and more capabilities, but also how innovative it is. Thanks to the Academy, we increase awareness and the possibility to close the flow of raw materials through:*

- *access to knowledge concerning the use of recycled raw materials;*
- *expanding the product and service offer with ready products from recycling;*
- *education and professional consulting;*
- *a wide range of pro-innovative services;*
- *services in terms of research and development."*

### 6.1.12. Barometer of the business cycle indicators

Name of good practice and cluster name	B-KOM – Barometer of the business cycle indicators – Metal Processing Cluster
Key area of good practice	 Cluster digitization
Other areas of good practice	 Innovation activity  Development of cooperation in the cluster  Cooperation with the environment  Counteracting the effects of the COVID-19
Purpose and circumstances of introducing good practice	<p>Cluster members are companies that participate in global value chains, which is why they quickly began to feel the effects of the crisis caused by the COVID-19 pandemic. At the same time, there was an urgent need for information and an analytical approach to the economic changes taking place on the part of entrepreneurs who are members of the cluster, including interest in the economic situation among entities in the Metal Processing Cluster and the metal industry. Answers were also sought whether this is a good time to invest, how to manage staff in times of restrictions, how to monitor safety rules, as well as other activities.</p>
Description of good practice	<p>The cluster's coordinator has developed an innovative tool for researching the economic situation during the COVID-19 pandemic. It is based on the GUS methodology adjusted to the needs of the cluster's population with the use of an IT tool and a standardized survey (the monthly survey also includes 2-3 additional questions taking into account the current needs reported by the cluster's coordinator or</p>

members, for example what should the *de minimis* aid model look like in the future). The tool has been implemented as a result of cooperation between the sphere of science (Institute of Management of the UwB) and the business sphere (Metal Processing Cluster and its members).

Both industrial as well as service and trade companies participate in the study. Thanks to taking advantage of the GUS methodology, it is possible to relate the survey results to the entire economy and make them objective. The results of the systematically conducted research are presented once a month at the Grupa Zaawansowanej Współpracy (Advanced Cooperation Group) of GZW PRO (the core of the group is made up of large and medium-sized entities), during meetings of the Cluster Board, Cluster Council, General Meeting of Cluster Members, and in a newsletter. A synthesis of the research results reaches the entire population of cluster members.

The results of the barometer present a set of basic information supporting decision-making processes at member companies, as well as the coordinator and the Metal Processing Cluster offices as to the directions and the scope of support for cluster entities. The tool allows to present the mood of entrepreneurs in the Metal Processing Cluster population, meaning the assessment of the financial situation of enterprises, a diagnosis and forecast of demand on domestic and foreign markets, any planned reductions or halts in production, as well as barriers in development. It is also part of the compendium of knowledge concerning development trends in the cluster population and the metal industry. The barometer is presented on a monthly basis.

The effect of introducing good practice

**Cyclical analysis of key indicators for the industry as a barometer of the economic situation.** The research results arouse great interest not only among cluster companies, but also among external entities, such as the Marshal's Office of Podlaskie Region or Ministry of Economic Development, Labour and Technology. As a result of implementing the good practice, the recipients of the Barometer gain knowledge concerning the economic situation and the functioning of enterprises, which allows to make the right investment decisions or those regarding following actions of enterprises. The solution received a PARP award in the category of "100 best projects for

increasing the level of company digitization".

The barometer has also been recognized as an interesting tool for studying the economic situation in selected populations by experts of the World Bank.

#### Possibility to use good practice



Researching the economic situation of a given industry and related industries by clusters allows, for example, to avoid high costs related to the purchasing of commercial reports and industry analyses. At the same time, it is a manner of aggregating knowledge in a cluster and popularizing innovative solutions in the economy and society. The good practice may also constitute an inspiration for other clusters to carry out in-depth research and development activities, both for the benefit of cluster members as well as entire industries.

*Mariusz Citkowski Phd – chairman of the Metal Processing Cluster Council, Institute of Management at the University of Bialystok:*

*"Thanks to a close cooperation between science and business, we can implement dedicated analytical tools. As a consequence, we can state that the economic situation barometer carried out by us is widely regarded as a good practice both in the region and in Poland. The solution is highly appreciated by entrepreneurs, because thanks to it they have gained reliability and stability of data that they can compare with data from the Central Statistical Office, which makes it easier for them to make operational or investment decisions".*

## 6.2. Good international practices

### 6.2.1. „Production France!”

Name of good practice and cluster name	„ Production France!” – MECALOIRE	
Key area of good practice		Counteracting the effects of the COVID-19
Other areas of good practice		Cooperation with the environment
Purpose and circumstances of introducing good practice	<p>Due to the outbreak of the COVID-19 pandemic, it was possible to notice a high risk of breaking the supply chain from production plants located in Asia to their sales markets in European countries. Cluster members realized the limitations of globalization as well as difficulties with the supply and the logistics chain related to it. The aim of the approach, initiated on the initiative of the Mécaloire cluster, is to prepare an offer for companies wishing to transfer their production, factory, or modernize production lines.</p>	
Description of good practice	<p>The cluster brings together companies from the mechanical and metallurgy sectors, as well as industrial partners in the region (businesses within a maximum of 2 hours from Saint Étienne). One of the desired trends is to shorten the supply chain. The Production France initiative aims to attract buyers from large French groups and ETI managers to relocate, thanks to a complete and competitive offer at the level of the subcontracting chain, repatriation of production and their chains, as well as support in terms of modernizing machinery parks.</p>	
The effect of introducing good practice	<p>In its portfolio, the cluster offers skills, methods, as well as human and material resources enabling for a reliable and quick transfer and relocation of production. The undertaken actions also contribute to shortening supply chains.</p>	
Possibility to use good practice	<p>Many regions of the world struggled with the problems that took place after the outbreak of the pandemic. Polish clusters, especially industrial clusters, copying solutions</p>	

developed under the Production France initiative could help counteract these problems in the future.

### 6.2.2. Complete value chain in terms of marine cleaning and waste disposal (Marine Recycling Cluster)

Name of good practice and cluster name

Complete value chain in terms of marine cleaning and waste disposal – Marine Recycling Cluster

Key area of good practice



Impact on the natural environmental

Other areas of good practice



Development of cooperation in the cluster

Purpose and circumstances of introducing good practice

The good practice addresses the identified need of a high demand for products and services that can improve the cleaning of the seas and prevent pollution of oceans. The cluster wants to pave the way to cleaner seas in the world thanks to smart technologies and modern methods. The system of selecting cluster members, based on a strictly defined value chain in the above area, can be considered particularly valuable.

Selecting members is deliberate and based on substantive foundations, with each entity having a specific place in the value chain.

Description of good practice

The Marine Recycling Cluster consists of 24 members and partners based in Vesterålen and Lofoten. These entities work together to become Norway's technology leaders in the fight against global marine garbage.

A network of companies is developing a complete value chain in terms of professional mapping, cleaning and handling of marine litter. It works with marine and environmental authorities, various types of organizations, and private companies - in Norway and abroad.

The effect of introducing good practice

The cluster maintains a high focus of its activity in the identified value chain, which works in favor of the effectiveness of undertaken actions as well as tightening the cooperation between its members.

Possibility to use good practice

Cluster coordinators should decide whether their goal is a quantitative growth of the cluster in terms of the number of members or a more conscious, deliberate selection of entities that are their members, so that they fit more closely into the value chains strictly defined in the cluster. In the latter case, it is possible to take advantage of the Norwegian cluster model.

### 6.2.3. Circular Economy Initiative (Luxembourg Creative Industries Cluster)

Name of good practice and cluster name

Circular Economy Initiative – Luxembourg Creative Industries Cluster

Key area of good practice



Impact on the natural environmental

Other areas of good practice



Development of cooperation in the cluster

Purpose and circumstances of introducing good practice

The cluster brings together entities that operate in the broadly understood creative industries. The Circular by Design initiative puts creative minds at the centre of the solution-finding process. It is aimed at the Luxembourg sector of creative industries, and it focuses on developing new design solutions and innovative business models accordant with the principles of the circular economy. The good practice addresses major environmental challenges including the depletion of natural resources and the generation of waste.

Description of good practice

In order to take advantage of the possessed resources more wisely, the cluster undertakes such initiatives as those in terms of promoting actions in the field of circular economy. The so-called *circular economy* is a concept according to which products, materials, and raw materials should remain in the economy for as long as possible and waste, if it is generated, should be treated as secondary raw materials that can be recycled, processed, and reused.

As part of its activity, the cluster organized a competition aimed at companies from the creative industry in order to develop new design solutions and ideas, in accordance with with the principles of a circular economy. Organizing the "Circular by Design Challenge" competition encourages

creative minds to develop new solutions and aims to accelerate the transition from a linear economy to a circular economy by combining creative minds with technology, production, and traditional industry. The competition is based on supporting early stage ideas, business models, and design actions in 5 different categories: fashion design, interior design, product design, product as a service, mobility, and connecting creative entrepreneurs with technology, manufacturing, and traditional industries.

The effect of introducing good practice

The Luxinnovation Creative Industries Cluster has managed to engage industry partners who are ready to implement and produce the best ideas in the categories included in the competition. The "Circular By Design Challenge" is an opportunity for creators to compete for a place in a 12-week coaching program and the opportunity to develop their ideas for services or products in a circular economy with one of the partners. In each category the winner is rewarded with a partnership agreement with industry partners in order to jointly produce and implement the idea.

Possibility to use good practice

In order to meet the challenges faced by clusters, it is necessary to increase the efficiency while using less raw materials, as well as reducing costs and limiting the environmental impact. Thanks to more efficient production processes and better management systems it is possible to significantly reduce the amount of generated pollution and waste as well as save water and other natural resources. Innovative solutions aimed at reducing the negative impact of humans on the environment have an impact on implementing the concept of sustainable development.

Establishing cooperation with creative sectors may also be inspiring for Polish clusters. That is because the effects of the "spreading" of the functioning of creative sectors and the role they play in other areas of the economy are becoming more and more visible. The creative sector is a very productive economic sector, hence its direct contribution to stimulating innovation, both within the sector and in other areas of the economy.



## 7. Conclusions

### 7.1. Trends in Polish clusters in 2010-2019

The current edition of the study was carried out in 2021 but covered the period of analysis of phenomena over the years 2018 and 2019. The subsequent start of the project was the result of m.in covid-19 pandemic. Comparing the results obtained in each edition of a study is subject to possible errors due to m.in.: different cluster selection, how benchmarks and median calculations are calculated based on unitarization of results<sup>42</sup> and modifications in the scope of sub-areas and indices. In addition, the 2020 edition study contractor did not have access to the actual values of indicators from previous editions. As a result, comparing the values of synthetic indicators will not provide precise information between the different editions of the study. The rest of the trend analysis was based primarily on the actual data of several indicators that were cited in the 2018 report.

- In a 2010 study, 47 clusters of 1866 entities participated in the study, including 1469 entrepreneurs. By contrast, in the 2012 study, the number of entities belonging to the 35 clusters surveyed was around 1535 organisations, of which 1137 were undertakings. In the next edition of the 2014 survey, the number of entities belonging to the 40 clusters surveyed was already 1917 (1550 enterprises). In the 2018 edition, the number of entities was already 3374 (2718 enterprises). According to the data collected, between 2018 and 2019, 872 organisations became new members of the clusters surveyed, while 326 organisations resigned during the same period. Based on data from coordinators, it can be said that at the end of 2019, in the 41 clusters surveyed (an increase of 1 cluster compared to the 2018 edition of the survey), the number of members was 3813 organizations (3133 enterprises). In recent years, we can talk about further growth, but no longer so dynamic, as between the 3rd and 4th edition of the benchmarking<sup>43</sup>.
- Over the last few years, there has been a significant increase in employment in entities that are members of the clusters studied. In 2014, it was 96.5 thousand people. In the 2018 edition, it was already 284.8 thousand people. According to estimates from the 2020 edition, the total employment among cluster members amounted to 514.6 thousand people. Total employment in member entities almost doubled compared to the previous edition.
- The benchmarking edition of 2018 saw a decrease in the number of people seconded to clusters in the coordinator's institution (the total number of staff decreased from 93.4 full-time jobs in 2014 to 89.9 full-time jobs in 2018). In the 2020 edition, this indicator increased significantly to 135 posts. This can mean a slight improvement of the situation of clusters within human resources and increase the ability to initiate a variety of development activities. Possible errors in estimating these phenomena may be due to

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<sup>42</sup>In the process of unitarily, the results are lost information about the units of measure and the actual values achieved by the clusters. For example, a value of 1 is the best-rated cluster in a given criteria, without being able to decide to which value it refers (if the actual values are not known).

<sup>43</sup> There was no survey in 2016.

the selection of different clusters that participated in the 2018 and current editions of the study.

- In the period 2012-2014, the budget of the clusters surveyed amounted to PLN 139.4 million. In the period 2016-2017 it was more than four times less, at the level of PLN 35.25 million, including external funds PLN 23.5 million. In the period 2018-2019, the value of the budgets of the clusters studied increased almost 10-fold, amounting to PLN 222.1 million (with note changes in the sample of clusters studied). Own resources amounted to more than PLN 17.3 million, while more than PLN 200 million came from external funds (mainly grants received for actions consistent with cluster coordination).

## **7.2. Specific and atypical phenomena for different cluster groups**

The following are specific and atypical phenomena for the different cluster groups that have been identified and described at the stage of the study:

- Although the negative impact of the COVID-19 pandemic occurred during the period beyond the survey period (2018-2019), there was a very significant impact of the pandemic on the way clusters functioned at the implementation stage. This applies in particular to the digitisation of processes in the cluster, including the transfer of meetings to virtual space. Clusters have found themselves quite well in a new reality. Paradoxically, there were voices from cluster coordinators (at the stage of the survey in this group of respondents) that the pandemic increased the attendance of cluster members during meetings (no need to travel).
- Polish clusters have quite commonly stopped renewing certificates granted by the European Secretariat for Cluster Analysis (especially for the silver badge, where only one Polish cluster of the previous six still has an active certificate). This conclusion was made at the stage of the study of cluster coordinators (as a result of the analysis of certain side threads that appeared during interviews). This is due to changes at the level of cluster certification bodies. Eucles (European Cluster Labelling Excellence Structure) will take over this role in the years to come. It can be inferred from the opinions of representatives of some clusters that, on the eve of significant changes in certification, it makes little sense to apply for quite costly licenses for an organisation that is about to cease its activity in this area. Especially once the organisational framework for the implementation of new solutions has been prepared.
- At the stage of recruitment for the study, there was a group of several clusters formed in the last 2-3 years, which has high development ambitions. These ambitions are manifested in m.in. adopted solutions in the field of management, communication or digitization processes, which can be observed in longer-running clusters, or in the list of strategic objectives for obtaining the status of the KNC. Most of these clusters did not meet the criteria for participating in the current benchmarking edition, but it is worth remembering them in the context of subsequent editions. The activity of these clusters is an excellent example of bottom-up initiatives that somewhat er in the face of repeated thesis that clusters were formed mainly during the period of availability of funds to finance the initial phase of their activity. At the same time, this situation shows that there is still some potential to create new clusters in Poland.

### 7.3. Strengths and weaknesses of clusters

The assessment of cluster strengths and weaknesses used the median value of cluster ratings across sub-areas. The strengths identified were those of the examined elements for which the median rating for the whole group of clusters studied exceeded 0.20 and the weaknesses were those for which the median did not exceed 0.10.

**Table 4. Strengths and weaknesses of the surveyed clusters (median value in brackets)**

Strengths of clusters	Weaknesses of clusters
Management processes (0.61)	Impact on the natural environmental (0.01)
Specialization and advanced technologies (0.44)	Financial resources (0.03)
Cluster digitization (0.43)	Development of cooperation (0.04)
Cluster communication (0.37)	Development of innovation (0.06)
Competence development in the cluster (0.26)	Potential for internationalisation (0.08)
Market activity (0.25)	Infrastructure resources (0.09)
Human resources (0.25)	International activity (0.12)
Export and pro-export activities (0.21)	

Source: Authors' analysis based on the cluster coordinator survey (N=41).

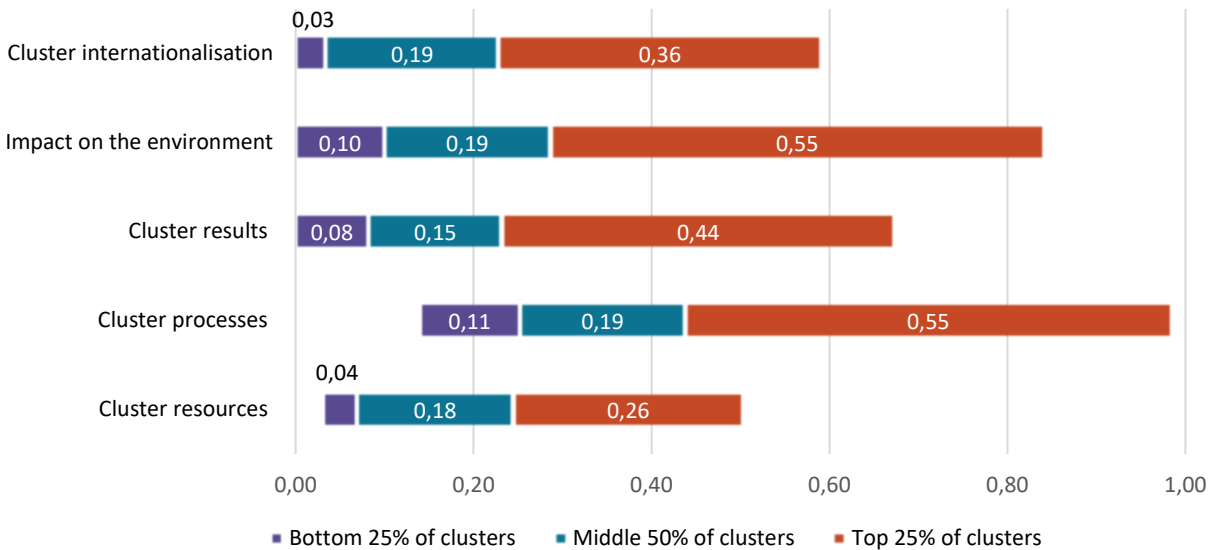
On the basis of the results obtained in the study, it can be concluded that the strength of Polish clusters is primarily the area concerning cluster processes (management processes, digitization, communication, market activity, in addition, specialization and technological advancement, as well as human resources and competence development).

The weakest sides of clusters include environmental impact, financial and infrastructure resources, cooperation development and innovation development. In addition, the potential for internationalisation and international activity have been poorly assessed.

The weaknesses identified are particularly noticeable in clusters with a small number of members, with a relatively short duration of operation and without KNC status. The KNC achieved a median value of less than 0.10 in only three sub-areas, i.e. development of cooperation, development of innovation and environmental impact. Weaknesses are less concerned with clusters created by 2010. In case of this group of clusters, the indicated weaknesses are not so much clearly perceived.

Additional conclusions were provided by an analysis of the distribution of synthetic indicators obtained by cluster (bottom 25%, middle 50%, top 25%). The analysis in this respect showed that the largest variation between clusters concerned the best of them (range of values: from 0.26 to even 0.55). This means that there was a group of several clusters in this group that achieved significantly better rates than the other few dozen included in the study. This is an argument that particularly weaker clusters should not compare their position with the value of indicators for the best clusters, but rather to averages (statistical annex), median or boundary ranges for average clusters.

**Graph 71. The values of synthetic indicators for groups of clusters (bottom 25%, middle 50%, top 25%)**



Source: Authors' analysis based on the cluster coordinator survey (N=41).

The graph also illustrates the situation where clusters appeared in the study for the first three areas (internationalisation, environmental impact, cluster results) which showed no practical activity or achievements. In the case of processes in a cluster, moving the bar to the right means that even in the category of the weakest clusters, some activity and achievements can be observed in this area.

## 8. Recommendations

The most important sources of recommendation formulation are:

- Benchmarking results, including analysis of cluster strengths and weaknesses. Weaknesses inspired the identification and description of recommendations to improve the situation.
- Qualitative conclusions from interviews with representatives of the clusters studied. During the implementation of the project, there was often a situation in which representatives of clusters provided numerous additional information about the health of a given cluster or more broadly clusters in Poland, together with recommended solutions.
- Analysis of good domestic and foreign practices as inspiration for the implementation of best practices in other clusters.
- Surveys of cluster members, especially in areas that can be considered as weaknesses in cluster activity.

The recommendations were made for both the cluster coordinators themselves, as well as other organizations that form the cluster ecosystem in Poland (government institutions i.e. local government institutions, government agencies, business environment institutions and scientific units).

Recommendation name	Recipient	Content of the recommendation
Undertaking activity aiming at searching for and obtaining new sources of financing (internal and external)	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ Institutions from the business environment</li> </ul>	Financial resources, which are currently one of the weaknesses of the clusters studied, are at the same time a decisive factor in ensuring their long-term activity and efficiency. They can both stimulate and limit the successful achievement of the objectives of cluster operations, so adequate management of financial resources is required. This makes it necessary to constantly solicit capital raising, but also, for example, to link membership fees more favourably to the services offered by cluster coordinators or to adapt the offer of financial institutions to the current needs of clusters.
European benchmarking (KNC against European structures)	<ul style="list-style-type: none"> <li>▪ government institutions, government agencies</li> <li>▪ cluster coordinators</li> </ul>	National Key Clusters distanced other clusters for most benchmarking sub-areas (with much better results) in terms of

Recommendation name	Recipient	Content of the recommendation
		<p>values obtained. For this cluster group, the analysis of results usually boils down to which of the first 10-15 places a given KNC cluster occupies. Therefore, it is worth considering extending the scope of benchmarking to an international perspective or launching additional research in parallel. The possibility of comparing the KNC to the European leader (e.g. clusters with a silver or gold ECEI badge currently or in the past<sup>44</sup>), should bring significant added value to the study. To avoid generating high costs for such an endeavour, it is worth identifying a group of key indicators from the current study (approx. 30-40), with the highest informative value. At the same time, these should be indicators that are easy for cluster coordinators to identify (abandoning indicators where detailed knowledge of processes and initiatives on the part of cluster members is required). To get valuable results for &amp; comparisons from the KNC' s point of view, it would be enough to get data from about 20-30 foreign clusters whose high position is or has been certified with a silver or gold ECEI badge).</p>
<p>Sharing real-world data from a given benchmarking edition with performers of subsequent editions of the study (the data may be</p>	<ul style="list-style-type: none"> <li>▪ government institutions, government agencies</li> </ul>	<p>The current way in which indicators are unitary practically excludes the possibility of comparing results between successive editions of the study. It results from</p>

<sup>44</sup>The Esca (European Secretariat for Cluster Analysis) award system will soon be replaced by a new initiative called EUCLES (European Cluster Labelling Excellence Structure).

Recommendation name	Recipient	Content of the recommendation
confidential), modifying the way indicators are unitarized		the situation, in which each time the minimum and maximum values changes of the indices which significantly affect the unitized values <sup>45</sup> . It is recommended that future benchmarking performers have access to actual data from previous editions of (or at least minimum and maximum values for each indicator). It would then be possible to adopt the same minimum and maximum indicators for unitization, thus allowing for a full comparison of results between editions.
Development of cluster offer and construction of service portfolio	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ scientific units</li> <li>▪ Institutions from the business environment</li> </ul>	<p>Cluster coordinators are met with quite a lot of interest from their members about the service offer. This applies in particular to the following categories of services:</p> <ul style="list-style-type: none"> <li>▪ Improving competences (training, workshops, courses). This type of support depending on the subject matter used from approx. 10 to 40% of members. A further 30-50% of cluster members are interested in such an offer.</li> <li>▪ Cluster members are also interested in additional advisory services from the coordinator. Depending on the subject matter, this type of support is interested from approx. 35 to 42% of cluster members. The greatest interest can be enjoyed by</li> </ul>

<sup>45</sup>In the current edition of the study, the highest number of coordinators seconded to the cluster was 10. This cluster has a level 1 level unitarized rate, and the remaining clusters have proportionally less. For example, if the highest declared value is 15 people in the next edition, the cluster will also have an unitarized value of level 1. In turn, a cluster of 10 delegates will get a value of 0.67. This example illustrates a situation where comparing the values of upgraded indicators is difficult.

Recommendation name	Recipient	Content of the recommendation
		<p>technological advice and monitoring of technological trends.</p> <ul style="list-style-type: none"> <li>▪ Services for internationalisation. This applies in particular to advice and the organisation of joint events (e.g. going to fairs or economic missions).</li> </ul> <p>The results of the study justify the further development of the service offer by the cluster coordinators.</p>
Increasing the impact on the environment	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ government institutions, government agencies</li> </ul>	<p>Implement a cluster-based development policy model. Given the increase in cluster members and employment of in member entities, leading clusters can play an increasingly important role in the economic development of the region and the country. The largest clusters can take on the role of financial intermediaries at regional level in the various types of support instruments as part of the continuation of regional operational programmes. This may include areas such as internationalisation and competence-raising.</p> <p>In addition, clusters can also take over other public tasks through accumulated know-how, organisational capacity and critical mass of members (in the case of large structures). This could include areas such as promoting R&amp;D cooperation, developing innovation or co-creating educational opportunities at different levels to fit the needs of the labour market.</p>



Recommendation name	Recipient	Content of the recommendation
Selection of cluster members generating synergies between them, based on a well-defined value chain in a given area	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> </ul>	<p>Analysis of the structures of different clusters in Poland makes it possible to conclude that a large group of clusters is still developing primarily quantitatively, i.e. in terms of the number of members. This sometimes leads to a situation where some clusters are dominated by, for example, various types of corporate and IT organizations, rather than companies that are the backbone of the substantive cluster.</p> <p>Meanwhile, good practice from Norway illustrates an approach, in which recruitment based on the possibility of including a new member in one of the defined value creation chains in the cluster is of paramount importance. In this way, it promotes building relationships between members, building a common product offer and conducting R&amp;D work, where each entity will know its role in the project.</p>
Supporting companies in developing the competences and qualifications of employees and in recruiting new staff	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ scientific units</li> </ul>	<p>Engaging in the creation of dual studies, taking up activities aimed at adapting the educational offer of universities to the needs of the labour market, promoting technical education and activities in this area are a response to the lack of sufficient number of qualified staff. Focusing activity on acquiring new staff and raising competences.</p>
Organisation of internal mentoring	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ scientific units</li> </ul>	<p>Supporting cluster members, especially small and medium-sized enterprises, through knowledge transfer and direct contact with</p>

Recommendation name	Recipient	Content of the recommendation
		mentors, such as large international corporations involved in the operation of clusters or scientific units. Many companies face similar challenges. By creating advisory instruments, it is possible to stimulate the creation of innovative ideas and projects.
Ensuring effective internal and external networking	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ Institutions from the business environment</li> </ul>	Networking activity allows for the development and intensification of network links between all participants in the innovation system. Networking enables you to gain new customers, can accelerate the development and launch of new products and increase the knowledge resources available to enterprises. Cluster coordinators, as entities associated with both entrepreneurs and with the scientific or financial community, are natural animators of such activities. Such meetings should extend beyond the boundaries of the cluster.
Creating the conditions for the internationalisation of activities	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ Institutions from the business environment</li> <li>▪ government agencies, agencies</li> </ul>	The internationalisation of activities is one of the less rated areas of activity of clusters. At the same time, there is a high demand for business support in this area. It is recommended to support cluster coordinators in the new financial perspective in such a way that they can become more involved in advisory and training and organisational activities (joint trips to trade fairs and economic missions).
Spread of good practices	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> <li>▪ government agencies, agencies</li> </ul>	Only the current benchmarking edition has pre-identified more than 60 good practices, i.e.

Recommendation name	Recipient	Content of the recommendation
		<p>solutions, actions, initiatives implemented in different clusters. Due to the volume of the report, only twelve of them were described. It is worth taking care of to disseminate good practices among cluster coordinators in the form of not only the report itself and the summary event. One idea could be to create an interactive tool, in which cluster coordinators could, by going through a string of questions, obtain a filtered set of good practices that can be implemented in a given cluster (along the lines of filtering questions for EU grants).</p>
<p>Increasing the interest of clusters in the positive impact on the natural environment</p>	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> </ul>	<p>The current benchmarking edition uses a new sub-area, i.e. the impact of clusters on the natural environment. It turned out that around half of the clusters do not take virtually any action in this regard. Given the post-2020 objectives of cohesion policy (one of the objectives for a more environmentally friendly and zero-emission Europe), clusters should be sensitised to the need to increase activity in this area.</p>
<p>Promotion of Industry 4.0 solutions, digitisation of processes and implementation of solutions in the area of key enabling technologies (KETs)</p>	<ul style="list-style-type: none"> <li>▪ cluster coordinators</li> </ul>	<p>Among the clusters studied, there is a group of clusters with extensive experience in the development and implementation of Industrial 4.0 solutions, process digitisation (ICT clusters) and KETs. Implementing such solutions in an era of economic digitisation and globalisation of value chains is essential to maintain the competitiveness of businesses. It is recommended that cluster</p>

Recommendation name	Recipient	Content of the recommendation
		<p>coordinators, which can be considered as technology and solution providers, create an offer for less advanced clusters in these areas (solution consumers). This should lead to mutual benefit. On the one hand, it can provide additional orders for solution providers and, on the other hand, for their customers the opportunity to increase their competitiveness.</p>

## 9. Attachments

### 9.1. Charts index

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### 9.3. Statistical annex

The following are presented in the tables summarizing the selected measures calculated for the sub-areas and main areas of the study. In order to be able to determine subsynthetic and synthetic indicators for specific areas, it was necessary to unitarily determine values. The indicators collected in the study are expressed by different units and take values from different numerical ranges. In order to be comparable (the demand for comparability of variables) they need to be harmonised. For this purpose,, unitarization was made in accordance with the provisions of the OSD. The purpose of unitarization was to obtain variables with a uniform range of variability, defined, classically, by the difference between their maximum and minimum values, which are consistently equal to 1. The harmonisation of the range of values of stimulant variables whose high values are desirable in terms of the overall characteristics of the phenomenon under examination (in this benchmarking study all designated indicators are stimulants) was carried out in accordance with the formula:

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

Gdzie:

$x_{ik}$  – the actual value of the variable  $x_{ik}$

$Z_{ik}$  – the normalized value of the variable  $x_{ik}$

$i$  – cluster number ( $i = 1, 2, 3, \dots, n$ )

$k$  – index number ( $k = 1, 2, 3, \dots, m$ )

$\max_i \{x_{ik}\}$  – the maximum value of  $k$  index

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

Table 5. List of selected measures for clusters in general

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development in the	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.03	0.01	0.00	0.03	0.09	0.00	0.05	0.06	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Pierwszy kwartyl	0.11	0.05	0.00	0.07	0.43	0.28	0.15	0.14	0.08	0.13	0.28	0.01	0.00	0.17	0.08	0.12	0.06	0.00	0.11	0.10	0.02	0.00	0.04	0.03	0.09
Median	0.25	0.09	0.03	0.13	0.61	0.37	0.25	0.17	0.18	0.38	0.36	0.04	0.04	0.26	0.13	0.19	0.11	0.01	0.35	0.21	0.08	0.06	0.21	0.13	0.16
Average	0.26	0.12	0.10	0.16	0.60	0.37	0.29	0.22	0.23	0.40	0.35	0.09	0.13	0.27	0.16	0.23	0.20	0.11	0.38	0.23	0.12	0.10	0.22	0.15	0.17
Third quartile	0.36	0.15	0.18	0.24	0.74	0.49	0.43	0.25	0.40	0.60	0.44	0.10	0.17	0.36	0.23	0.33	0.19	0.06	0.62	0.29	0.20	0.14	0.36	0.23	0.23
Benchmark	0.77	0.43	0.49	0.43	1.00	0.74	0.86	0.67	0.88	1.00	0.73	0.71	0.80	0.64	0.59	0.67	1.00	1.00	1.00	0.74	0.41	0.76	0.70	0.56	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 6. List of selected measures for clusters with the KNC status

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.13	0.02	0.03	0.07	0.59	0.06	0.13	0.12	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
First quartile	0.26	0.06	0.14	0.20	0.70	0.36	0.24	0.15	0.07	0.14	0.32	0.03	0.03	0.31	0.13	0.21	0.04	0.01	0.07	0.12	0.09	0.07	0.23	0.16	0.17
Mediana	0.32	0.11	0.21	0.26	0.74	0.49	0.38	0.21	0.20	0.35	0.44	0.07	0.09	0.36	0.23	0.33	0.19	0.04	0.38	0.34	0.17	0.14	0.44	0.27	0.24
Average	0.39	0.13	0.23	0.25	0.77	0.46	0.37	0.28	0.27	0.34	0.41	0.14	0.22	0.39	0.25	0.31	0.33	0.20	0.40	0.31	0.18	0.20	0.38	0.25	0.25
Third quartile	0.53	0.17	0.28	0.32	0.83	0.58	0.45	0.37	0.44	0.42	0.47	0.10	0.30	0.52	0.30	0.40	0.65	0.18	0.72	0.42	0.25	0.24	0.50	0.36	0.30
Benchmark	0.77	0.43	0.49	0.43	1.00	0.74	0.86	0.67	0.88	0.95	0.73	0.71	0.80	0.64	0.59	0.67	1.00	1.00	0.92	0.74	0.41	0.76	0.70	0.56	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 7. List of selected measures for clusters without KNC status (other)

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.03	0.01	0.00	0.03	0.09	0.00	0.05	0.06	0.02	0.00	0.12	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05
First quartile	0.10	0.04	0.00	0.06	0.40	0.22	0.12	0.14	0.08	0.13	0.24	0.00	0.00	0.12	0.06	0.12	0.06	0.00	0.12	0.09	0.02	0.00	0.01	0.02	0.08
Median	0.16	0.07	0.01	0.08	0.50	0.31	0.18	0.16	0.15	0.44	0.33	0.04	0.03	0.21	0.10	0.17	0.08	0.01	0.34	0.20	0.06	0.02	0.08	0.07	0.14
Average	0.19	0.11	0.03	0.11	0.50	0.32	0.24	0.18	0.21	0.43	0.31	0.06	0.07	0.20	0.11	0.18	0.12	0.05	0.36	0.18	0.09	0.05	0.13	0.09	0.13
Third quartile	0.28	0.14	0.02	0.14	0.62	0.39	0.31	0.23	0.30	0.69	0.37	0.09	0.11	0.29	0.15	0.22	0.14	0.04	0.59	0.25	0.10	0.08	0.25	0.13	0.17
Benchmark	0.50	0.38	0.21	0.32	0.91	0.63	0.66	0.34	0.69	1.00	0.52	0.24	0.35	0.46	0.31	0.37	0.78	0.51	1.00	0.42	0.30	0.23	0.38	0.27	0.27

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 8. List of selected measures for clusters created by 2010

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.06	0.02	0.00	0.06	0.40	0.06	0.13	0.12	0.02	0.00	0.26	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.03	0.08
First quartile	0.17	0.07	0.02	0.07	0.66	0.30	0.22	0.17	0.09	0.12	0.34	0.04	0.02	0.25	0.13	0.20	0.06	0.00	0.00	0.12	0.08	0.05	0.19	0.12	0.14
Median	0.26	0.11	0.15	0.20	0.71	0.46	0.29	0.22	0.26	0.35	0.37	0.06	0.08	0.33	0.17	0.26	0.14	0.04	0.39	0.21	0.11	0.10	0.32	0.18	0.21
Average	0.28	0.15	0.15	0.19	0.72	0.41	0.36	0.24	0.31	0.37	0.40	0.10	0.18	0.33	0.21	0.29	0.25	0.09	0.37	0.25	0.15	0.16	0.33	0.21	0.21
Third quartile	0.38	0.19	0.21	0.26	0.81	0.52	0.44	0.30	0.47	0.48	0.47	0.11	0.29	0.41	0.27	0.35	0.20	0.07	0.65	0.35	0.22	0.19	0.47	0.32	0.26
Benchmark	0.59	0.43	0.47	0.43	1.00	0.74	0.86	0.49	0.88	0.95	0.73	0.57	0.80	0.60	0.57	0.67	1.00	0.71	0.90	0.63	0.41	0.76	0.70	0.56	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 9. List of selected measures for clusters created in 2011-2015

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.06	0.01	0.00	0.03	0.09	0.00	0.05	0.06	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
First quartile	0.11	0.04	0.00	0.06	0.40	0.21	0.13	0.14	0.06	0.13	0.22	0.00	0.00	0.15	0.06	0.12	0.06	0.00	0.17	0.10	0.02	0.00	0.00	0.02	0.08
Median	0.24	0.06	0.02	0.13	0.50	0.37	0.17	0.16	0.08	0.38	0.33	0.03	0.00	0.24	0.10	0.16	0.08	0.00	0.44	0.22	0.05	0.02	0.09	0.05	0.15
Average	0.27	0.10	0.08	0.15	0.53	0.35	0.25	0.21	0.17	0.43	0.32	0.08	0.09	0.24	0.14	0.18	0.15	0.12	0.43	0.22	0.09	0.07	0.16	0.11	0.16
Third quartile	0.35	0.15	0.11	0.24	0.71	0.39	0.40	0.23	0.23	0.70	0.39	0.10	0.15	0.32	0.22	0.21	0.11	0.04	0.68	0.28	0.14	0.09	0.29	0.18	0.18
Benchmark	0.77	0.35	0.49	0.37	0.91	0.68	0.66	0.67	0.50	1.00	0.53	0.71	0.58	0.64	0.59	0.41	0.86	1.00	1.00	0.74	0.39	0.42	0.50	0.37	0.35

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 10. List of selected measures for clusters created after 2015

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.03	0.04	0.00	0.06	0.30	0.30	0.08	0.09	0.08	0.00	0.23	0.01	0.03	0.05	0.05	0.11	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.08
First quartile	0.08	0.07	0.00	0.07	0.38	0.30	0.11	0.11	0.08	0.32	0.27	0.03	0.05	0.10	0.06	0.12	0.06	0.01	0.08	0.07	0.10	0.00	0.05	0.08	0.09
Median	0.12	0.11	0.00	0.08	0.42	0.32	0.19	0.13	0.19	0.44	0.29	0.05	0.09	0.16	0.09	0.21	0.13	0.10	0.12	0.14	0.17	0.06	0.10	0.12	0.13
Average	0.16	0.11	0.00	0.09	0.45	0.37	0.23	0.15	0.24	0.34	0.30	0.05	0.08	0.16	0.10	0.23	0.26	0.10	0.15	0.18	0.15	0.09	0.12	0.12	0.13
Third quartile	0.19	0.15	0.01	0.10	0.49	0.39	0.32	0.17	0.35	0.46	0.32	0.07	0.12	0.23	0.12	0.32	0.32	0.18	0.18	0.25	0.21	0.15	0.17	0.16	0.17
Benchmark	0.36	0.17	0.01	0.15	0.66	0.56	0.44	0.24	0.49	0.50	0.36	0.09	0.12	0.29	0.17	0.37	0.78	0.21	0.35	0.42	0.25	0.23	0.25	0.23	0.18

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 11. List of selected measures for clusters with 20-49 members

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas	
Minimum value	0.03	0.01	0.00	0.04	0.09	0.06	0.08	0.11	0.02	0.00	0.18	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.06
First quartile	0.07	0.04	0.00	0.06	0.40	0.24	0.11	0.15	0.07	0.06	0.23	0.00	0.00	0.08	0.05	0.11	0.06	0.00	0.06	0.07	0.02	0.00	0.00	0.02	0.02	0.08
Median	0.11	0.06	0.00	0.07	0.44	0.31	0.15	0.16	0.08	0.45	0.30	0.03	0.00	0.17	0.09	0.12	0.06	0.00	0.34	0.19	0.04	0.00	0.06	0.05	0.05	0.09
Average	0.15	0.10	0.01	0.09	0.47	0.31	0.22	0.18	0.16	0.42	0.29	0.05	0.04	0.17	0.09	0.14	0.08	0.05	0.37	0.16	0.08	0.02	0.12	0.07	0.07	0.12
Third quartile	0.17	0.13	0.02	0.09	0.50	0.38	0.20	0.22	0.21	0.65	0.35	0.09	0.03	0.25	0.12	0.16	0.11	0.01	0.60	0.23	0.09	0.04	0.22	0.11	0.15	
Benchmark	0.50	0.35	0.08	0.24	0.75	0.61	0.66	0.29	0.49	1.00	0.46	0.13	0.35	0.39	0.22	0.35	0.22	0.51	1.00	0.33	0.30	0.09	0.36	0.21	0.19	

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 12. List of selected measures for clusters with 50-99 members

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas	
Minimum value	0.06	0.01	0.00	0.03	0.13	0.00	0.05	0.06	0.02	0.00	0.12	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05
First quartile	0.13	0.03	0.00	0.08	0.41	0.29	0.12	0.10	0.07	0.04	0.27	0.01	0.03	0.23	0.10	0.18	0.08	0.00	0.00	0.09	0.02	0.02	0.04	0.03	0.03	0.11
Median	0.26	0.07	0.02	0.13	0.50	0.30	0.21	0.16	0.18	0.43	0.35	0.03	0.06	0.31	0.12	0.21	0.11	0.00	0.14	0.19	0.06	0.06	0.09	0.07	0.07	0.17
Average	0.24	0.07	0.06	0.12	0.54	0.36	0.21	0.16	0.18	0.43	0.31	0.04	0.15	0.27	0.15	0.25	0.25	0.07	0.26	0.21	0.10	0.09	0.17	0.12	0.12	0.15
Third quartile	0.33	0.09	0.06	0.14	0.70	0.50	0.27	0.21	0.26	0.71	0.38	0.05	0.14	0.33	0.20	0.33	0.18	0.16	0.45	0.33	0.15	0.11	0.26	0.18	0.18	0.19
Benchmark	0.42	0.19	0.28	0.26	0.88	0.63	0.43	0.35	0.46	1.00	0.47	0.09	0.80	0.46	0.39	0.41	1.00	0.21	0.90	0.42	0.37	0.33	0.56	0.35	0.24	

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 13. List of selected measures for clusters of 100 and more members

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.13	0.04	0.01	0.07	0.50	0.06	0.17	0.12	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
First quartile	0.26	0.10	0.15	0.24	0.69	0.35	0.29	0.17	0.09	0.25	0.36	0.06	0.03	0.24	0.15	0.21	0.04	0.02	0.23	0.17	0.09	0.11	0.22	0.16	0.17
Median	0.37	0.15	0.21	0.26	0.74	0.49	0.41	0.24	0.39	0.35	0.45	0.09	0.15	0.40	0.24	0.30	0.19	0.04	0.51	0.25	0.14	0.14	0.38	0.24	0.27
Average	0.40	0.18	0.22	0.27	0.76	0.44	0.42	0.29	0.34	0.36	0.44	0.17	0.19	0.37	0.24	0.30	0.28	0.19	0.46	0.31	0.18	0.19	0.36	0.24	0.25
Third quartile	0.53	0.22	0.26	0.32	0.88	0.58	0.49	0.36	0.50	0.42	0.50	0.18	0.29	0.52	0.30	0.37	0.43	0.13	0.72	0.41	0.25	0.24	0.48	0.32	0.30
Benchmark	0.77	0.43	0.49	0.43	1.00	0.74	0.86	0.67	0.88	0.89	0.73	0.71	0.58	0.64	0.59	0.67	0.86	1.00	0.92	0.74	0.41	0.76	0.70	0.56	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 14. List of selected measures for clusters from Eastern Poland

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.06	0.01	0.00	0.05	0.40	0.06	0.08	0.07	0.02	0.00	0.17	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.06
First quartile	0.16	0.05	0.00	0.08	0.47	0.20	0.15	0.14	0.07	0.15	0.26	0.03	0.01	0.18	0.09	0.12	0.06	0.00	0.16	0.11	0.05	0.03	0.00	0.06	0.09
Median	0.24	0.11	0.03	0.13	0.50	0.37	0.43	0.23	0.20	0.28	0.37	0.08	0.04	0.28	0.16	0.21	0.08	0.04	0.28	0.17	0.13	0.06	0.21	0.11	0.16
Average	0.26	0.13	0.10	0.16	0.60	0.34	0.35	0.26	0.23	0.30	0.35	0.12	0.12	0.28	0.17	0.22	0.17	0.17	0.34	0.23	0.15	0.10	0.23	0.16	0.18
Third quartile	0.33	0.15	0.19	0.24	0.71	0.44	0.49	0.31	0.39	0.45	0.42	0.11	0.17	0.38	0.24	0.34	0.18	0.12	0.54	0.28	0.25	0.12	0.35	0.27	0.24
Benchmark	0.58	0.35	0.43	0.33	1.00	0.63	0.66	0.67	0.55	0.68	0.53	0.71	0.58	0.60	0.59	0.49	0.86	1.00	0.87	0.74	0.39	0.42	0.70	0.39	0.35

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 15. List of selected measures for clusters from other regions

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas
Minimum value	0.03	0.01	0.00	0.03	0.09	0.00	0.05	0.06	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
First quartile	0.10	0.05	0.01	0.07	0.41	0.30	0.14	0.15	0.08	0.10	0.28	0.01	0.00	0.15	0.08	0.13	0.06	0.00	0.03	0.09	0.02	0.00	0.05	0.03	0.10
Median	0.25	0.08	0.02	0.13	0.67	0.37	0.22	0.16	0.10	0.42	0.36	0.04	0.04	0.25	0.12	0.19	0.11	0.01	0.41	0.21	0.07	0.06	0.18	0.13	0.16
Average	0.27	0.12	0.11	0.16	0.60	0.39	0.26	0.19	0.23	0.45	0.35	0.07	0.13	0.27	0.16	0.23	0.22	0.07	0.39	0.23	0.10	0.11	0.21	0.14	0.17
Third quartile	0.36	0.17	0.18	0.25	0.75	0.51	0.31	0.22	0.42	0.75	0.43	0.09	0.14	0.36	0.20	0.31	0.19	0.06	0.66	0.32	0.14	0.14	0.36	0.19	0.22
Benchmark	0.77	0.43	0.49	0.43	1.00	0.74	0.86	0.49	0.88	1.00	0.73	0.57	0.80	0.64	0.57	0.67	1.00	0.71	1.00	0.63	0.41	0.76	0.56	0.56	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 16. List of selected measures for clusters with the majority of members operating in high or medium-high technologies

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas	
Minimum value	0.03	0.01	0.00	0.03	0.30	0.06	0.08	0.07	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
First quartile	0.10	0.05	0.00	0.07	0.44	0.25	0.15	0.14	0.07	0.04	0.25	0.01	0.00	0.10	0.06	0.12	0.06	0.00	0.06	0.09	0.02	0.00	0.03	0.02	0.09	0.09
Median	0.26	0.11	0.02	0.13	0.59	0.33	0.28	0.17	0.11	0.28	0.34	0.04	0.04	0.25	0.12	0.17	0.06	0.01	0.19	0.17	0.09	0.05	0.16	0.11	0.15	0.15
Average	0.26	0.13	0.11	0.16	0.60	0.35	0.32	0.22	0.22	0.34	0.34	0.10	0.11	0.23	0.15	0.22	0.20	0.12	0.27	0.20	0.12	0.10	0.20	0.14	0.17	0.17
Third quartile	0.35	0.16	0.20	0.24	0.71	0.48	0.44	0.25	0.39	0.48	0.38	0.10	0.12	0.32	0.17	0.32	0.15	0.07	0.46	0.23	0.21	0.12	0.34	0.21	0.19	0.19
Benchmark	0.59	0.43	0.49	0.43	1.00	0.74	0.86	0.67	0.88	1.00	0.73	0.71	0.58	0.59	0.59	0.67	1.00	1.00	0.72	0.74	0.41	0.76	0.70	0.56	0.47	0.47

Source: Authors' analysis based on the cluster coordinator survey (N=41).

Table 17. List of selected measures for clusters with the majority of members operating in medium-low and low technologies

Measure	Human resources	Infrastructure resources	Financial resources	Cluster resources - total for the area	Management processes	Cluster communication	Market activity	Marketing activity	Innovation activity	Cluster digitization	Cluster processes - total for the area	Development of cooperation	Development of innovation	Competence development	Cluster results - total for the area	Cooperation with the environment	Influence on shaping the surroundings	Environmental impact	Specialization and advanced	Impact on the environment - total for the area	Potential for internationalisation	International activity	Export and pro-export activities	Cluster internationalisation - total for the area	Total for all areas	
Minimum value	0.10	0.01	0.00	0.04	0.09	0.00	0.05	0.06	0.02	0.00	0.12	0.00	0.00	0.15	0.06	0.12	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05
First quartile	0.15	0.05	0.01	0.07	0.44	0.32	0.14	0.15	0.08	0.35	0.31	0.03	0.01	0.23	0.10	0.19	0.11	0.00	0.43	0.24	0.06	0.04	0.06	0.05	0.14	0.14
Median	0.24	0.07	0.06	0.12	0.69	0.41	0.23	0.17	0.21	0.44	0.38	0.07	0.05	0.32	0.19	0.23	0.15	0.01	0.73	0.28	0.08	0.09	0.28	0.16	0.19	0.19
Average	0.28	0.11	0.10	0.16	0.59	0.41	0.23	0.20	0.26	0.51	0.37	0.07	0.16	0.34	0.19	0.24	0.20	0.08	0.58	0.28	0.13	0.11	0.26	0.17	0.19	0.19
Third quartile	0.34	0.13	0.17	0.25	0.75	0.51	0.29	0.23	0.42	0.74	0.46	0.09	0.23	0.41	0.25	0.32	0.22	0.04	0.85	0.34	0.16	0.17	0.43	0.26	0.25	0.25
Benchmark	0.77	0.38	0.28	0.37	0.88	0.68	0.47	0.38	0.69	1.00	0.49	0.18	0.80	0.64	0.39	0.35	0.78	0.71	1.00	0.63	0.37	0.33	0.61	0.37	0.30	0.30

Source: Authors' analysis based on the cluster coordinator survey (N=41).





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