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Trouble in Paradise? Barriers to Open Innovation in Regional Clusters in the Era of the 4th Industrial Revolution

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Abstract: The purpose of this paper is to provide an insight into the barriers faced by clusters as open innovation intermediaries. Literature review and an empirical study were performed, involving a nation-wide survey, case studies, and in-depth interviews with cluster actors involved in open innovation activities. This article conceptually links open innovation and clusters in the context of the fourth industrial revolution, empirically identifies barriers hindering open innovation in clusters, and indicates factors that might affect the open innovation processes in networked ecosystems. The findings confirm that the perception of barriers hindering open innovation in clusters differs between clusters already implementing open innovation and those which are still not active in this area. The findings contribute to a comprehensive understanding of the potential roles of clusters as open innovation intermediaries in the context of transitioning economies. With clusters playing a role in open innovation intermediary, public support at cluster level could increase openness to cooperation not only for member companies, but all participants in the regional innovation ecosystem.

Keywords: open innovation; regional clusters; open innovation intermediary; innovation ecosystem; 4th industrial revolution; innovation policy

1. Introduction

The fourth industrial revolution is a concept of organizational and technological changes along with value chains integration and new business models development that are enabled by innovative technologies, connectivity, and IT integration [1]. The advancement of integrated processes necessitates the development of proficiencies that will be to a greater extend relational, cognitive, and analytical, and will require close cooperation with the external partners of a company. To maintain and leverage capability to collaborate, however, it is necessary to manage open innovation models, involving different actors in the collaboration process, with different motivations and purposes [2]. The concept of open innovation (OI) holds that innovation capabilities are spread among many actors of an innovation ecosystem [2–4].

Regional clusters seem to provide a conducive environment to OI because significant and beneficial improvements to OI processes are induced by the geographical proximity [5–7]. Specifically, Simard and West [8] recognized regional clusters as a perfect framework to analyze OI because of the existence of two pivotal factors: networking involving many actors and the flows of knowledge. There is a suggestion [9] that the OI model leads to benefits that can be further augmented in regional clusters. The majority of existing literature, however, has concentrated on a micro-level view [10,11] or macro-economic issues [12,13]. We hope that this paper will contribute to the narrowing of this gap in research by taking a meso-level perspective in its examination of OI in the context of the fourth industrial revolution.

Clusters, especially in transition economies, are predominantly composed of small and medium enterprises [14]. Research shows that, while for large companies open innovation is a strategic choice to access complementary assets and capabilities better mastered by their partners, for SMEs, open innovation is a necessity as it helps compensate for the resources and assets that they lack [15–17]. There is a considerable variety in the effectiveness of different clusters, prompting a need to examine it further and to understand barriers to open innovation vis-a-vis regional clusters.

The above considerations were the basis for formulating research questions for an exploratory study:

Q1: What are the main barriers hindering open innovation in regional clusters?

As the attitude towards this relatively new phenomenon might be conducive to change alongside the experience of clusters and cluster members in introducing the open innovation model, the second research question of the study is

Q2: Do perceived barriers differ between clusters, active and non-active, in the area of open innovation?

This study was performed in the context of a transition economy. Transition economy is an economy which is changing from a centrally planned to a market economy [18]. To date, most of the research on open innovation can be found in advanced market economies. The importance of a transition economy context is justified as the institutional environment shapes the structure of political, social, and economic incentives, and thereby, limits the scope of the strategic choices available to individuals and organizations [19] and influences the use of open innovation strategies by companies [20]. It is believed [21] that research opportunities are available within this area to uncover processes which can surmount the low level of trust in order to facilitate cooperation in an innovation ecosystem.

The originality of this paper stems from this, it being the first focusing on practical experiences of clusters as intermediaries of open innovation in the context of transition economy. The paper might be seen as a contribution to the emerging literature on the spatial, cultural, and organizational dimensions of open innovation. Moreover, it expands previous research on cluster channels' likely impact on open innovation in SMEs.

This paper is structured as follows: First, the basic premises and the connections of open innovation and cluster concepts with regards to the fourth industrial revolution are discussed. Thereafter, the mixed-method research design is presented. In the next sections, the results of the study are presented and the barriers to the clusters' potential role as open innovation intermediaries are analyzed and discussed. Finally, conclusions, contributions, and limitations are presented.

2. Literature Review and Research Framework

Open innovation connects the micro-, meso-, and macro-levels of innovation analysis [22]. OI continuously enhances innovation competency by allowing business models to be dynamically created, altered, dissolved, and recreated. This occurs through the exchange of knowledge and co-development of products in loosely coupled networks of companies and other relevant actors [23].

This study builds on the conclusion that collaborating with external partners offers the benefit of risk diversification wherein uncertainties are shared. Adopting an OI model eliminates a company's dependence on its own R&D for innovation [3,24]. As a result, interorganizational networking must be used extensively to capture, incorporate, and expand on both knowledge and ideas [2]. Networking is essential when considering the OI model's two explicitly different processes: inside-out and outside-in. The former refers to the offering of knowledge, ideas, and innovation which have not been absorbed by the company. The latter reflects the augmentation of the company's own knowledge base by acquiring innovation from external sources or partnerships [25]. Therefore, both inside-out and outside-in processes benefit from networking with and the cultivation of a diverse group of external actors.

Many OI studies stumble upon the fact that there is no specific definition of open innovation activities but rather a wide range of cooperative undertakings—with different levels of maturity and openness. Open innovation is about the implementation of activities relevant to the acquisition and

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usage of external knowledge ranging from user-centered innovation, commissioning R&D services, and even going as far as the free revelation of knowledge [21,26]. None of these types of cooperation practices are clearly identifiable and partly overlap. In addition, the tools used to implement open innovations are very diverse in terms of their assumptions and the goal to be achieved as a result of their application.

Nonetheless, the research stream has identified multiple benefits of open innovation relating to an increase in individual company's innovation performance. It is acknowledged as an approach to the acceleration of internal processes and innovative efforts [27]. There is an expectation that OI will provide a company with access to knowledge and resources, which would otherwise be unavailable. There is a further expectation that it will enable firms to reach both strategic and financial potential from actively commercializing knowledge [21,22,25]. Increasing cooperation propensity, in that regard, is also seen as a prerequisite for sustainable Regional Innovation Systems [28].

However, multiple barriers to OI have been recognized in several studies [29–32]. Many companies, SMEs in particular, lack not only in resources but also in the capacity to take advantage of OI [33]. The same applies to the development of organizational learning routines that require resources difficult to provide, for instance, dedicated managers to coordinate multiple networks [34]. Apart from the resource constraints, there are a number of cultural and psychological barriers to OI such as the Not-Invented-Here (NIH) and Not-Used-Here (NUH) syndromes that impede open innovation practices. This is due to the fact that the implementation of open innovation model [22,35]

- Is based on the managers conducting a primary evaluation of external knowledge and competences;
- Is established through the company's employees' willingness to cooperate;
- Is evaluated against the ability of the company to take maximum advantage of intentional outflows and inflows of information.

Another main barrier that often emerges is the fear of competitors gaining significant knowledge when a company is revealing internal matter [36]. This gives rise to a paradox of openness—the creation of innovations often requires openness, but the commercialization of innovations requires some form of protection [37]. For this reason, important decisions as to the degree of openness are contingent on the range of appropriation strategies to which the company has access [38].

An intermediated network approach has repeatedly been proposed as a solution both to support collaboration for innovation and to overcome barriers, especially those which prevail in SMEs [39,40]. According to De Silva et al. [41] and Howells [42], intermediaries provide a supporting function for the cooperation of parties throughout the process of innovation. Innovation intermediaries are sometimes necessary because open innovation by its very nature is deliberate. An appropriate framework is called for as a prerequisite to facilitating open innovation practices for integrating and commercializing of external knowledge. Clusters seem to fulfill that role and are believed to be successful innovation intermediaries; however, most of the research in that area was performed in the advanced economies [31].

Innovation clusters are agglomerations of cooperating companies, organizations, and governments, which are geographically localized. There is an interactive pairwise collaboration between the various types of these networked actors. They enjoy a highly developed pattern of cooperation associated with the triple, and subsequently, the quadruple helix model, wherein society also plays a role [43–45]. A study by Claver-Cortes et al. [46] offers summarized evidence of the impact of clusters and takes into consideration factors such as capital productivity, labor productivity, and innovation intensity. Clusters contribute to the furtherance of the fourth industrial revolution by increasing the competitiveness and attractiveness of a region [47]. Due to policies of regional diversification and smart specialization, there is a suggestion that the 4th industrial revolution is an era "beyond clusters". However, according to Suwala and Micek [48], it is certainly not a "post cluster" era. Clusters which are successful are shown to be built on a "practice of clustering", i.e., a set of future-oriented activities carried out jointly by regional actors and coordinated in order to enhance the local texture [14,49,50].

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This study links clusters as industry networks with a concept of the fourth industrial revolution, implying technological and organizational challenges which afford opportunities for [51–53]

- Developing a more responsive management embracing a culture of openness and collaboration;
- Cultivating new skill sets among change agents;
- Creating and reinforcing networks of collaboration involving various partners.

Clusters seem to offer a conducive environment facilitating those challenges and implications. They provide a favorable knowledge environment, simplify and increase the efficiency of the business processes, and organize the policy-making in this area [14]. The fourth industrial revolution not only utilizes platforms, but also calls for a shift from value chains towards highly flexible networks of interconnected actors. Thanks to this, clusters appear to be fittingly positioned to act as central elements in such configurations.

Moreover, there are several global grand challenges that affect economies in all stages of development and call for open collaboration [21,54]. Unfortunately, although there has been increased adoption of open model of innovation in developed countries [55], firms from transition economies, such as Poland, distinctly fall short. In Polish conditions, companies are very reluctant to cooperate with scientific and research institutions [56]. However, the significant changes currently resulting from the fourth industrial revolution have presented new opportunities for leapfrogging to companies in transition economies.

3. Materials and Methods

This study is a part of a nation-wide, multi-stage research project on open innovation in clusters. It is of an exploratory nature because there is, to date, a lack of systemic investigation in the research into open innovation and clusters. The data used for this paper stem from two main data sources:

- A quantitative survey among coordinators of 31 clusters located in Poland;
- A qualitative analysis of two case studies of clusters, based on semi-structured personal interviews with different groups of stakeholders (9 actors from the two respective clusters).

3.1. A Survey

The subject of the survey was a cluster initiative, which is a cooperation platform and a tangible manifestation of cooperation between companies. The person filling in the questionnaire was the cluster coordinator, i.e., the potential or actual organizer of open innovation in the cluster. The selection of the sample was deliberate and covered the entire population of active cluster initiatives in Poland, which was estimated at 81 initiatives at the time of the study. Active clusters were those meeting the basic requirements of the cluster management standards developed by the Polish Agency for Enterprise Development. The criteria included having entities from business, science, and administration as members; conducting activities and events for the cluster participants; coordinating at least one joint project with cluster members; and having a website or other platform for remote communication with participants. It was decided to carry out the original survey among cluster coordinators, because as such they are involved in facilitating the innovative cooperation of member companies. Additionally, representing the entire community of participants, they often collect data on various activities performed by members [14].

An email with a dedicated link to the online survey was sent to all coordinators of the identified active clusters in Poland. In addition, information about the study was sent to the appropriate units of regional and local administration to be forwarded to clusters operating in a given region. A total of 31 cluster initiative coordinators completed the questionnaire, representing a return rate of 38.2%. It was concluded that the returned questionnaires are representative for the target population. Clusters represented 16 industries, with the most common industries represented being ICT industry; energy and renewable energy sources; biotechnology; food industry. The examined initiatives have been

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functioning on average for over 7 years (minimum 2 and maximum 14). The studied clusters had an average of 69 members (median 50). The smallest of the clusters had 12 members, and the largest over 300. The share of SMEs as cluster members was above 75% in all of the clusters taking part in the survey.

Open innovation may involve the use of various methods and tools. Despite several years of research in this field, the challenge for researchers is the diversity of practices of implementing an OI model especially in the network context. There is no official classification of open innovation activities, and all the more none on the cluster level. We operationalized open innovation activity at cluster level as a second-order construct, measured by 9 items. The open innovation activities were adopted to the cluster context from activities most commonly presented in the literature on open innovation regarding individual companies [57–60]. In the survey, the list of open innovation activities at cluster level consisted of following actions—cluster is actively engaging in and directly supporting:

- Acquiring expert knowledge (outside of member companies), e.g., designing a new product in the partnership of several companies, providing research and development facilities for members, partner investment projects;
- Technology transfer and license trading, e.g., support in purchasing a license to use a given technology, assistance in acquiring partners, consultancy in the field of intellectual property rights protection;
- Platforms and complex systems, e.g., creating a common product development platform for several cluster members, testing products in a real environment, demonstration projects;
- User-driven innovation, e.g., support cluster members in involving users in designing, testing or implementing new products;
- Knowledge crowdsourcing, e.g., organizing an open competition to solve a given problem or using a virtual community to implement new products;
- Open data, e.g., support in sharing or obtaining open data for business purposes;
- Social innovations directed to the public sector or communities, e.g., supporting the creation of products aimed at improving the quality of life of individual groups of people or entire communities;
- Design thinking, e.g., support in design activities using rapid prototyping;
- Mass customization, e.g., supporting member companies in offering customers individually tailored products on the mass market, but at relatively low prices.

Respondents were asked to indicate from a list the types of open innovation activities that are carried out at the cluster level, e.g., actively facilitated by the cluster coordinator. They were also asked to indicate the scale of these activities (small or large scale). In this study, it was assumed that open innovation activity is being undertaken in the examined cluster when at least one of the nine types of activities listed in the questionnaire was undertaken on a significant scale. The considerable scale of the activity indicates the involvement of various types of resources to implement an open innovation activity.

Five-point Likert-scale ranging from 1 (not important) to 5 (very important) was used to assess the barriers to open innovation at the cluster level as perceived by the cluster coordinators. Descriptive statistics were used to analyze the results. In a pilot study, a group of cluster coordinators completed the survey to check for understandability. The questions regarding barriers to open innovation at cluster level were asked both in the clusters performing open innovation activity as well as in those not performing such activities and were then compared. The barriers were adopted to the cluster context from the barriers faced by individual companies, especially SMEs [29–32]. Additionally, conclusions from the pilot study and an expert panel—earlier phases of the research project that this study is a part of—were taken into account [36]. In the survey, the list of barriers consisted of

- Significant costs of open innovation cooperation;

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- Costs in relation to expected effects;
- Concerns of member companies about intellectual property rights (IPR);
- Lack of knowledge about methods and tools of open innovation;
- Companies' fear of losing control over the innovation process;
- Unwillingness to delegate essential employees;
- Difficulties in managing joint open projects;
- Low potential to absorb innovations in companies;
- Companies feeling no need for open innovation.

3.2. Case Study Analysis

The case study analysis was applied to two clusters that operate in high-tech industries and carry out extensive open innovation activities. The selection of case studies was based on the classification of a phenomenon-driven approach, which is usually applied when the investigated phenomenon is dynamic and complex [61]. Cases were chosen from a pool of clusters which ranked the highest in the preceding survey in terms of the number and scale of different open innovation activities. The purposeful sampling was applied on the basis of possibility of clearly illustrating the studied issue. In addition, the cases were chosen to come from different industries and represent a different strategic approach to OI activities, which have given an additional perspective of comparing them with each other. In addition to research objectives, the selection of these specific cases was also dictated by the possibility of their use in business practice as a benchmark and a source of a good practice. One of the cases was an IT cluster with 120 members operating for 9 years. The second one was a biotech cluster with 40 members operating for 7 years. Both clusters have an over 75% share of SME among members. The clusters are located in different regions and perform many open innovation activities for their members. Both clusters were established through a bottom-up approach of companies and other ecosystem actors with a goal of enhancing effectiveness of these companies' business performance through coopetition.

In order to gain data for the case study, 9 semi-structured personal interviews (CAPI method) with actors from those two clusters were performed. The actors represented companies (6 actors), R&D or higher education institutions (2 actors), and a regional administration responsible for regional cluster and innovation policy (1 actor). All actors were actively involved in open innovation activity of selected clusters. The interviews were conducted in a semi-structured way, aimed to better understand the observed barriers. The interviews took place in the first quarter of 2018 and lasted between 45 and 60 min. All interviews were recorded, and transcriptions were subsequently made. Although an open approach was taken to permit different stakeholders to describe barriers to open innovation in their clusters, some supplementary questions were added in order to align the interviews and to allow for comparison of the data.

4. Results

4.1. The Survey

The findings of the survey study show that 17 out of 31 examined clusters (55%) engaged actively in open innovation activity, i.e., undertook at least one type of open innovation actions (on a significant scale) from the nine actions listed in the survey. Over 45% of clusters did not undertake in any of the types of open innovation activities. The ones that did, did on a very small scale. In accordance with the base line of this study, those clusters were then treated as not undertaking open innovation activity. The analysis and interpretation of research results was made, taking into account the division of clusters into the above two groups. No significant correlation was found between the type of barriers to OI and other grouping factors like age, size, or industry of the cluster.

The most common type of open innovation support for their members in the studied clusters were activities related to platforms and complex systems—14 surveyed clusters (45%) have undertaken such

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activities on a large scale. Obtaining expert knowledge from outside member companies was the second most popular type of open innovation activity. This type of activity was undertaken on a significant scale by the nine studied clusters (29%). Each of the groups of activities of the following types—social innovations, crowdsourcing, technology transfer, and license trading—were implemented by six clusters, respectively. Another type of OI activity—user-driven innovation—was implemented in five initiatives (16%). Fewer initiatives carried out design thinking (4% and 13%). The least popular activities are those related to open access to data and mass customization. Only a few initiatives (2 and 1, respectively) have implemented them on a significant scale (source hidden as it refers to a previous paper published by the same authors). All of the clusters participating in the study were planning to start or enhance support for open innovation for their members in the next 12 months.

In the study, cluster coordinators were asked to indicate the importance of the listed barriers to support open innovation among members on a five-point Likert scale. The responders assigned the most importance to the barriers related to difficulties in managing joint projects, concerns of participating companies about intellectual property rights. The third most important barrier was the assessment of costs in relation to expected effects. The least importance was assigned to a statement that the member companies did not feel the need for cooperation. The (weighted) average importance is presented in Table 1.

Table 1. Assessment of the barriers of open innovation in clusters (1–5 Likert scale).

Barriers of Open Innovation in Clusters [1] (1 = Not Important, 5 = Very Important)	Average for All Clusters (N = 31)	Average for Clusters Facilitating Open Innovation (N = 17)	Average for Clusters not Facilitating Open Innovation (N = 14)
difficulties in managing joint open projects	**4.2**	**4.1**	**4.3**
concerns of companies about intellectual property rights (IPR)	**4.1**	**4.1**	4.1
costs in relation to expected effects	**4.1**	**4.1**	4.1
lack of knowledge about methods and tools of open innovation (OI)	4.0	3.7	**4.4**
fear of losing control over the innovation process	3.9	3.6	4.1
low potential to absorb innovations in companies	3.9	3.6	4.1
significant costs of OI cooperation	3.8	3.5	**4.2**
unwillingness to delegate essential employees	3.5	3.1	3.9
companies feeling no need for OI cooperation	3.2	3.1	3.3

[1] The three most important barriers for a given group are marked bold and underlined.

Among the clusters undertaking open innovation, similarly to the results for all the clusters, the coordinators assigned the most importance to barriers related to difficult management of a joint project and companies' concerns regarding intellectual property rights. Barriers related to lack of knowledge of open innovation tools in the initiative, low absorption potential, or significant costs of cooperation were relatively less important. On the other hand, cluster coordinators that did not actively support open innovation attributed the most importance to barriers related to lack of knowledge about tools and methods, difficult management of a joint project, but also potentially high costs of cooperation (which in the case of initiatives actively open innovation were not that significant).

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4.2. Case Studies

Analysis of the two case studies allowed to confirm the main barriers hindering successful support of open innovation in clusters but also indicated solutions to at least some of them. A barrier that most commonly appeared in the interviews was the issue of initial uncertainty regarding intellectual property rights. Before the commencement of cooperation, some companies from the OI active clusters also had considerable concerns related to securing know-how in joint projects. However, among enterprises that previously participated in these types of projects within the cluster, these issues were no longer a cause for concern. As one of the cluster members put it: "It's the first one you are anxious about. But if you have been involved in at least one project like this, you already have a grasp and you are set up to deal with the next one, without unnecessary doubts".

In each open innovation project implemented by the studied OI active clusters, the issue of intellectual property rights was solved individually. Model solutions proposed by the cluster coordinator (e.g., model contract, availability of an IPR specializing lawyer) and areas of cooperation discussed in detail reduced fear to a minimum and was no longer seen as a barrier. The most frequently defined areas of confidentiality were the areas of open access to the results of jointly generated research, in particular in projects co-financed from Horizon 2020 funds. Consortium coordinators took special care of defining the scope of using the project results and the contracts were agreed in a fine detail. A cluster coordinator from one of the initiatives underlined: "We have a specialized legal counsel in place to make sure that all the parties involved in the open innovation project are able and willing to share some precisely described internal knowledge and at the same time are satisfied with the results of the cooperation and accordingly protected."

Another barrier to open innovation at cluster level indicated by interviewees from both examined initiatives is distrust among entrepreneurs as to whether such cooperation will bring measurable benefits in relation to potential costs and risk incurred. It was rather an issue of trust in potential partners for such a cooperation and risk of costs in case of an unsuccessful/failed cooperation than the actual costs of undertaking open innovation activities. There is an initial high-level of distrust, even between member companies. Respondents emphasized that there is still lingering belief among entrepreneurs that if they want to sustain a competitive advantage, they should create solutions internally within the company, which without external support is very difficult, especially for SMEs. This seems to be a barrier of a much bigger significance in the transition economies than in the developed market economies with effective institutional and organizational structure. On the other hand, respondents from companies that have engaged in open innovative cooperation, even after initial reluctance, are afterwards very eager to undertake subsequent joint projects, emphasizing that any financial and time expenditures connected to open innovation have been recovered many times, both in the form of financial as well as increased organizational and technological potential of the company. A representative of a member company was very straightforward: "If we knew earlier, how much we would gain from open innovation projects, we would engage in them much sooner".

The barrier of difficulties in managing join projects came up in all of the interviews. According to interviewees, joint activities in the area of open innovation require the parties involved to demonstrate a high level of organizational and communication capabilities as well as a certain maturity. The cooperation imposes the duty of careful administration, compliance with certain rigors of cooperation, and empathy towards the needs of partners and the entire consortium. Many companies, according to respondents, still have trouble with this approach and need cluster support in this regard. Within both of the examined OI active clusters, coordinators encouraged members to enter open innovation projects, support managing of joint projects but require for the companies to be very proactive and share responsibility for the entire process.

There is a large group of companies, also in the OI active clusters, which for various reasons do not currently have the technological and/or organizational potential to cooperate with external partners. Companies, for example, focus on using the current business model and do not feel the need for development. There is also a group of dynamically developing companies trying to manage

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technological processes in the same way they were managed when the company was small. According to interviewees, companies in transition economies, like Poland, seem to underestimate the role of technological and organizational support and consulting. The studied clusters are trying to show the importance and effects of this type of support, in particular for SME companies that are not always fully aware of the benefits or are not able to obtain such services on the market.

5. Discussion

Regarding the first research question (Q1), the results of this study are in line with previous research findings regarding barriers to open innovation in SMEs [29–32] and emphasize the following barriers preventing clusters from adopting OI on a larger scale among member companies:

- Concerns of member companies about intellectual property rights (IPR);
- Difficulties in joint project management;
- Limited knowledge about open innovation methods and tools;
- A lack of best practices illustrating the effects in comparison to costs.

Regarding the second research question of this study (Q2), the barriers are indicated as hindering open innovation in clusters depended on the experience of cluster in supporting the OI activities. Main barriers to open innovation activities in clusters that were active in the OI area were difficulties in managing joint projects and enterprises' concerns regarding intellectual property rights. Potential loss of control over resources may increase the need to protect the intellectual property of the parties involved [62]. The results were confirmed in the qualitative analysis in selected cases. The importance of barriers significantly decreased with the direct participation of companies in joint innovative projects in the cluster, member companies learning about the experiences of other companies from the cluster undertaking such activities, and the development of detailed solutions for intellectual property rights. Model solutions introduced by experienced clusters, e.g., model contract, availability of an IPR specializing lawyer, and a specific process of defining the usage of the project results, seem to reduce the significance of the IPR barrier, though not completely eliminating it. Dissemination of these specific solutions in other clusters would probably reduce the significance of those barriers there as well. This calls for best practice exploring and disseminating good practices for the management of joint projects and securing intellectual property rights.

Clusters that did not introduce OI activities attached more importance to barriers related to lack of knowledge of open innovation tools and high costs of cooperation (which barriers are much less important for clusters that actually undertake OI activities). This may be related to internal factors of initiatives themselves, e.g., coordination problems or path dependency in some regions. It may also indicate that barriers preventing clusters from supporting activity related to OI do not have to be actual open innovation problems, but rather they are perceived as such by coordinators and cluster members, when in fact they relate to their innovation activity in a general sense [63]. This may be an indication of the overestimation of the importance of the costs of undertaking open innovation and the lack of sufficient knowledge on effective management of joint projects. Support for clusters in accessing trainings about the OI tools and methods and highlighting best practice examples in each cluster/industry may contribute to reducing the significance of the above barriers and making better use of opportunities related to open innovations in clusters.

Conclusions from case studies confirm the low activity of a large group of companies in clusters in initiating and looking for opportunities for innovation cooperation. This might be related to their technological and organizational potential, as well as the ability to absorb knowledge from outside and translate it into innovative products available to recipients. According to various literature streams dealing with innovation management, there is both a low capacity for absorption and resource constraints for significant barriers to innovation per se and not specifically to open innovation [33,34,64]. A better understanding of open innovation processes in SMEs therefore remains necessary, especially

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in order to enhance the understanding of the challenges for establishing successful open innovation partnerships [65].

Open innovation in clusters seems to be characterized by the active and direct role taken on by the cluster coordinators resulting in a very hands-on approach to specific open innovation processes. Such clusters fulfill the role, outlined by Chesbrough et al. [4], as open innovation intermediaries, which actively combine new solutions, ideas, and talent, and which may, on this basis, enable innovation within other organizations [66]. Within public policy, such intermediaries should be regarded as critical agents, offering a far greater societal value than the value which they present to companies.

The findings of the study seem to point to the critical importance of support for this type of activity in clusters by regional and central administration. Clusters fulfill the public role as an intermediary of an innovation cooperation and a potential central element of a fourth industrial revolution ecosystem, but the need to finance open innovation activities from very limited resources of their member contributions means that they must limit their activities in this area. Models of financing innovative activity in transition economies, such as Poland, include very weak incentives for open innovation cooperation, compared to the developed countries and their cluster policies [67,68].

The initiatives selected as case studies operate at a high level, support dozens of enterprises in innovation activities, and based on the models and competences developed by them, it can be expected that by receiving the appropriate support, they would achieve even better results in opening the innovation processes of companies from the SME sector. Support for coordinators and the promotion of tools and methods as well as good practices related to undertaking OIs in clusters seems to be a rational solution here. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

6. Conclusions

The findings of the study provide an insight into the barriers faced by clusters as open innovation intermediaries. This article has argued that the concept of open innovation, as it was originally coined, and as it has been applied by clusters, can become one of the pillars for implementing the concept of the fourth industrial revolution [68]. For companies, it is often necessary to eschew familiar management styles in favor of a non-traditional method—instead of attempting to control knowledge, actors need to acknowledge and manage the ecosystem within which they can co-innovate [69,70]. A successful transformation requires conditions inherent in clusters—mutual trust, compatibility, close cooperation, and common principles. The specificity of clusters as a combination of competing and cooperating companies seems to fit well in such a framework.

This paper is a significant contribution to the OI knowledge related to open innovation in clusters, providing an indication of the degree to which clusters face barriers in supporting open innovation and how they deal with those barriers. The mere fact of cooperation between enterprises within clusters does not prejudge the success of joint innovative projects. Nonetheless, engaging in open innovation at cluster level seems to multiply the chance for this success through strategic and operational support in this difficult process, but it faces many barriers. The use of proven methods and tools of open innovation seems to facilitate setting open innovation cooperation among companies that have not yet undertaken it or face specific constrains, in particular SMEs. The above conclusions provide arguments and justify the creation of a systemic support for open innovation activity in clusters.

Even though these findings carry ramifications for policymakers in many regions, our analysis took into consideration that not all regions are distinguished by the same conditions. This study adopted a contextual view indicating considerable diversity across clusters in terms of open innovation processes and barriers thereto. This diversity indicates that path dependency will always affect cluster development since it is a highly contextualized process. Consequently, place-based policies specific to each region will be required to reflect local conditions.

The contribution of this multi-stage exploratory study to the literature is expressed in providing knowledge about the open innovation phenomenon present in an economic reality. The study magnifies

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the modalities of open innovation in clusters, and, therefore, the findings are generalizable in this specific context. The study also provides important grounds for international comparisons, pointing to the specific conditions of the phenomenon for transition economies. The practical plane of this study includes providing knowledge on how to overcome barriers hindering open innovations in clusters, which can become a basis for recommendations both for the practice of coordinating innovative activities in clusters, but also for planning evidence-based economic policy.

The limitation of the study lies primarily in the size of the sample. The process of cluster development in Poland has started relatively recently, and the lack of a coherent cluster policy has limited the size of available research samples. Moreover, although the analysis takes it into account, the results are based on the viewpoints of the cluster coordinators and selected actors from OI active clusters in the transition economy context. Therefore, generalizations could be possible only where sufficient future studies have been carried out on more cases in different contexts.

This study could be instrumental to an understanding of the place-based aspects of open innovation and it is the hope of the authors that it will encourage further study into the role of clusters in the era of the fourth industrial revolution. This is especially relevant as research is currently hindered by several factors, notably a lack of official classification of practices pertaining to open innovation.

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