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Proximity and Innovation in Clusters: How Close, How Far?

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From the Editor

This special issue of the Journal of Entrepreneurship, Management and Innovation, entitled *Proximity and Innovation in Clusters: How Close, How Far?*, tries to shed new light on the concept of proximity, which is a cognitively attractive but still scarcely explored area. The earliest publications on proximity were published at the end of the twentieth century, and the development of this concept was strongly influenced by the French School of Proximity. However, the most influential publications are by Ron Boschma, who distinguished five fundamental dimensions of proximity: geographical, social, cognitive, organizational, and institutional. Proximity is particularly essential for the development of cooperation among business entities embedded in a specific territory. The idea of proximity is reflected in all concepts of regional development based on knowledge and innovation. This also applies to the cluster concept, in which references to all the abovementioned dimensions of proximity can be found. Applying the category of proximity to the cluster concept can be treated as an attempt to understand and explain factors of a non-economic nature that may affect (positively or negatively) the development of innovation in clusters. Proximity is recognized as a factor facilitating access to knowledge and fostering the development of innovation. However, there are no unequivocal findings regarding the relevance of particular dimensions of proximity from the point of view of innovation development. Until now, the superior role of geographical proximity in creating a competitive advantage through innovation has been particularly emphasized in the literature. However, more and more authors have begun to depreciate the role of physical proximity, all the more so because it can be partially, or even entirely, replaced by other dimensions of proximity. Furthermore, being too close might also have a negative impact on the development of innovation in clusters – maximizing proximity may lead to isolation and closure.

The six papers published in this special issue focus on the multidimensional nature of cooperation developed in geographical proximity, while appreciating the importance of other non-spatial dimensions of proximity. Most of the presented papers deal with cluster cooperation, although among them, some adopt a slightly broader view of innovation ecosystems.

The first paper, by Marzena Frankowska, refers to the concept of embeddedness, which was used to understand better the relationships between the participants in a cluster-type inter-organizational network, and the development of cooperation. Due to its multidimensionality, the embeddedness concept – just like the concept of proximity – is perfectly suited to explaining the mechanisms for developing cooperation in clusters. In view of this, the author sought to define the key dimensions of enterprise embeddedness in a cluster. The research process included both qualitative and quantitative research. As a result, it was established that four dimensions of embeddedness are of key importance for cooperation between enterprises embedded in a cluster, namely: structural, geographical, institutional, and relational. Furthermore, it was confirmed that there is a positive relationship between the embeddedness of enterprises in a cluster and their cooperation.

The second paper, by Emilio Camarena-Gil, Carlos Garrigues, and Francisco Puig, focuses on cluster cooperation within innovation processes in the textile industry. The main purpose of the paper was to examine the effect of different dimensions of proximity on innovation processes as well as to analyze the level of coordination in a Spanish textile cluster. The authors conducted qualitative research in two leading firms operating in a textile cluster in Valencia. Their research shows that the innovations of cluster companies are developed in isolation, and additionally, in a discontinuous, marginal, and uncoordinated manner. Moreover, the study strongly emphasizes geographical and cognitive proximity in the studied cluster, and at the same time, indicates a low level of social proximity, which is manifested by a low level of trust among cluster partners.

Similar conclusions can be drawn from the third paper, written by Anna Wasiluk and Fahime Sadat Saadatyar. Given the importance of social proximity for the development of cluster cooperation, the authors set the goal of assessing the level of trust of enterprises to competitors and cooperators, as well as identifying factors affecting the level of this trust. The authors presented the results of quantitative research conducted in enterprises operating in Poland in selected sectors of the economy: construction, food, metal and machinery, and furniture. The presented research results show that the level of trust among the surveyed enterprises is low, and this does not apply only to direct competition. This severely limits the establishment and development of cooperation in the context of cluster activity. Although the problem of a low level of trust is often emphasized in publications concerning Poland, this problem is noticeable in other countries as well (an example of which is the earlier article on the Spanish cluster). The presented study, therefore, can contribute to those works regarding the development

of trust among companies operating within and outside clusters, taking into account the cultural context.

The fourth paper, by Marita McPhillips, links the concept of clusters with the concept of open innovation, which strongly refers to proximity, especially in the social, but also the cognitive dimension. The author's intention was to investigate the potential role of clusters as intermediaries of open innovation for cluster members, as well as to identify factors that may affect the successful adoption of this role by clusters. The study was exploratory and based on in-depth interviews with experts in the field of innovation and clusters in Poland. The findings add to the state-of-the-art knowledge by shedding new light on the role of clusters, which – acting as proxies – might support open innovation. As the study shows, this role is not limited only to the network of cluster members. Clusters, based on geographical proximity, which favor the development of trust and knowledge sharing, might shape and co-create a broader open innovation ecosystem.

The next two papers continue the issue of innovation ecosystems. In the fifth article, Elżbieta Wojnicka-Sycz, Marcin Kaczyński, and Piotr Sycz perceive Regional Smart Specializations as innovative ecosystems based on social, cognitive, and geographical proximity. The main purpose of the paper was to develop and test a tool for the analysis of the effectiveness of innovation ecosystems, taking into account the three distinguished dimensions of proximity. The authors developed a case study for the Subcarpathian region in Poland based on multiple analyses, including a literature review, web resources analysis, statistical data analysis (e.g., OECD Input-output tables), as well as an analysis of the results of the CAWI survey. The results of their study prove that Regional Smart Specializations (RSS), based on geographical proximity, also manifest cognitive and social proximity, as companies operating within RSS are more Research & Development and innovation-intensive, and more prone to establish and develop cooperative relationships. In the studied Subcarpathian region, this applies to Aviation, Automotive, and ICT RSS, which stimulate the innovation-based development of this region. The developed tool can be used for further analysis of the paths of cooperation and their trajectories in RSS.

In turn, the sixth paper, by Małgorzata Runiewicz-Wardyn, presents research on the role of proximity and its dimensions in creating university-driven social networks. Furthermore, the second research problem analyzed in the paper is the structure and dynamics of successful university-based innovation ecosystems. The study was conducted in selected university-based life-science ecosystems in the European Union and the United States using methods characteristic of both qualitative and quantitative research. The study identified the relationships between individual dimensions of proximity

within the university-driven social networks in life-science ecosystems. The research results indicate that proximity in the geographical, but also cognitive and organizational dimension contributes to the development of trust (and thus proximity in the social dimension). In turn, cultural and social proximity leads to better communication and knowledge sharing, which further strengthens cognitive proximity.

The papers collated in this issue introduce an additional voice to the discussion on clustering and proximity by delivering new insights into cluster cooperation, which is, on the one hand, developed on the basis of geographical proximity, and on the other, contributes to the development of proximity in different dimensions. The presented research results can also be helpful in determining the optimal level of proximity among cooperating entities in clusters or – with a slightly broader view – in innovation ecosystems, all the more so as there is no agreement as to what scale of proximity would be most beneficial for the development of cooperation, especially in the area of innovation. Moreover, the issues discussed may be the basis for further, more in-depth research. Finally, the papers provide some practical implications for public authorities responsible for the development of sets of strategies and policy measures leading to strengthening their region's cooperative and innovative potential. They can also be useful for cluster coordinators and members who, through participation in cooperation networks, experience effects related to the development of proximity in various dimensions.

I would like to thank the authors for their contributions to this special issue. I would also like to express my sincere thanks to the reviewers for their commitment and contribution to improving the quality of the submitted articles. I hope that the collated papers will be interesting for readers and will become an inspiration for conducting further research on proximity in clusters.

Anna Maria Lis, Guest Editor, Department of Industrial Management, Faculty of Management and Economics, Gdańsk University of Technology, Poland

Multidimensional analysis of embeddedness and cooperation in a cluster – a literature and empirical study

Marzena Frankowska[1]

Abstract

Cooperation of enterprises within inter-organizational networks is a complex research and cognitive area due to the multidimensional nature of cooperation, which is often a mixture of motives, intentions, goals and operating conditions. Literature studies have revealed the so far very meager and scattered work in the field of embedding cooperation between enterprises in inter-organizational networks, which definitely does not sufficiently describe the impact of the context of collaboration on enterprise cooperation. The main aim of the article was to understand and explain, on the basis of the concept of embeddedness, whether there are relations between the participation of enterprises in a cluster-type inter-organizational network (embeddedness and its dimensions) and their cooperation in the cluster. Implementation of research goals required the development of a research process covering three stages. The essence and dimensions of embeddedness of cooperating enterprises in inter-organizational networks (structural, relational, social, positional, territorial, geographical, spatial, institutional, ecological, political and temporal) were determined. Next, a survey of European cluster managers (study 1) on cooperation in a cluster was carried out in order to better understand the dimensions of embeddedness of enterprises cooperating in clusters (qualitative research, IDI). In the next stage, a survey of cluster enterprises was carried out (study 2) to determine the relations between their embeddedness in the cluster and cooperation with other cluster companies (quantitative research, CAWI). Then, triangulation of data sources, research methods and context was used. As a result, it was established that four dimensions of embeddedness are of key importance for cooperating enterprises embedded in the cluster, namely: structural, geographical, institutional and relational. Moreover, the results of the research show that there is a positive relation between embedding enterprises in the cluster and their cooperation.

Keywords: *cluster, network organization, network, embeddedness, cooperation, collaboration, proximity, cluster manager, cluster facilitator*

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INTRODUCTION

Although the issue of cooperation between enterprises has long been present in research on strategic management, nowadays, it is taking on a new dimension. First of all, attention is paid to the multidimensional nature of cooperation, which is often a mixture of motives, intentions, goals, and operating conditions. The difficulty in understanding the nature of the exchange is due to the fact that, more and more often, the partners are not bound by hierarchy or relations based on authorities (Pelletier, Vieru, & Croteau, 2017). This is particularly relevant to cooperation within inter-organizational networks.

Clusters are an example of network structures in which the cooperation of enterprises aims to obtain benefits primarily from geographical proximity, sectoral concentration, and social factors. Due to the achieved positive effects, a significant increase in interest in cluster and cluster initiatives has been observed for three decades not only in the scientific circles and the enterprise and R&D sector but also among representatives of higher levels of public management (cluster policy) (Vlados & Chatzinikolaou, 2019; Gancarczyk & Bohatkiewicz, 2018).

This dissertation discusses the voluntary membership and functioning of enterprises within a cluster structure on the basis of the concept of embeddedness, which has not yet been well recognized in both a cognitive and research scope. The multidimensionality of embeddedness of inter-organizational cooperation, as well as its often paradoxical impact on other research variables, such as effectiveness, competitive advantage, flexibility or innovation, indicates that this is an area requiring in-depth exploration. It can be said that the conceptualization of embeddedness and its operationalization are not fully developed. At the same time, the embeddedness concept has broad applications in many research areas. It is noted that its wider use in economic research could eliminate some of the shortcomings of the analysis, which are characteristic of neoclassical economics (Czernek & Marszałek, 2015). Economic behavior is embedded in a network of relations that provide context for economic processes (Granovetter, 1985).

Literature studies have revealed the so far very meager and scattered work in the field of embedding cooperation between enterprises in inter-organizational networks, which definitely does not sufficiently describe the impact of the context of collaboration on enterprise cooperation (Lis, 2019; Sobolewska, 2020). The conducted studies prove that a research area has been identified that has not yet been extensively explored, a fact which requires undertaking work to strengthen the theoretical and empirical approach. Therefore, two research goals have been defined in the paper:

- determination of key dimensions of enterprise embeddedness in the cluster;
- examination of the relation between the identified dimensions of enterprise embeddedness in a cluster and cooperation between cluster enterprises.

Implementation of research goals required the development of a research process covering three stages, on which the dissertation structure was based. First, the essence and dimensions of embeddedness of cooperating enterprises in inter-organizational networks were determined based on literature research. Next, a survey of European cluster managers (study 1) on cooperation in a cluster was carried out in order to understand the dimensions of embeddedness of enterprises cooperating in clusters better. In the next stage, a survey of cluster enterprises was carried out (study 2) to determine the relations between their embeddedness in the cluster and cooperation with other cluster companies. The article ends with a discussion on the results of the research presented and conclusions.

LITERATURE REVIEW

The essence and dimensions of enterprise embeddedness in a cluster

The need for a broader understanding of the conditions for cooperation of enterprises in clusters finds a number of solutions in the concept of embeddedness. This is a relatively new concept, which was originally introduced by Polanyi in 1944 as part of the broadly understood new economic sociology and later popularized in the works of Granovetter. Nowadays, the concept of embeddedness is understood in multidimensional terms and, hence, its explanation requires comprehensive literature studies.

Granovetter used the concept of embeddedness to explain how social relations affect the economic behavior of entities and transaction conditions. Granovetter (1985) noted that the structure of the network is the result of many interpersonal relations and the individual position of a given entity in the network, as well as how it affects the behavior of other entities. Granovetter (1992) distinguished between structural and relational embeddedness. Structural embeddedness refers to the ownership of the social system and the network of relations as a whole. It describes the impersonal configuration of relations between people and individuals. Whereas, relational embeddedness defines the type of personal relations that develop during interactions between individuals and are reflected in friendship, camaraderie and respect, which translates into the behavior of actors. Embeddedness is expressed in the role of social relations and the

structure of these relations in building trust and weakening the occurrence of opportunistic behavior. Consequently, it is observed that cooperation with actors of known reputation (known from social relations) is preferable to that with unknown entities.

The concept of embeddedness was eagerly taken up by researchers, as it opened a wide cognitive field in the study of individual aspects of inter-organizational cooperation. As noted by Harrison and van Hoek (2010), the shape of inter-organizational relations is always partly determined by the specific properties of the environment in which the partners operate. Individuals and organizations are connected to their environment through diverse direct and indirect relations that form the environment in which economic activity is implemented (Nyholm, 2011).

Today, embeddedness has become a multidimensional concept (Moody & White, 2003). According to Goodman (2003), embeddedness is a socio-material construct and, therefore, it is an ambivalent, conditional, and dynamic concept. It is used in various contexts and its various dimensions are described, as summarized in Table 1.

Table 1. Research on the concept of embeddedness by selected authors

Author	Dimension of embeddedness
Granovetter (1985, 1992)	Structural, relational
Gulati and Gargiulo (1999)	Structural, relational, positional
Uzzi (1999)	Social
Saxenian (1994) Molina-Morales, Capo-Vicedo, and Martínez-Fernández (2012)	Territorial, cultural
Johannisson, Ramirez-Pasillas, and Karlsson (2002)	Material, structural, institutional
Jones, Hesterly, and Borgatti (1997)	Relational, temporal
Halinen and Törnroos (1998)	Temporal, spatial as well as political, technological and market
Nyholm (2011)	Socio-institutional
Penker (2006)	Social, territorial, ecological
Lebeau and Bennion (2014)	Territorial, political, socio-economic
Xu and Beamon (2006)	Operational

Source: Frankowska (2018).

The concept of embeddedness is directly related to enterprise cooperation rooted in inter-organizational networks (network embeddedness) (Martinez-del-Rio & Cespedes-Lorente, 2014), including clusters. The social network in the cluster is developed by taking various actions and using various means. These networks are supported by both social and geographical proximity,

as well as enabling the spread of information between cluster entities, thus playing a central role in the development of their competitive abilities (McEvily & Zaheer, 1999). It should be noted in this respect that embeddedness in social relations is studied at the level of individual actors and is, therefore, a microfoundation for explaining behaviors, processes and their results at organizational and inter-organizational levels (Coleman, 1990; Abell, Felin, & Foss, 2008). Uzzi (1996) uses the concept of social embeddedness, which he defines as the scope in which commercial transactions are carried out through social relations and networks of relations, which in turn are based on exchanges related to social, non-commercial principles that perform the function of supervisory transaction mechanisms.

Moreover, as the quoted author claims (Uzzi, 1996), the mechanisms of supervision over social embeddedness are revealed prior to the transaction. This approach makes it possible to explain why economic or managerial activities are rooted in social relations, which in turn affect the allocation of managerial activities and the estimation of resources (Stańczyk-Hugiet, 2016). Similarly, Johannisson, Ramirez-Pasillas, and Karlsson (2002) distinguish *substantive embeddedness* that can be explained as embeddedness expressing a material existence related to the content of social rooting of economic activity. This approach refers to the concept of social capital, which emphasizes the structural dimension of social networks. Actors, depending on how they are embedded in the network, can derive various benefits from the relation network (Chiu & Lee, 2012).

Embeddedness in a network gives a different perspective on how to evaluate and analyze enterprise collaboration. Gulati and Gargiulo (1999), based on the works of M. Granovetter, developed three dimensions of embeddedness in the inter-organizational network, indicating, apart from structural and relational, also positional embeddedness. According to the researchers, structural embeddedness captures the impact of relations between actors on the possibility of their cooperation. Thus, it determines how the structure of the network affects the propensity and the ability of enterprises to cooperate. The following parameters are examined: extent, density, hierarchy, connections. Furthermore, it is believed that the number of network actors (cluster members) affects the level of embeddedness (Dayasindhu, 2002). According to Johannisson, Ramirez-Pasillas, and Karlsson (2002), structural embeddedness refers to a structure, for example, patterns of personal social relations and social interaction networks or a relational structure and architecture of network ties. It includes direct and indirect linkages as well as weak and strong ones.

As part of relational embeddedness, the impact of social ties on the economic behavior of actors is examined. In this dimension, it is recognized

that the company is surrounded by other actors with whom it creates an inter-organizational network. Collective social capital that is based on trust and enables access to information permeates this network in a way that promotes or limits the activity of the company (Zaheer, McEvily, & Perrone, 1998). The benefits of access to information obtained through relational embeddedness are based on the actors' personal ties. Multilateral trust embedded in personal relations also strengthens the close coordination of cooperation of the actors who share the same social capital.

In turn, positional embeddedness allows recognizing the roles of actors in the network (Gulati & Gargiulo, 1999), as well as the impact of the location of a single actor on their decisions and actions. Structural equivalence is particularly eagerly used as a measure of position, which shows similarities between actors due to their position in the network and centrality, illustrating the extent of the actor's relations with others (Czakon, 2012).

Clusters and cluster initiatives are an inter-organizational network in which enterprises and their value chains are rooted. When conducting their scientific considerations and observations, researchers began to recognize subsequent dimensions of embeddedness that are related to the attributes of clusters and their specificity of operation. One of the most important distinguishing features of clusters is the geographical concentration of enterprises; thus the embeddedness in the region of operation is the subject of much-conducted research.

Saxenian (1994), in her famous work *Regional advantage: Culture and competition in Silicon Valley and Route 128,* noticed that the ability to build competitive advantage results from territorial embeddedness, which is related to the culture prevailing in the area and the values shared there. The author stated that the success of the Silicon Valley cluster is the result of its embedding in an industrial system that is both decentralized and based on cooperation with dense social networks and a high level of social capital. Halinen and Törnroos (1998) also drew attention to the role of space and geographical location in the operation of the network by considering spatial embeddedness as one of the most important dimensions that should be used to describe the context of a place of interaction. A similar approach was shared by Lebeau and Bennion (2014), who proposed to distinguish territorial embeddedness from structural embeddedness. This type of embeddedness combines the geographical (location), spatial (impact area), and social (culture of the place) dimensions. According to the authors, territorial embeddedness embodies the so-called spatial loyalty towards the actors' place of activity in the network. In other studies, Penker (2006) also pointed to territorial embeddedness. In her opinion, the spatial context comprises the local and territorial dimensions of embeddedness resulting from local practices and methods of operation.

Whereas, Molina-Morales, Capo-Vicedo, and Martínez-Fernández (2012), in their studies of clusters, distinguished embeddedness in a territory, understood as a sense of belonging to a given community located in a specific geographic space. It comes down to using a homogeneous system of shared common norms and values as well as personal relations as elements conducive to the creation of an "atmosphere of productive activity". This approach refers to the cognitive dimension of the network by Nahapiet and Ghoshal (1998). When carrying out in-depth literature studies, it might be noticed that the effects of territorial embeddedness of the network can be both positive and negative, and the very dimension of embeddedness relates to both the physical distance of actors (geographical proximity) and the location enabling access to specific resources. This approach is developed in work by Cerceau, Mat, and Junqua (2018), who stated that the management of organizational resources is shaped by the context of the territorial embeddedness in which they operate, while the way of resource management shapes the specificity of a given location. The specific approach to resource management resulting from their territorial location, along with the interactions taking place, was called Industrial Ecology, which refers to another ecological dimension of embeddedness described later in the dissertation.

To sum up, geographical embeddedness is not only associated with physical presence in a given area, which is reflected in a reduction in spatial transaction costs, but it also applies to participation in local culture and even tradition, which enables the cognitive coherence of actors in the inter-organizational network and influences their behavior during cooperation. Hence, geographical embeddedness is an important element of cluster research.

When observing the evolution of the cluster concepts, attention is paid to the need for their institutionalization, which is related to the purposeful organization of cluster activity in the form of cluster initiatives. Hence, institutional embeddedness is another dimension recognized by researchers.

Johannisson, Ramirez-Pasillas, and Karlsson (2002) developed the concept of institutional embeddedness in an inter-organizational network, which refers to linkages with economic institutions and social organizations. Researchers operationalized the concept in which they included economic and social institutions at the local level, and provided empirical data on social relations that support the process of local economic development. Van de Ven (1993) also indicates the importance of institutional embeddedness in the context of the study of associations of entrepreneurship and industrial infrastructure, which, according to him, includes:

- institutional solutions aimed at legalizing, regulating and standardizing new technology;

- public resources of basic scientific knowledge, financing mechanisms and access to competent employees;
- carrying out research and development, production, marketing, and distribution functions by enterprises working for the commercialization of innovation.

The aim of the research was, among others, to determine to what extent the industrial infrastructure identified in this way facilitates or limits entrepreneurship. It was noted that industrial infrastructure does not arise or change immediately by the actions of one or even several key entrepreneurs. Instead, it appears in the course of numerous institutional events, resources and property that co-create each other for a long time, becoming the context of actions undertaken by enterprises. Furthermore, it was established that this type of institutional embeddedness could act as a fictitious force that hinders technological development and adaptation of the enterprise.

In turn, the relational-institutional dimension of embeddedness is proposed by Nyholm (2011), who, in her research, operationalized embeddedness in three orders. The author identified:

- embeddedness in the first order regarding personal relations among cooperating enterprises in a geographically concentrated network;
- embeddedness in the second-order resulting from the membership of persons representing enterprises in local economic and social institutions (e.g., clusters);
- embeddedness in the third-order concerns situations in which economic and social institutions fill gaps in relations between enterprises.

The last order refers to the concept of Burt's structural holes (1992), while the mentioned organizations assume the role of tertius iungens (third who joins) (Obstfeld, 2005). It seems that embeddedness in the third-order illustrates the role of the cluster coordinator. The approach of Nyholm (2011) integrates individual exchange relations as personal ties connecting economic and social activity with the activities of institutions and their role in initiating cooperation between enterprises.

Another described dimension of embeddedness is temporal embeddedness proposed by Halinen and Törnroos (1998). It refers to how enterprises are related in time, i.e. in the past, present, and future. Embeddedness in time can be illustrated by past experience that affects responses, collaboration, and perceptions of the inter-organizational network. As Janasz (2016) notes, the sphere of collective imagination of individual types of organizations formulates their strategies in close connection with their own experiences and past. Expectations for the future have a similar impact, and established relations, to the same extent as experiences, have an impact on decision making as part of the interaction activation process. This

is in line with the approach of Jones et al., according to whom embeddedness is a continuous process that constantly shapes the relations between various actors of the inter-organizational network (Jones, Hesterly, & Borgatti, 1997). Thus, embeddedness not only shapes the interaction of actors in the inter-organizational network, but it is also shaped by them. Temporary embeddedness reveals a new perspective and indicates that actors can not only surrender to the context in which they operate (passive attitude), but they can react (reactive attitude), and even take actions actively shaping the nature of embeddedness (active attitude).

Other dimensions of embeddedness were proposed by Lebeau and Bennion (2014), which adds to the complexity of the discussed construct. The researchers distinguished, among others:

- political/policy embeddedness – related to the occurrence of expectations and actions of stakeholders representing and implementing local policy. It may also result from past traditions and future aspirations;
- socio-economical embeddedness – concerns the perception and definition of the role in a social environment. It is also related to one's opinion, including reputation or lack of it. The economic dimension determines the local environmental conditions related to, inter alia, the labor market.

The embeddedness dimensions presented here may have particular significance in the activity of clusters rooted in a public entity, which refers to the typology presented by Markusen (1996). At the same time, they can also apply to large cluster organizations, which, being regionally rooted, pursue national cluster policy goals e.g. *go global* clusters in Germany, *pôle de compétitivité* in France (Bembenek, Frankowska, & Haviernikova, 2016).

As the last presented dimension of embeddedness, it is worth presenting Penker's research (2006), which distinguished, among others, the ecological dimension of the inter-organizational network embeddedness. Ecological embeddedness covers all relations with nature and the local environment, and constitutes the expression of the production and distribution practices, as well as purchasing attitudes used in the area of location. It applies to purchased components, energy savings, and pro-ecological activities.

The described dimensions indicate that embeddedness means participating in a certain imposed narrative in the operating environment. The nature of the narrative can have a positive, negative, or even silent effect, which means that a given inter-organizational network (cluster initiative) is not noticed in the environment.

The impact of embeddedness in a cluster on its actors

The presented dimensions of embeddedness confirm the multidimensionality and complexity of this concept, as well as the possibly diverse impact on enterprise collaboration. Embeddedness in a positive aspect enables the acceleration of decision-making, strengthens cooperation and organizational learning, as well as reduces the costs of monitoring cooperation and is a condition for achieving high-level results. It also serves as an effective platform for information exchange and innovation (Uzzi, 1996; 1997). Embeddedness in a cluster can trigger social mechanisms between actors of an inter-organizational network that play a role of coordinating relation security. They include (Jones, Hesterly, & Borgatti, 1997):

- access restriction, which may result in a limited number of cluster members;
- macroculture, expressed in sharing common values and norms;
- threat of collective sanctions, penalties may be imposed by cluster members for behaviors not accepted by the partners;
- solidifying the reputation of actors, manifesting in the appropriate perception of the skills and reliability of partners in the inter-organizational network.

The mentioned mechanisms are ambivalent and, depending on the situation, may constitute factors supporting or limiting the cooperation of enterprises in the cluster (Mitręga & Zolkiewski, 2012). Researchers note that in some situations, embeddedness in an inter-organizational network can resemble a snare from which it is difficult to break free (Dayasindhu, 2002). The problem may be the desire to legitimize the actions taken, as well as the phenomenon of homophily expressed in greater acceptance for individuals and similar behaviors (Golub & Jackson, 2012; Kamath & Cowan, 2015). Social capital, embeddedness and homophily promote collaboration as well as allow sharing culture and strong collective identification (Coleman, 1990), but they can also maintain rigid relations and redundancy of information. An example is a study of Martinez-del-Rio and Cespedes-Lorente (2014) regarding the dissemination of environmental practices in clusters. Cluster members with a higher level of network embeddedness are more pressured to achieve environmental responsibility, which is due to the following premises:

- they perceive the moral and cognitive legitimate pressure to take appropriate action as stronger;
- established set of social norms, values and beliefs is more reliable for them within the cluster network;
- there is a fear of losing access to knowledge or other values provided by the cluster if they are sanctioned by other members of the cluster network.

These statements prompted Uzzi (1997) to formulate the term "paradox of embeddedness." The results of other research on the impact of embeddedness in an inter-organizational network (cluster) on the cooperation of enterprises indicate its various dimensions and effects. Research conducted by Balland, Belso-Martínez, and Morrison (2016) regarding understanding the exchange of informal knowledge proves that structural and social embeddedness has a significant impact on the functioning of the analyzed cluster both in terms of technical knowledge networks and business knowledge networks. As a result, they explain the formation of unformalized knowledge networks because of enterprise embeddedness, their status and distance between enterprises. This is important in acquiring external knowledge resources by cluster inter-organizational network companies. In turn, research conducted by Dayasindhu (2002) regarding a software cluster showed a relation between embeddedness (particularly associated with local culture), knowledge exchange, presence in the cluster and global competitiveness of enterprises. According to the author, territorial embeddedness may be a barrier to the development of cooperation between enterprises in the cluster and their competitive advantage. In the local culture, it is badly received if employees of a company establish relations with other organizations, which is manifested by a reluctance to participate in events promoting knowledge sharing (e.g., symposia, seminars). The author pointed to the need to increase the awareness of the management of enterprises in the cluster in terms of understanding the relation between the level of trust and embeddedness in local culture to strengthen the exchange of knowledge and access to knowledge resources in the cluster. Lin, Huang, Lin, and Hsu (2012) conducted research on clusters where the dominant actors are OEMs (*Original Equipment* Manufacturer), which, therefore, regard the cooperation of enterprises in supply chains embedded in the cluster. The research took into account the context of relational, structural and positional embeddedness in managing alliances of enterprises cooperating in the cluster. The research results allow for a better understanding of the ways in which formal coordination mechanisms are conditional on embeddedness in a clustered OEM network. First of all, the results show that embeddedness in the network is complementary to the formal mechanisms of coordination of cooperation between enterprises. Secondly, the relation between transaction risk and inter-organizational formal coordination mechanisms may be stronger or weaker depending on the conditions of the network in which enterprises are rooted.

Another study on high tech clusters proves the existence of a relation between structural embeddedness and enterprise collaboration in an inter-organizational network (cluster), which is based on the possibilities of using external cluster effects (Chiu & Lee, 2012). On the other hand,

the results of research conducted by Lebeau and Bennion (2014) allowed identifying a cluster anchored in a public entity (universities). Moreover, they drew attention to the multidimensional and sometimes contradictory levels of impact of the entity's embeddedness in the local environment. In another case, Chiffoleau (2009) carried out research on alternative food supply chains in southern France in the context of their embeddedness in the local environment. Alternative supply chains constitute an organized form of supplying local food products to consumers, excluding concentrated retail trade and transnational companies. The study included an analysis of relations between producers as a result of local embeddedness and their relation with the possibility of organizing supply chains in a traditional way. Research results prove that local embeddedness in the relational dimension is a key element of the local production system and coordination of producers' cooperation. A similar view is shared by Nyholm (2011), according to whom the conducted study of assessing the activation of relations in the supply network must take into account the logistics cluster where the surveyed logistics operators are embedded. A very interesting statement was made by Penker (2006), who conducted research on the rooting of food supply chains. She mapped the local network of actors (cluster) involved in food supply chains and in conclusion to the results of the research stated that the question is not "are the supply chains embedded or not?", but should rather be formulated: "where and how are they embedded?."

A review of the cited research shows that there is a relation between embedding in a cluster and the way cluster enterprises operate. At the same time, the test results do not give clear results, as the obtained answers indicate both positive and negative embeddedness as well as paradoxical effects. Moreover, a review of the literature on the subject allows the identification of research and cognitive gap in the form of not specifying those dimensions of embedding enterprises in the cluster that significantly affect the cooperation of cluster actors. Therefore, it will be important to determine which dimensions of embedding actors in a cluster are related to undertaking and developing cooperation between enterprises (regardless of the direction of impact).

METHODOLOGY AND RESEARCH METHODS

The concept of the research process

The issue of embedding cooperating enterprises in an inter-organizational network is a complex research area that has not been extensively explored so far. To maintain the rigor of the reliability of the research process in

management sciences, it is recommended to use many mutually corrective and verifying methods referred to as triangulation (Denzin, 1978; Stańczyk 2018). As a result of the literature research, many dimensions of enterprise embeddedness in a cluster were identified. Thus, further research process was divided into two stages. First of all, it is important to identify which of the embeddedness dimensions are significantly related to the undertaking and development of cooperation by cluster enterprises. In the next step, the relations between the identified dimensions of embeddedness and the cooperation of enterprises in clusters will be analyzed. The assumptions of the research process are presented in Figure 1.

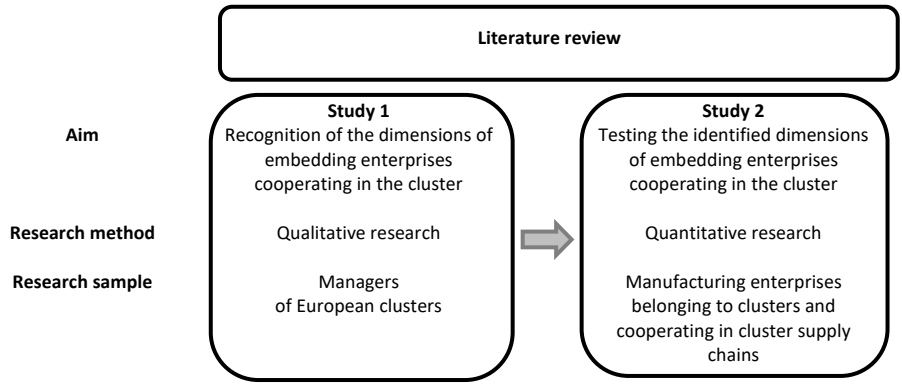

Figure 1. Framework of research methodology

The study included:

- triangulation of data sources at the collective level, consisting in obtaining, using and comparing data from various sources in order to describe a specific phenomenon related to the studied groups (Study 1: cluster managers, Study 2: manufacturing cluster enterprises);
- triangulation of methods regarding the mixing of qualitative (No. 1 test) and quantitative (No. 2 test) methods;
- triangulation of the environment and location, called contextual triangulation, associated with the need to conduct research in various places (study No. 1: European clusters, study No. 2: nationwide study of clusters in Poland).

Characteristics of empirical research

Stage 1: Qualitative research

Research method and description of research sample

Firstly, introductory and exploratory research was conducted. It was important to recognize the context of the functioning of enterprises in a cluster and the conditions created for their cooperation based on the opinion of cluster managers. The research results indicate that cluster managers play a special role in creating conditions for the cooperation of cluster actors and are a valuable source of knowledge (Ingstrup, 2010, 2013; Frankowska 2019). The aim of the study was, therefore, to fill the identified cognitive and research gap in determining the dimensions of embedding enterprises in the cluster and its impact on the process of cooperation of actors. Therefore, the proposed study took into account the acquisition of knowledge of cluster managers regarding the perception of how clusters operate, the conditions and scope of cooperation in a cluster, as well as the attitudes of cluster enterprises.

The collected research material was analyzed within the following research areas:

- specifics of cooperation between enterprises in a cluster;
- impact of embeddedness in a cluster on enterprise collaboration.

Qualitative research was chosen as the research method, which is used to learn more about and describe complex market phenomena (Strauss & Corbin, 2008). It allows the exploration of an area that is not fully recognized, which is the cooperation of enterprises in a cluster. The technique applied is *in-depth interview* (IDI) based on a semi-structured interview (Levitt, Motulsky, Wertz, Morrow, & Ponterotto, 2017; Gopaldas, 2016). This interview is characterized by the development of a scenario covering important topics to be addressed, as well as non-standardized questions. The researcher formulates them and thus adapts to the course of the conversation. Open questions are gradually specified in more detail (Dudwick, Kuehnast, Jones, & Woolcock, 2006). Qualitative studies are not representative studies of the entire surveyed population. Therefore, selecting respondents is of key importance in order to obtain the right research material for further reasoning. In this study, the relevant assumptions were adopted for selection and choosing respondents, in order to understand the phenomenon most comprehensively, which is the embeddedness of cooperating enterprises in a cluster (Table 2).

Table 2. Criteria for selecting respondents for research

Cluster selection criteria		Selection aims
1	Root region	Clusters from different EU countries – the international nature of research
2	The period of functioning of the cluster organization and its manager	Clusters in the maturity phase, minimum 4 years of operation, which provides the opportunity for the manager to evaluate cooperation in the cluster in the long term
3	Cluster activity profile	Manufacturing clusters with different sectoral specializations
4	Supply chain stage dominating in the cluster	Clusters representing different stages of the supply chain, from raw material sourcing to final buyers
5	Cluster reputation and scope of activity	Clusters with a recognized reputation on the home market and active internationally
6	Manager's consent	Managers who are willing to share knowledge and devote their time

To maintain a broad perspective of assessing the cooperation of enterprises in clusters, respondents in the study were managers of European clusters. The characteristics of the studied clusters are presented in Table 3.

Table 3. Characteristics of the studied clusters

Features	Descriptions
Cluster name 1	**CD2E (Création Développement des Eco-Entreprises)**
Registered office	France, Nord-Pas de Calais
Status	*Le pôle de compétitivité* (accreditation)
Sectoral focus	A cluster of innovative environmental technologies in the field of ecological waste and pollution treatment, water consumption, the use of renewable energy sources, responsible use of soil, and eco-construction and eco-materials.
Year of establishment and background	A regional initiative in the field of establishing a cluster in 2000. The cluster started operating after two years of preparation, while the cluster's headquarters in Loos-en-Gohelle was opened in 2004. The idea of the cluster is to respond to the need for modern and environmentally responsible reindustrialization of traditional brownfield sites in the region of northern France (Région Hauts-de-France).
Cluster name 2	**TRIPLE STEELIX 2.0**
Registered office	Sweden, Norra Mellansverige
Status	Incorporated association, Member of Vanguard Initiative (EU)
Sectoral focus	Metal-machine and metallurgy cluster
Year of establishment and background	The cluster was established in 2005, initially as the Swedish Steel Producers Association Jernkontoret. The name Triple Steelix 2.0 was adopted in January 2015. The cluster operates as *a global centre of excellence for advanced steel products.*

Features	Descriptions
Cluster name 3	**TRETORGET**
Registered office	Norway, Hedmark og Oppland
Status	Private entity, limited liability company
Sectoral focus	Wood cluster
Year of establishment and background	The cluster was established in 2002 on the basis of mapping commissioned by public authorities. The study showed that this location had the potential to create a cluster. Initially, it was a political initiative financed by public funds, however, after about 5-6 years of activity, the cluster coordinator transformed into a private entity.
Cluster name 4	**FEMAC (Future Emerging and Modern Agriculture in Catalonia)**
Registered office	Spain, **Catalunya**
Status	Bronze Label Certificate awarded by the European Secretariat for Cluster Analysis (ESCA) for quality management (currently Gold Label) Association
Sectoral focus	Agricultural machinery cluster
Year of establishment and background	The cluster was established in 1999. Previously, enterprises producing farming equipment made attempts to cooperate in entering foreign markets, however, did not achieve significant results.
Cluster name 5	**VOJVODINA METAL CLUSTER**
Registered office	Serbia, Vojvodina
Status	Bronze Label Certificate awarded by the European Secretariat for Cluster Analysis (ESCA) for quality management, Association
Sectoral focus	Metal-machine and metallurgy cluster
Year of establishment and background	The cluster was initiated in 2011 by receiving EU funds for the implementation of a two-year project launching the cluster initiative. It continues to operate up to this day.
Cluster name 6	**ŚLĄSKI KLASTER LOTNICZY (Silesian Aviation Cluster)**
Registered office	Poland, Silesian voivodeship
Status	Key National Cluster (PARP accreditation) Bronze Label Certificate awarded by the European Secretariat for Cluster Analysis (ESCA) for quality management (2018) Association
Sectoral focus	Aviation industry cluster
Year of establishment and background	Initially, Federacja Firm Lotniczych (FFL) was established in the 1990s as a result of the cooperation of 15 private companies. The cluster was established in 2006, and since 2008, the FFL association has been the coordinating unit of the cluster.

Only manufacturing clusters with experience in functioning on the home and international market were selected for the study. Furthermore, the clusters participating in the study by definition were supposed to represent

various sectoral specializations and stages of the supply chain to ensure the most comprehensive view of the specifics of cooperation between enterprises in clusters (Figure 2).

The previously arranged interviews were carried out during international conferences and brokerage meetings of cluster managers. The interviews lasted about 45 minutes. Each of the interviews was carried out based on a previously prepared scenario and was recorded. In total, six in-depth interviews were conducted.

Study 1: Data analysis and study results

The analysis of the collected research material, on the one hand, indicates the complexity of the subject matter, and on the other, allows noticing the common elements and some similarity of processes occurring in clusters. The conclusions were formulated both in relation to the specifics of cooperation between enterprises in the cluster and the impact of embeddedness in the cluster on enterprise cooperation.

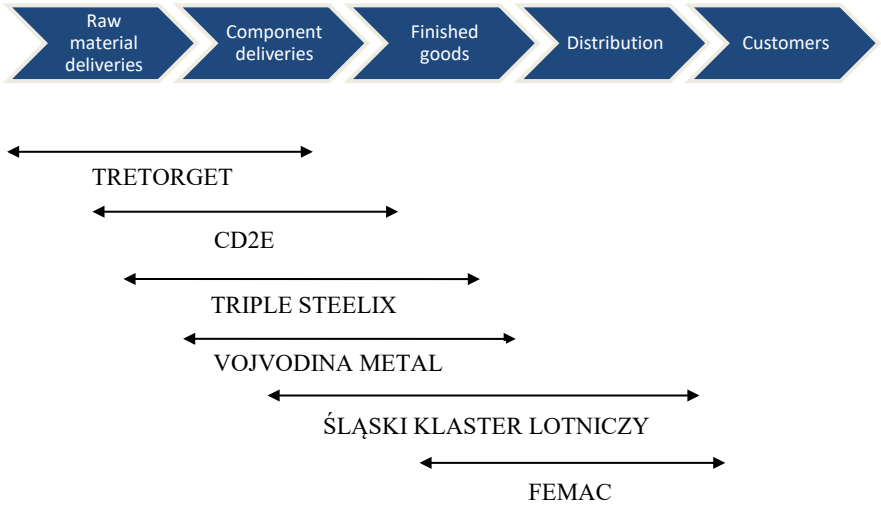

Figure 2. Dominant scope of cluster activity in the supply chain structure

One of the main effects of the study is the disclosure of many barriers in the field of business cooperation. They result from both competitive relations between enterprises (FEMAC, Tretorget, Śląski Klaster Lotniczy, Triple Steelix, Vojvodina Metal Cluster), general distrust and reluctance (Vojvodina Metal

Cluster, Tretorget), differences in the potential of large and small enterprises (Triple Steelix, CD2E), as well as differences in the ways traditional and modern companies, operate (CD2E). Therefore, the composition of the actors in the cluster and their structure has a significant impact on cooperation. In order to establish cooperation in a cluster, enterprises need:

- time to carefully get used to other enterprises (Femac, Tretorget, Śląski Klaster Lotniczy, Triple Steelix, Vojvodina Metal Cluster, CD2E);
- financial support measures enabling implementation of projects within a cluster (Tretorget, Śląski Klaster Lotniczy, Vojvodina Metal Cluster, CD2E);
- good ideas (projects) for achieving individual economic benefits and a synergy effect (all clusters);
- manager - facilitator who takes into account the individual approach in collective action for the cluster (all clusters).

Interestingly, the study shows the great importance of being embedded in a cluster in shaping the attitude of enterprises in the scope of engaging in cooperation. In the studied clusters, geographical embeddedness that connects the place of activity with local history, tradition and culture, and translates into behavioral aspects of the functioning of enterprises (attitude and applied practices) plays the most important role. In the case of Triple Steelix and Śląski Klaster Lotniczy, the territorial context gives a sense of pride in a region with traditions and significant achievements, as well as motivates to act. However, the situation of the Tretorget and CD2E clusters indicates that territorial embeddedness may resemble a snare from which it is difficult for enterprises to break free, and which becomes an inhibitor in further expansion, limits aspirations, and the ability to cooperate. Moreover, of great importance is political embeddedness, which indicates the role of public actors in the development of the cluster in the sense of applying the appropriate cluster policy, and in the cognitive dimension, i.e. giving importance to specific activities, attitudes, and vision for the development of the cluster in the region. The Triple Steelix cluster and, especially, the CD2E cluster are examples where the strength and weakness of the region (traditional industry sectors, i.e. mining and shipbuilding) are to acquire an innovative and environmentally-friendly dimension, which starts ventures and introduces a new quality to enterprises.

During the study, temporal embeddedness in the cluster, which describes the changing attitude of enterprises to relations in the past, present and future, was also distinguished. All managers of the studied clusters emphasized the importance of time, which is necessary to develop relations that take up several years of cluster activity. This seems surprising, due to the voluntary membership to the cluster and the lack of coercion into cooperation with

cluster actors. However, the reasons described and the international selection of clusters indicates that this cannot be accidental. Therefore, according to the observations of the respondents, the phenomenon of coopetition widely described in the literature requires time and is a difficult process in its essence.

As the research findings show, one of the most important types of embeddedness is relational embeddedness, which also indicates this important dimension of the cluster network. The role of managers refers to clusters as a social network. An institutionalized cluster in the form of a cluster initiative, operating through managers in a formalized manner and offering specific services to enterprises, must operate mainly in the relational dimension. The cluster manager, in the course of their tasks, develops relations that enable the creation of social capital in the cluster. This stage is the most difficult and takes the most time. First, the manager creates individual relations between themselves and the companies, and in the next step builds relations between companies. By using neutral activities, creating a space for cooperation, they create social capital in the cluster. Only an appropriate level of social capital makes it possible to start cooperation. It is not owned by either the cluster manager or individual enterprises. It belongs to the actors who make it up, or rather people representing cluster actors. It is worth referring to research indicating that it is individuals (people), not enterprises, or other cluster entities that are real actors in the cluster (Helfer et al., 2014). Thus, the separation of institutional dimension of the cluster (formal participation, payment of contributions, etc.) and the relational dimension, which takes place between individuals, is carried out. The manager performs the function of *tertius iungens*, i.e. third who joins (Obstfeld, 2005), however, their role is not so much to fill the structural gaps in the information flow system, but rather to integrate subsequent actors into the network of relations on the basis of mediated trust chains. The study reveals a certain mechanism consisting of the need to build a network of relations that provide opportunities to share resources and competences as part of cooperation in a cluster. The study provides empirical grounding for the claim that critical resources may be located outside the enterprise and be embedded in inter-organizational activities and processes, which have been determined by Dyer and Singh (1998) as relational resources.

The role of the cluster manager is also to increase network efficiency through actions balancing the distribution of forces among actors, e.g. strengthening entities with a weaker position in the network structure (SME enterprises, new members), which refers to the dimension of structural embeddedness in the cluster. Activities stimulating cooperation are aimed at overcoming barriers in the cooperation of actors and thus achieving synergistic effects in the form of increasing the efficiency of the functioning

of individual enterprises and the entire cluster network. On the other hand, they cannot disturb the competition rules in the cluster and the manager's neutral attitude towards the actors of the cluster network.

To sum up, the purpose of qualitative research was to determine the dimensions of embeddedness in a cluster, which have a significant impact on cooperation between cluster enterprises. Based on the collected research material, four embeddedness dimensions, of key importance, were established, i.e.

- geographical embeddedness – determined by belonging to a specific area of a cluster operation;
- structural embeddedness – defining the systems of cooperating enterprises in a cluster;
- institutional embeddedness – indicating the impact of the cluster as an organized cluster structure on enterprises;
- relational embeddedness – illustrating the role of relations and bonds in the cooperation of enterprises in a cluster, as well as in initiating cooperation.

At the same time, it was recognized that although the study indicates the importance of the fifth dimension, which is temporal embeddedness, this dimension is dynamic and will not be included in the No. 2 study that uses quantitative methods (static character). Importantly, research findings indicate significant barriers to initiating business cooperation.

Stage 2: Quantitative research

Characterization of research method and research sample

Based on the identified dimensions of enterprise embeddedness in the cluster (study No. 1), the next stage tested the relations between the cooperation of cluster enterprises and the fact of embedding these enterprises in a cluster in accordance with individual dimensions. In order to achieve this, the main hypothesis was formulated:

H1: There is a significant relation between the cooperation of enterprises belonging to clusters and their embeddedness in a cluster.

Next, the main hypothesis was disaggregated into four partial hypotheses, which took the following form:

H_a: There is a significant relation between the cooperation of cluster enterprises and their geographical embeddedness in a cluster.

H_b: There is a significant relation between the cooperation of cluster enterprises and their structural embeddedness in a cluster.
H_c: There is a significant relation between the cooperation of cluster enterprises and their institutional embeddedness in a cluster.
H_d: There is a significant relation between the cooperation of cluster enterprises and their relational embeddedness in a cluster.

The study was carried out on a nationwide sample of 135 Polish production enterprises declaring belonging to clusters and simultaneously cooperating in supply chains with other cluster enterprises. The research was performed using a quantitative research method, a standardized questionnaire comprising applied questions with a five-point Likert scale (Dawes, 2008) using a computer-assisted interview (CAWI). The specific study was preceded by a pilot study among 20 companies.

Study 2: Data analysis and study results

The statistical analysis was carried out in the following order:

- study of existing interdependencies to verify the hypotheses presented in the paper;
- analysis of the distribution of responses in terms of factors favoring and limiting the cooperation of enterprises in the cluster.

Analysis of interdependencies

Based on study No. 1, the dimensions of embeddedness in a cluster were conceptualized and operationalized. In order to examine the relations between the cooperation of enterprises belonging to clusters and their embeddedness in the cluster, observable variables describing individual dimensions of embeddedness were introduced (Table 4).

The data collected during the research was subjected to in-depth statistical analysis. In order to verify the hypotheses and the dependency analysis (correlation), a significance test was applied on the chi-square statistic values (assuming that the level of significance for a given result will indicate a significant dependence that is $p = 0.05$) that are a part of the statistical inference, while the strength of such a relation was determined on the basis of Cramér's V, Tschuprow's T and C-Pearson.

Table 4. Observable variables describing dimensions of embeddedness in a cluster

Embeddedness dimension	Symbol	Independent variables
Geographical embeddedness	GEO1	Cluster actors are located close enough to each other
Structural embeddedness	STR1	The cluster has the right number of actors
	STR2	The cluster includes the right actors
Institutional embeddedness	INS1	Participation in the cluster is based on formal principles (contract, bylaw, regulations, declaration, etc.)
	INS2	In the cluster, the goals and/or strategy are properly defined and well known
	INS3	The coordinator performs their duties well
Relational embeddedness	REL1	Communication between cluster actors is sufficient
	REL2	The coordinator helps build good relations and trust among cluster actors
	REL3	Cooperation of the cluster companies is based on personal contacts

Determining the degree of dependence strength resulting from the value of the correlation coefficient is not clearly normalized. This dissertation adopts the interpretation in accordance with Table 5.

Table 5. Interpretation of correlation coefficient values

Correlation coefficient value	Strength of linkages between variables
0-0.2	weak
0.2-0.4	moderate
0.4-0.6	average
0.6-0.8	strong
0.8-1.0	very strong

Source: Czyżycki, Hundert, & Klóska (2006, p.157).

In extreme cases, if the value of the correlation coefficient is 0, it means a complete lack of linkage, and when it is 1, it means full linkage. Table 6 presents the study on the correlation between the observable variables (independent variables) and the interaction of cluster members with other cluster enterprises (independent variable).

Table 6. Analysis of the relations between dimension of embeddedness in a cluster and cooperation of cluster enterprises

Embeddedness dimension	p-value	Tschuprow's T	Cramér's V	C-Pearson
GEO1	0.00061	0.27461	0.27461	0.48139
STR1	0.000039	0.29974	0.29974	0.51417
STR2	0.021287	0.22585	0.24269	0.38751
INS1	0.000009	0.31097	0.33416	0.50093
INS2	0.003816	0.25505	0.25505	0.4544
INS3	0.00002	0.30557	0.30557	0.52146
REL1	0.000746	0.27259	0.27259	0.47867
REL2	0.011641	0.24148	0.24148	0.4349
REL3	0.000502	0.27653	0.27653	0.48398

It should be noted that various correlation coefficients based on chi-square statistics (Bergsma 2013; Wijayatunga, 2016) are used interchangeably in the literature. Therefore, for comparison purposes, Table 6 uses the correlation coefficients listed (Cramér's V, Tschuprow's T and C-Pearson). However, in the rest of the dissertation, the reasoning will refer only to the C-Pearson's coefficient.

The analysis of the research results indicates that there is a significant relation with average strength between all independent variables (dimensions of enterprise embeddedness in the cluster) and the dependent variable (cooperation of enterprises). The exception is the STR2 variable, where there is a significant relation, however, of moderate strength. Thus, all partial hypotheses were maintained. As a consequence, the main hypothesis was also confirmed, according to which there is a relation between embedding enterprises in a cluster and them deciding to cooperate.

Factors favoring and limiting cooperation in a cluster – analysis of the distribution of answer structure

The primary goal of cluster organizations is to create conditions for cooperation of its actors. The belonging and functioning of enterprises within-cluster organizations are associated with subjective expectation of benefits. Hence, in the course of research, the conditions for cooperation in the cluster were assessed, which required identification of factors favoring and limiting cooperation. Respondents were asked about the reasons for cooperation in the cluster. They pointed out the importance of individual factors in undertaking and developing cooperation with cluster entities, as shown in Figure 3.

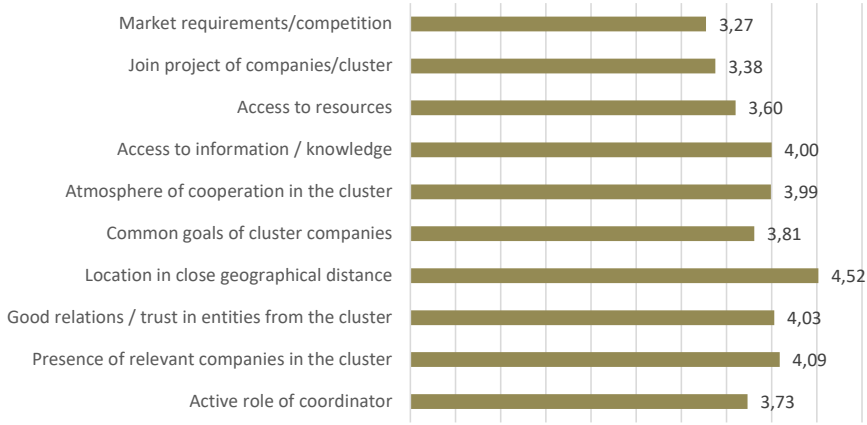

Figure 3. Average assessment of the importance of reasons for cooperation between cluster actors

Figure 4. Average assessment of the importance of barriers limiting cooperation in a cluster

Analysis of the research results (Figure 3) proves that the main reasons for cooperating in a cluster are the geographical proximity (4.52) of enterprises with an appropriate manner and scope of activity (4.09), that is characterized by good relations and trust (4.03), an atmosphere of cooperation (3.99), and sharing of knowledge between enterprises (4.00). The convergence of the goals of cluster enterprises (3.81), as well as the active role of the cluster

coordinator (3.73), is also important. At the same time, it turns out that protection against competition is a relatively weak factor motivating the cooperation of companies, just like a joint cluster project. In the latter case, the reason may be limited funding for cluster projects among the studied clusters (Frankowska, Myszak, & Jedliński, 2016).

However, a cluster, as a cooperation-oriented organization, may, as a result of improper functioning and management, limit cooperation or not fully create opportunities for cooperation. Hence, the respondents were also asked to assess the barriers to cooperation occurring in the cluster (Figure 4). The analysis of average assessments of the importance of individual barriers limiting cooperation in a cluster proves that the barriers occur to a relatively small extent. Among the factors inhibiting cooperation, one may indicate the lack of common goals of companies (2.87) or their unwillingness to cooperate (2.70). They should be included in the internal conditions of enterprises, which may, however, be caused by factors related to territorial embeddedness, which refers to the culture and customs prevailing in the area of cluster operation. The barrier that can be overcome is the lack of knowledge about enterprises in the cluster and poor familiarity of them (2.76), which in turn is related to the job of cluster managers.

ANALYSIS AND DISCUSSION OF THE RESULTS

Research on embedding cooperating enterprises in a cluster is a complex issue. Therefore, it should be investigated based on methodological pluralism, which is presented in Table 7. In the research process, an attempt was made to find the truth by identifying relations of enterprise embeddedness in clusters with their cooperation. This became the main objective of the research carried out by both European cluster managers and the cluster enterprises themselves.

The research allowed making the following findings. First of all, the relation between the company's membership in the cluster (embeddedness in the cluster) and cooperation between cluster actors was confirmed. The survey of cluster managers enabled the identification of the main dimensions of embeddedness related to the cooperation of companies.

Four dimensions of embeddedness in the cluster were adopted, which include:

1) Geographical embeddedness, which is determined by belonging to a specific area of cluster operation.
2) Structural embeddedness, which defines the system of cooperating enterprises in the cluster.

Table 7. The scope of methodological triangulation used in the research process

Triangulation	Study 1	Study 2
Data sources	Research on European cluster managers	Research on enterprises belonging to clusters
Research methods	Qualitative research – in-depth direct interviews (IDI)	Quantitative research - on a representative nationwide research sample (CAWI)
Context	European clusters	National enterprises

3) Institutional embeddedness, which illustrates the impact of the cluster as an organized structure on cluster enterprises and their cooperation.
4) Relational embeddedness, which indicates the role of relations and bonds in the cooperation of enterprises in the cluster, as well as in initiating their cooperation.

Then, in the next stage of the research process (study of cluster enterprises), the relations between the indicated dimensions of embeddedness in the cluster and the cooperation of cluster enterprises were confirmed (Table 6). Thus, all formulated research hypotheses were upheld.

Creating and stimulating cooperation in a cluster is its primary value (Morgulis-Yakushev & Solvell, 2017). At the same time, it is a challenge for cluster enterprises, who are often competitors. Therefore, the issue of factors favoring and limiting cooperation constituted a natural background to the research on enterprise embeddedness in the cluster.

Research results, regarding the assessment of the reasons for undertaking cooperation in a cluster, confirm the relations between individual dimensions of embeddedness in the cluster and the cooperation of cluster enterprises (Figure 3). The highest average grade (4.52/5.00) was obtained by the close geographical distance of enterprises (geographical embeddedness). Following that, of key importance were factors connected to relational embeddedness: good relations in the cluster (4.03/5.00), access to information and knowledge (4.00/5.00), as well as the atmosphere of cooperation in the cluster (3.99/5.00). Relatively high average scores were received by factors related to structural embeddedness, which could include: the presence of relevant companies in the cluster (4.09/5.00) and common goals of the cluster companies (3.81/5.00); as well as the factor reflecting institutional embeddedness, which is the active role of a manager (3.73/5.00).

The conducted literature analysis proves the positive, negative, and paradoxical impact of embeddedness in a cluster network. These observations were confirmed in the research of European cluster managers. However, the methods used in quantitative research did not allow for explicit reference

to these regularities. Moreover, the arrangements regarding the barriers to cooperation in the cluster were not confirmed. Both the literature research and, above all, the research of cluster managers identified clear barriers to cooperation occurring in a cluster. According to the collected research material, they resulted, among others, from geographical embeddedness perceived from the perspective of identity and culture prevailing in the region of the cluster's operation, or from structural embeddedness manifested in differences in the size, potential, and working practices of cluster enterprises. However, the obtained results of barrier assessment by cluster enterprises do not confirm these findings. Analysis of average assessments of the importance of individual barriers limiting cooperation in a cluster proves that the barriers occur to a relatively small extent (Figure 4). On the one hand, it should be recognized that these results are consistent with the average assessments of factors favoring cooperation in the cluster. On the other hand, they were not confirmed in regards to the findings of the cluster managers' research, who pointed to significant barriers to the cooperation of cluster enterprises. Nevertheless, it should be remembered that both the specificity of the studied groups (cluster managers and production companies) and the existing limitations of individual research methods (qualitative and quantitative research) result in the fact that it was not possible to compare fully the research material obtained in the course of two studies. In addition, the survey of managers was dynamic in the sense that it included the time perspective of the cluster organization. Thus, the opinions of the respondents included the entire cooperation process from the moment of initiation to the subsequent stages of its development. In turn, cluster enterprise surveys are static and present an assessment of the interviews being carried out at a given moment.

CONCLUSIONS

The main aim of the article was to understand and explain, based on the concept of embeddedness, whether there are relations between the participation of enterprises in a cluster-type inter-organizational network (embeddedness and its dimensions) and their cooperation in the cluster. In order to successfully implement such a task, it was necessary to conduct extensive literature studies and conduct in-depth empirical research.

Literature research allowed exploring the concept of embeddedness and identified its various dimensions. The following types of embeddedness were described: structural, relational, social, positional, territorial, geographical, spatial, institutional, ecological, political, and temporal. This, in turn, allowed conducting empirical research. In the first place (study 1), in-depth interviews

(IDI) with managers of European clusters (France, Spain, Norway, Serbia, Sweden, Poland) representing organizations in maturity and covering all stages of the value chain (upstream and downstream supply chain) were carried out. Research material was obtained, allowing addressing identified research problems, which include:

- recognition of the mechanism of cooperation of enterprises in the cluster;
- observing the relation of embeddedness in a cluster with cooperation of enterprises.

As a result, it was established that four dimensions of embeddedness are of key importance for cooperating enterprises embedded in the cluster, namely: structural, geographical, institutional and relational. Thus, the identified cognitive gap was filled, and the first research goal was achieved. The above-mentioned findings required further in-depth research. Hence, the second of the research objectives set out was the necessity to verify empirically the relations of embeddedness in the cluster with the cooperation of enterprises. In accordance with the postulate to maintain methodological rigor and verify methods (triangulation), research was continued using a different method and a different data source. Thus, study 2 used quantitative methods (CAWI) and it was carried out among production enterprises belonging to clusters. The results of the research maintained all partial hypotheses. As a consequence, the main hypothesis was confirmed, according to which there is a positive relation between the embeddedness of enterprises in the cluster and their cooperation.

The conducted literature and empirical research (qualitative and quantitative) confirmed that the concept of embeddedness is widely used in management sciences in many research areas. Taking into account interpersonal relations, as well as social, institutional and geographical circumstances of decisions and economic activities, can enrich the analysis, both in the micro- and meso-economic dimensions. It is about a holistic approach and understanding the embeddedness of cooperating companies in the network, which will allow for a more effective search for ways to gain competitive advantage. At the same time, one should be careful not to oversocialize approaches regarding shaping behavior in economic relations (Nyholm, 2011). As Uzzi (1997) underlines, the optimal level of embeddedness is a medium-range, which is not too close, so as not to separate relations and lead to their fragmentation, or too loose, so as to allow the formation of relations between actors of the inter-organizational network.

The concept of embeddedness is mainly used to illustrate social complexity and that other contexts of economic activity should not be ignored. It helps better understand the changes and development of inter-

organizational networks. The value of this dissertation is to confirm the importance of contextual factors (embeddedness in a cluster) for cooperation undertaken in the inter-organizational network, as well as indicate the main dimensions of embeddedness in the cluster related to the cooperative activity of enterprises. In the application dimension, these findings can be of great importance for both cluster managers and decision-makers responsible for shaping cluster policy.

The research presented in the article is not without restrictions. Despite the use of methodological triangulation, it was only possible to partially confront the research material obtained in the course of two studies. This applies in particular to assessing barriers to cooperation between cluster enterprises. Although this was not the main topic of the research undertaken, it seems that this difficult cognitive and research area is related to the ambiguous and even paradoxical impact of embeddedness on the cooperation of enterprises in cluster-type inter-organizational networks. It is, therefore, an area requiring further exploration and research effort.

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Abstrakt

Współpraca przedsiębiorstw w sieciach międzyorganizacyjnych jest złożonym obszarem badawczym i poznawczym ze względu na wielowymiarowy charakter współpracy, na którą często składają się motywy, zamiary, cele i warunki działania. Badania literaturowe ujawniły dotychczas bardzo skąpą i rozproszoną wiedzę w zakresie osadzania współpracy przedsiębiorstw w sieciach międzyorganizacyjnych, co zdecydowanie nie odzwierciedla w wystarczającym stopniu wpływu kontekstu na współdziałanie przedsiębiorstw. Głównym celem artykułu jest zrozumienie i wyjaśnienie, w oparciu o koncepcję osadzenia, czy istnieją relacje między uczestnictwem przedsiębiorstw w sieci międzyorganizacyjnej typu klaster a współpracą w ramach danej sieci klastrowej. Realizacja celów badawczych wymagała opracowania procesu badawczego obejmującego trzy etapy. Określono istotę i wymiary osadzenia współpracujących przedsiębiorstw w sieciach międzyorganizacyjnych (strukturalnych, relacyjnych, społecznych, pozycyjnych, terytorialnych, geograficznych, przestrzennych, instytucjonalnych, ekologicznych, politycznych i czasowych). Następnie przeprowadzono wywiady bezpośrednie wśród europejskich menedżerów klastrów (badanie 1) na temat współpracy w klastrze w celu lepszego zrozumienia wymiarów osadzenia przedsiębiorstw współpracujących w klastrach (badania jakościowe, IDI). W kolejnym etapie przeprowadzono badanie przedsiębiorstw w klastrze (badanie 2) w celu określenia relacji między ich zakorzenieniem w klastrze a współpracą z innymi firmami klastra (badania ilościowe, CAWI). Następnie zastosowano triangulację źródeł danych, metod badawczych i kontekstu.

W rezultacie ustalono, że cztery wymiary osadzenia mają kluczowe znaczenie dla przedsiębiorstw współpracujących w klastrze. Jest to osadzenie strukturalne, geograficzne, instytucjonalne i relacyjne. Ponadto wyniki badań pokazują, że istnieje pozytywna zależność pomiędzy włączeniem przedsiębiorstw do klastra a ich współpracą.
Słowa kluczowe: *klaster, organizacja sieciowa, sieć, osadzenie, współpraca, współdziałanie, bliskość, menedżer klastra, moderator klastra*

Biographical note

Marzena Frankowska is an associate professor at the Logistics Department of the Institute of Management at the University of Szczecin. She is President of the Management Board of the industrial cluster and a manager in international research projects. She is also the author of numerous publications on supply chains, inter-organizational networks, including clusters, as well as the cooperation of manufacturing enterprises and their development.

Conflicts of interest

The author declares no conflict of interest.

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Innovating in the textile industry: An uncoordinated dance between firms and their territory?

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Abstract

Considering the process of innovation development, this paper aimed to examine the effect of different dimensions of proximity and the level of coordination that exists in a textile cluster. This study employed a qualitative method, based on in-depth interviews that were conducted with two leading firms in a textile cluster in Valencia, Spain, which is subject to intense competition from producers in Asia. Firms were selected according to the criteria of innovation development and opportunity. This is a pilot study that precedes a more ambitious one. The results suggested that firms' innovations are developed in an isolated, discontinuous, marginal, and uncoordinated way, and clustering has a marginal effect. Furthermore, despite high geographical and cognitive proximity, low social proximity is maintained by the low level of trust between the firms. These findings may be of significant practical value for practitioners and institutions. Firms can gain a better understanding of the importance of being located in a cluster, as this is a key factor for their survival under intense competition. However, geographical proximity is not sufficient, and firms need to cooperate with each other and share their ideas and experiences. In addition, institutions should interact more with companies, speak their language, meet their needs, and devise strong cluster initiatives. This study provides a more comprehensive understanding of how institutions and firms interact within a cluster in the process of innovation development and elaborate upon different dimensions of proximity among firms.

Keywords: *cluster, innovation, proximity, Spain, territory, textile-clothing*

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INTRODUCTION

The effect of clustering on the competitiveness of companies is hardly a new topic in the business literature. Paradigmatic examples, such as Silicon Valley (USA) for information technologies or Castellón (Spain) for tiles, speak for themselves. In these territories, the local productive system (firms and other actors) has been developed. Every type of activity is carried out in the value chain, and the final effect is positive (Puig & Marques, 2010). These cases are often used as a reference when analyzing successful companies. They provide a model for regional development and are a source of inspiration for academics and professionals alike (Molina-Morales & Martínez-Fernández, 2003). The activities of these territories, and the manner in which such activities are carried out, provides a good road map to study other sectors such as the textile industry.

To analyze these geographic realities, the aspects that can be studied are varied. In terms of the implemented business model (how firms do business and compete), two factors are considered fundamental: a) structural (size, ownership, activity, etc.) and b) strategic (implemented responses and strategies) (Lambert & Davidson, 2013). In the latter case, strategies such as internationalization or innovation are frequently used as a basis for research (Claver-Cortés, Marco-Lajara, Seva-Larrosa, & Ruiz-Fernández, 2019). This does not come as a surprise; in a globalized world, innovation has become key to survival for textile firms (Golf-Laville & Ortega-Colomer, 2012).

But what is the strategic relationship between the territory in which the firm is located and the implementation of innovations? A cluster represents the geographical space in which firms interact with companies and institutions that belong to the same sector and which are interrelated by ties of competition and cooperation (Porter, 1998). Authors including Baptista and Swann (1998) have demonstrated that when both aspects (company and territory) interact effectively, the region becomes a platform and a stimulus for innovation, and an excellent place to compete (as Silicon Valley or Castellón).

In the innovation process, the geographical and institutional proximity between the actors involved in this process promotes an understanding among the companies of what is transmitted to them by institutions, and at the same time, the institutions that belong to the cluster understand what the companies demand (Sivadas & Dwyer, 2000; Albors-Garrigós, Hervás-Oliver, & Hidalgo, 2009). In addition to the aforementioned proximities, firms and institutions in the cluster also need other proximity dimensions to break down barriers to innovation development. Such proximity dimensions include cognitive (to share the same knowledge base), social (being part of the same

social environment), and organizational (to belong to the same organization) proximities (Boschma, 2005; Balland, Boschma, & Frenken, 2015). Moreover, thanks to externalities and spillovers, geographic clustering can help smaller firms to overcome their size constraints (Porter, 1998). However, sometimes both innovation and territory interact or "dance" in an uncoordinated way and produce unexpected results (Heinonen & Ortega-Colomer, 2015).

Thus, this paper aims to examine the effect of different dimensions of proximity and the level of coordination that exists in a textile cluster in the process of innovation development. To this end, this study focused on one of the most important Spanish textile clusters and carried out in-depth interviews with the executives of two representative companies. The interviews addressed issues related to the implementation of innovations, the influence of the territory in that process, and the level of the different dimensions of proximity that exist within the cluster.

This article is presented in six parts. Section 2 presents the literature review, which elaborates on the introduction, and explains the importance of innovation for growth, its conceptualization, and features, as well as the effect of proximity on innovation. Section 3 describes the research methodology and provides a brief description of the textile sector and the Valencian textile cluster. Section 4 presents the main results of the in-depth interviews and is followed by the discussion in section 5. Section 6 presents conclusions that summarize the main findings. A series of proposals are outlined for coordinating this dance between firms and institutions, the limitations of the study are identified, and directions for further research are suggested.

LITERATURE REVIEW

Concept of innovation

Innovation is not a new phenomenon. Primitive societies sought natural resources to ensure their survival and exerted the minimum amount of effort in the performance of their tasks. Many classic authors regarded innovation as a factor that indirectly stimulates economic growth through its effects on the variables that influence it in a more direct way, such as the division of labor. However, academics such as Schumpeter (1982) and Solow (1956), among others, asserted that, in addition to capital and labor, innovation is a key factor for development and economic growth. Following this line of thought, other authors, such as Freeman (1987) and Porter (1998), posited that the acquisition of new and more advanced technologies is an important factor for a country or a region, such that innovation represents the only way, in the

long term, that a country can more effectively develop a competitive position and promote sustainable economic growth. The concept of innovation is an open one, and it is subject to different interpretations (Tidd & Bessant, 2018[4]), although all authors agree that innovation is a new concept that involves improving a product, service, or process, and results in significant effects on the particular environment.

The Organization for Economic Cooperation and Development (OECD) developed the Oslo Manual (OECD, 2005), which distinguishes between four different types of innovation and provides some reasons for their implementation. These four types of innovation include the following:

1) Product innovation: this type of innovation involves significant changes in the capabilities of goods and services, such that either, new products and services are developed, or substantial improvements are made to existing products and services.
2) Process innovation: represents significant changes in production and delivery methods.
3) Organizational innovation: refers to the implementation of new organizational methods. These can include changes in business practices, in the organization of the workplace, or in the firm's external relations.
4) Marketing innovation: involves the implementation of new marketing methods, for instance, product design, packaging, or pricing.

Innovation is an activity that is linked to company performance: "*The ultimate reason (as to why companies innovate) is to improve firm performance, for example, by increasing demand or reducing costs*" (OECD, 2005, p. 29), and also by deeming innovation to include the implementation of a novelty and its introduction to the market, as opposed to its mere development. The factors that foster innovation are varied and their influence differs (see Table 1). For example, the organization of the workplace (or the territory) can enhance the exchange of knowledge with other organizations due to the proximity among the different actors.

Furthermore, the literature concurs that there are various mechanisms that might obstruct the implementation of innovation (Table 2). For example, such mechanisms include the weaknesses of institutions (associations, institutes, etc.) in terms of their equipment or, in other words, their uncoordinated policies for innovation (Bramwell, Nelles, & Wolfe, 2008).

4 The authors mention no less than six different definitions of innovation (Tidd & Bessant, 2018), quoting scholars such as Peter Drucker and Michael Porter or entrepreneurs such as Richard Branson.

Table 1. Factors that foster innovation

Competitors, demand, and markets	Production and distribution	Organization of the workplace	Other factors
Increase market share	Enhance the quality level	Enhance internal communication in the firm	Reduce the environmental footprint
Widen the product portfolio	Diminish costs and reduce raw materials and energy consumption	Exchange knowledge with other organizations	Increase safety and health
Adapt more quickly to customers' needs	Increase efficiency and capacity	Enhance work conditions	Follow the rules

Source: own elaboration based on OECD (2005).

Table 2. Factors hindering innovation

Economic factors	Factors related to knowledge	Factors related to markets	Institutional factors
High innovation costs	Lack of necessary knowledge	Uncertainty. Demand can be low, and hence, innovation costs cannot be recovered.	Lack of necessary infrastructure and technology.
Risks and uncertainty	Lack of qualified personnel	Potential market already dominated by incumbents	Legislation does not favor a determinate innovation: environmental, fiscal,…

Source: own elaboration based on OECD (2005).

Territory, proximity, and innovation

The concept of proximity, which relates to innovation and the dissemination of knowledge, has followed a process that can be compared to the distance dimensions that are observed between countries, as described in *International Business* (IB) literature. In 2001, Pankaj Ghemawat (Ghemawat, 2001) introduced the CAGE framework, which identifies several distance dimensions:

- c*ultural*: refers to differences in religious beliefs, race, and social norms that determine how people interact with one another and with companies and institutions;
- *administrative:* expressed as the existence of historical or political connections, political hostility, or institutional weaknesses;
- *geographical:* calculated as the physical (i.e., transport) distance between two countries;
- *economic:* reflects differences in income between nationals of different countries or differences in the costs of resources.

In the exchange of knowledge, and in particular, in the development of innovation, the reverse concept is used. The cluster literature has always advocated the importance of the physical distance between companies (or, more precisely, the lack thereof) in relation to the definition and delimitation of a cluster, as well as its influence on the performance of the firms located within it. It was not until the early works of the French School of Proximity (Torre & Rallet, 2005), and especially those of Boschma and his collaborators (Boschma, 2005; Balland et al., 2015), that different dimensions of proximity were added to the equation in an effort to explain their impact on successful knowledge interchange and potential innovations.

According to Boschma (2005), proximity can be measured according to five different dimensions (i.e., cognitive, social, geographical, organizational, and institutional). Importantly, he pointed out that negative effects arise from too little proximity between actors (this is, actors are distant from each other), and/or actors that are too close to each other. Thus, proximity is a variable that should be optimized, rather than minimized. Delving deeper into this concept, Molina-Morales, Belso-Martínez, Más-Verdú, and Martínez-Cháfer (2015) posited that attention should be given to the formation and dissolution of inter-firm linkages, as the development of innovation is based on such linkages. By studying a mature cluster of footwear firms in Spain, they found a relationship between the different dimensions of proximity and the creation of inter-firm linkages. We can refer to these conclusions in the present study, as the cluster presented in this paper is also mature[5]. Having reviewed Boschma's observations regarding the different dimensions of proximity and their relationship with innovation, we identified:

Cognitive proximity

Cognitive proximity is the shared knowledge base that enables communication between the actors (Boschma, 2005). It is also helpful for understanding

5 The textile activity in the region started well before the 20th century. It first took advantage of the available hydraulic power, then of steam power engines. ATEVAL, the association of firms in the sector, was founded in 1977, and AITEX, the technological institute, started its activities in 1985.

and processing new information. Too much proximity may lead to a lack of sources of novelty, increase the risk of lock-in and undesirable knowledge spillovers, and will inevitably result in problems of communication, as the actors are unable to exchange actionable information (Nooteboom, 2000). Contrastingly, low cognitive proximity, in terms of competences and skills, enables communication (Boschma, 2005).

In a mature cluster in Spain, Molina-Morales et al. (2015) found that too much cognitive proximity negatively affected the creation of linkages, which are a key element for the exchange of information and interactive learning. In contrast, Lazzeretti and Cappone (2016) studied the ties between entities in the high technology consumer goods cluster in Tuscany, Italy[6]. They revealed that cognitive proximity promoted the formation of ties, not only in the initial phase of the cluster but also, albeit to a lesser extent, in the later cluster stages.

The location of the firm in a cluster may help to attain the optimum level of cognitive proximity (Maskell, 2001), as clusters consist of firms that share a common knowledge base, and the knowledge creation that is generated among them occurs through variation as well as by means of a deepening division of labor. Their knowledge base consists of diverse, albeit complementary, resources. Co-location within the same cluster allows the local actors to closely monitor each other and share their cognitive base while preserving the diversity that is necessary for interactive learning (Boschma, 2005). As a consequence of the division of labor and specialization, the knowledge bases of the different firms diverge, which stimulates deeper learning. Because of growing specializations, the knowledge bases of firms diverge to such an extent that interactive learning is stimulated, although communication is hindered by too much divergence.

Social proximity

Social proximity is derived from embeddedness theory (Granovetter, 1985), which posits that economic relations occur while being embedded in a social context, such that social relations also affect the economic results of these relations. Social proximity is defined at a micro-level[7], and these relations are thought to be embedded when they are based on trust, which arises from friendship and regular intercourse. This form of trust eases

6 This cluster is composed of firms that work in the fields of geology, IT, chemistry, biology, and engineering, which mainly concentrate on the restoration of areas that have a rich cultural heritage. In addition to these big and small firms, one has to add several universities (e.g., Pisa, Florence and Padova), research institutions, and other knowledge providers. In contrast with the foodstuff and textile clusters in Valencia which were mentioned in the article, it can be considered a young cluster.
7 This social proximity, as defined at a micro level, is not to be confused with the adherence to a set of values as religious or ethnic values. This more macro level of proximity will be dealt with when explaining the institutional proximity concept.

the transfer of tacit knowledge, which is rarely exchanged through market mechanisms (Maskell & Malmberg, 1999).

This notion is formed from the rationale that a low level of social proximity affects the building of trust, resulting in a low level of knowledge interchange, which thereby impedes the development of innovations. However, the opposite situation also presents an unwelcome effect. Too much social proximity may cause the actors to underestimate the possibility of opportunism and, when maintained over a long period, this causes the actors to be locked into the established way of doing things, instead of using their capacity to learn and innovate (Uzzi, 1997).

Locating in an industrial cluster territory may compensate for the negative consequences that arise from too much social proximity: Networks that have overly tight bonds will "dissolve" because, in an agglomeration, agents have greater opportunities to establish relations with other parties and to accede to networks of a supra-regional level (Gordon & McCann, 2000). Location can also enhance social proximity via geographical proximity, and firms can benefit from frequent contacts as well as greater opportunities to build trust.

Organizational proximity

While Boschma (2005) argued that it is necessary to share a common knowledge base and common competencies in order to approach firms and generate knowledge, it is also true that knowledge creation depends on the coordination of the exchange of complementary knowledge both inside and outside organizations. Organizational issues are coordination mechanisms, and they are also the vehicles of these exchanges.

Organizational proximity enhances learning and encourages innovation development, and it is associated with several degrees of intensity, from a pure spot relation between the actors, which is an example of low organizational proximity, to a hierarchically organized firm or network that has strong linkages. Close organizational proximity promotes innovation development as it ensures the rights of ownership over such development. However, too much organizational proximity leads to a lack of flexibility in respect to the implementation of innovations, and organizational lock-in can prevent access to novelty, resulting in insufficient feedback mechanisms that are critical for knowledge development (Blanc & Sierra, 1999). It is believed that an organizational arrangement, which is composed of divisions that have a sizeable degree of autonomy, or of trust-based networks between the organizations (Nooteboom, 2000), may guarantee the desired level of flexibility, while also ensuring close organizational proximity.

Institutional proximity

Institutional proximity is associated with the institutional framework at a macro level. In contrast to social proximity, institutional proximity is formed by the relationships among actors at a macro-level. North (1990) differentiated between a macro-level institutional environment (e.g., norms and values related to conduct) and a micro-level institutional environment in which norms and values are embedded in specific interchange relations.

Edquist and Johnson defined institutions as "sets of common habits, routines, established practices, roles, or laws that regulate the relations and interactions between individuals and groups" (Edquist & Johnson, 1997, p. 46). Formal institutions (laws and norms) and informal institutions (cultural norms and habits) influence how the actors coordinate their tasks. These institutions influence how knowledge is interchanged and how innovation is developed (Boschma, 2005), by minimizing opportunism and uncertainty.

In this sense, institutional proximity is a factor that enables knowledge interchange and innovation development (Heinonen & Ortega-Colomer, 2015). However, as observed in the case of the other proximity dimensions, institutional proximity can be detrimental to innovation development, particularly when its level is excessive. When there is too much institutional proximity, episodes of institutional lock-in can occur, blinding the actors to new possibilities, which intensifies institutional inertia and impedes essential institutional re-adjustments (Bramwell et al., 2008). This situation can be avoided by implementing a system of institutional checks and balances (Herrigel, 1993), which can promote institutional stability while also encouraging openness and flexibility. This system facilitates the necessary political checks and balances that allow for political change, and encourages changes in laws and norms. It can furthermore prevent power from accumulating in the hands of the actors, which could lead to control of the system. Molina-Morales et al. (2015) confirmed this effect when they verified that too much institutional proximity hinders the creation of linkages in a mature cluster. In contrast, Lazzeretti and Capone (2016) found that institutional proximity enhances the formation of ties in the early stages of a cluster as well as in later stages, although the latter case was observed with less intensity.

Geographical proximity

Geographical proximity is defined as the spatial (or physical) distance between economic actors, in both a relative and absolute sense (Boschma, 2005). A smaller distance between actors enhances information exchange,

thus facilitating the transfer of tacit knowledge. In respect to knowledge sources, a short distance increases the level of innovative performance (Audretsch & Feldman, 1996).

However, geographical proximity *per se* is neither a necessary nor sufficient condition for interactive learning to occur. Other forms of proximity can serve as substitutes for geographical proximity (Grabher, Ibert, & Flohr, 2008). Learning networks do not need a spatial limitation, and tacit knowledge can be transmitted across large distances provided that a standard of organizational proximity exists (through the coordination of tasks carried out by a central body) and that there is a given level of cognitive proximity between actors so that the knowledge can be absorbed (Rallet & Torre, 1999). Similarly, if geographical proximity is not complemented by a minimum level of cognitive proximity, it is insufficient for the effective transmission of knowledge.

Geographical proximity can be achieved by firms that belong to the same cluster, as the distances involved are small in scale. However, too much proximity can lead the firms in a region to be too inward-looking. This resulting lack of openness to the outside world can affect the cognitive proximity of actors, which is aggravated in the case of specialized regions, and this situation has been observed to occur in a cluster (Boschma, 2005). This spatial lock-in can be avoided by forming linkages with partners outside the region while also maintaining close links with local actors. Molina-Morales et al. (2015) found close geographical and social proximities in the case of firms located in a mature cluster, and such proximities had a positive effect on the formation of inter-firm linkages, which is a prerequisite for achieving information exchange. This effect was also observed by Lazzeretti and Capone (2016) in both the early and later stages of the cluster's life, although in the last stages of the cluster, the intensity of the effect was lower. By researching cluster initiatives, Lis (2019) observed that geographical proximity had the same effect on cooperative relationships between firms.

The different dimensions of proximity can influence the information exchanges between actors in the cluster. By researching the level of the different dimensions of proximity within the cluster, we can obtain valuable information about how innovations developed within it, as innovation is based on knowledge exchanges between actors.

Innovation and clustering effect

Industrial districts and clusters are two models of production organization which propose, simultaneously, two approaches of economic development that consider territorial location to be fundamental, and both suggest developing models of production and exchange based on the binomial

company and society. According to the literature, an industrial district can be understood as a "socio-territorial entity characterized by the active presence of a community of people and a population of companies in a natural and historically determined area" (Becattini, 2015). We define clustering as the action through which firms concentrate, and their interaction is considered in both a geographical and sectorial sense (Schmitz, 1992). This action results in the formation of clusters (Albors-Garrigós et al., 2009) that have a significant effect on the companies that are located within them, particularly in terms of the introduction of manufacturing innovations (Baptista & Swann, 1998), financial performance differences (for instance, profitability), as well as non-financial differences (i.e., internationalization), which are measured in relation to their location inside or outside the agglomeration (Molina-Morales, 2001; Rodríguez-Victoria, Puig, & Gonzalez-Loureiro, 2017). Therefore, the "territory effect" is a structural feature within the manufacturing sector, and it results in a relevant territorial specialization and encourages a higher entrepreneurial activity rate in the area (Delgado, Porter, & Stern, 2010). This entrepreneurial attitude means that both new and existing companies are concerned about the implementation of renewal and innovation policies.

The main advantage of a cluster lies in how it contributes to improving the competitive advantage of the companies that are located within it, which thus increases the competitiveness of the cluster as well as that of the region where the cluster is located (Martin & Sunley, 2003). Porter (1998) suggested that this is due to the relationships that exist between the companies, which positively influence the four vertices that determine the diamond or rhombus that explains the competitive advantage. Following the guidelines of Porter (1998), we can further specify the factors that encourage these competitive improvements to take place by classifying them into three basic categories as follows:

1) Productivity enhancements: this occurs as a result of specialization, the complementarity of the activities of the actors (participating companies), the increase in the bargaining power of companies, and the reduction in transaction costs.
2) Promotion of innovation: as a result of a greater ability to perceive new customer needs, new technological, commercial, or productive possibilities through joint research are made possible.
3) Creation of new companies: thanks to the reduced level of risk and lower entry barriers, as well as established relationships and potential customers for new companies.

Empirical evidence identified a «clustering effect» on productivity, innovation rates, and entrepreneurial attitudes (Molina-Morales & Martínez-Fernández, 2003; Puig, González-Loureiro, & Marques, 2014, Rodríguez-Victoria et al., 2017; Claver-Cortés et al., 2019). These externalities can be

explained by three types of advantages that are difficult to achieve using another approach (Camisón, 2004):

1) Shared advantages: within a cluster, the development of ideas about competition and cooperation.
2) Competitive advantages: based on identifying competencies, and on differentiating elements of the companies that belong to a cluster which allow them to compete more effectively.
3) Comparative advantages: these types of advantages include the territory in which the companies are located. For example, it is worth mentioning that the Ontinyent area is the "capital" of the textile cluster at a regional level, and is home to almost 44% of the companies. Within the cluster area, around 33% of the manufacturing companies are associated with the traditional textile company.

Therefore, this organizational model, which is based on geographical proximity, is an important stimulus for innovation and the sustainability of companies, as it favors competitiveness: Some textile companies would not have grown to such a significant extent had they been located in another part of Spain (Puig & Marques, 2010). Clusters extend vertically in the value chain which includes suppliers and auxiliary industries, and they also extend horizontally or transversally, by incorporating knowledge providers, public institutions, educational institutions, industrial parks, technological institutes, information services, recycling, and technical support firms, which are key to implementing innovations (Golf-Laville & Ortega-Colomer, 2012). However, while geographical proximity is a necessary prerequisite for the organizational model, it is by no means sufficient for the effective coordination of the incumbent firms.

RESEARCH METHODS

Research design, approach, and cases

Our study is based on qualitative research. Qualitative data represent non-numeric data which have been obtained by employing different research strategies (Saunders, Lewis, & Thornhill, 2009). Qualitative research aims to obtain rich information about people's lives, experiences, behaviors, social movements, cultural phenomena, or management (Yin, 2018), which cannot be represented by numbers. In its broadest sense, the term "qualitative methodology" refers to research that produces descriptive data: The written or spoken words or the observable behavior of the individuals being studied (Taylor, Bogdan, & DeVault, 2015). Qualitative methods can be used to obtain complex details about some phenomena, such as feelings, thought processes

and emotions, which are difficult to extract using other more conventional research methods (Yin, 2018; Najda-Janoszka & Daba-Buzoianu, 2018).

The sample consists of two companies dedicated to the textile industry, which are located in Ontinyent territory. In line with Tognazzo and Mazzurana (2017), we explored only two cases for several reasons: a) this study is the first step towards a more ambitious research project; b) by selecting two cases, we were able to carry out a more comprehensive analysis, allowing us to acquire and report our experiences with the gathering of new and unfamiliar data (von Krogh, Spaeth, & Lakhani, 2003); c) as Dyer and Wilkins stated: "Moreover, because Eisenhardt argues that the more cases a researcher studies, the better (within certain limits) for generating theory, she seems to lose the essence of case study research: The careful study of a single case allows researchers to identify new theoretical relationships and question old ones" (Dyer & Wilkins, 1991, p. 614).

According to Puig and Marques (2010), the productive process of the textile industry can be summarized as a cycle that involves spinning, weaving and dyeing, finishing, and dressmaking, which transforms a series of inputs (fibers, chemical products, etc.) into outputs or final products. These products can be highly varied (Canals, 2003), and may include blankets, bedspreads, carpets, sports clothing, and clothing from technical textiles, etc. In this process, it is important to point out that each link contributes to the elaboration of a finished product with added value, such that there is an interaction between the different links. The alteration or disappearance of any of these links would only endanger the continuity of the other companies located along the chain. In this sense, globalization has triggered some unbalances in the value chain, leading to the closure of some companies, or to an increase in the price of some raw materials and semi-finished products. Hence, the importance of innovation processes and continuous training for human resources to further enhance their skills, as well as the Industry 4.0 processes, all of which aim to support the entirety of the production process.

Historically, Spain's textile industry, which is a mature sector, has played an important role in the country's industrial development. According to data from 2013, 1.7 million people were employed by 185,000 European companies in the industry, which generated a turnover of 166 billion EUR. The sector accounts for a 3% share of value-added and a 6% share of employment in total manufacturing in Europe. The sector in the EU is based around small businesses (European Commission, 2019).

The textile industry in Spain is traditionally associated with two regions, namely, Catalonia and the Valencian Community. The Valencian textile cluster is formed by firms located in the counties of La Vall d'Albaida, el Comtat, and L'Alcoià, and it is composed of around 500 firms, with a total staff of 4,100

employees. In this cluster, the main agglomeration of firms is located in the city of Ontinyent, which accounts for almost 33% of the activity (ATEVAL, 2017). In the Ontinyent region, the textile companies that prevail are small and medium-sized firms, many of which are family businesses, in the same vein as those in other South European countries such as Portugal or Italy (European Commission, 2019).

To ensure confidentiality, the firms which were studied are referred to as Alpha company and Beta company. The selection of these companies was based on criteria including relevance (i.e., the implementation of innovation initiatives, as confirmed by the information retrieved from our contacts in the cluster) and opportunity (i.e., their willingness to participate in the study).

This analysis, upon which our study is based, has allowed us to understand how innovation has developed within the cluster, the role of the different dimensions of proximity in its development, and the degree of coordination between the institutions and firms in the cluster. The features of the participating companies are shown in Table 3. Both are bigger than the average firm in the cluster (9 employees) and the age of around 25 years. The interviews with these companies were carried out in February of 2017, and the interviewees included either CEOs or members of the Executive Committees of the firms.

The collection of information derives from a series of in-depth interviews, which were conducted with these two companies, as well as a participatory observation of the daily work performed by their top executive managers. These interviews took place during the first months of 2017. The recordings were transcribed and then coded manually, searching for information about the diverse aspects related to the object of this research (i.e., how innovation was developed, the effect of clustering in this development, level of proximities in the cluster and their effects, degree of coordination between the actors of the territory). The interviews were structured in three parts: 1) *introductory questions* from which we obtained basic information about the companies, its vision, and the future of their industry; 2) *innovation implemented*, with the objective of understanding the level and types of innovations achieved by the firms, and 3) *influence of clustering* and the role of institutions and proximity in these processes.

Table 3. Features of the firms in the sample

Variables	Alpha company	Beta company
Turnover (2016)	Around 12 million EUR	Around 3 million EUR
Turnover (2016) per employee	120,000 EUR	100,000 EUR
Operating result (2016)	Around (– 500,000 EUR) (loss)	Around +300,000 EUR (profit)
Employees (as of the end of 2016)	Around 100	Around 30
Type of products	Household textiles (blankets, pillows…)	Sewing of sporting apparel based on technical textiles
Ownership	Worker's Cooperative	Family firm
NACE Rev 2 Code	1392: Manufacture of made-up textile articles, except apparel	1431 Manufacture of knitted and crocheted hosiery
Company type	Worker's Cooperative	Private limited liability company
Type of innovation	Product, process, marketing innovation	Product, process, marketing innovation
Interviewee	Member of the Executive Committee	General Manager

Source: own elaboration on SABI (2019).

ANALYSIS AND RESEARCH RESULTS

Vision and future of the textile-clothing industry

As described in the theoretical framework, the new global economy and the progressive economic and social transformations that have taken place in recent years are bringing about a competitive rearrangement of each one of the phases along the value chain of the sector, from what is to be manufactured to what is to be sold.

Both of the managers who were interviewed agreed that they operate in a mature and traditional sector that experiences significant competition from emerging economies. These aspects are in line with other studies, such as those carried out by Costa and Duch (2005) or Cerverón and Ybarra (2016). Nevertheless, the dynamism that this industry possesses, in terms of renewal, innovation, and internationalization, encouraged a positive vision of the future among the managers of both of the companies. The main results of the interviews were triangulated and contrasted with relevant members of the territory.

In conclusion, both companies had to innovate processes to subsequently manufacture the desired products; the Alpha company produced new blankets, and the Beta company diversified its products and finishes. It is also important to mention that both companies utilize Industry 4.0 technology in their production process, which is an essential resource in maintaining competitiveness, and it furthermore contributes to their medium and long-term sustainability (Müller, Kiel, & Voigt, 2018).

It is worth noting that the CEO of one of the firms studied hinted that *"…one of the features of this sector is its high level of competence. Until some years ago, it was unthinkable to expect firms in the sector to gather at a conference or an event"*. Shortly afterward, the same person stated that *"unless ATEVAL*[8] *acts as a catalyzer among the textile firms, trust between them could not be built, and then the opportunities for cooperation will not show."* We believe that this is the role of the institutions in the cluster; they are bodies that enhance organizational proximity, which is based on the establishment of trust-based networks between organizations that facilitate close organizational proximity while also maintaining flexibility, as mentioned previously (Nooteboom, 2000). These reflections are in line with the study of Sydow and Staber (2002).

Implementation of innovation

At this point, the following question arises: How did the firms in this study carry out the innovations? We asked whether innovations were carried out internally (i.e., using their own resources), or by means of external resources (i.e., via synergies with other companies in the sector, as well as by engaging with institutions such as AITEX, ATEVAL, etc.).[9]

Alpha company

"Our innovations have been mainly carried out by using our own resources, as we have a design department, a textile engineer on the staff, technicians specialized in product development, and people from other departments who are properly trained according to the needs of the company. We also had to resort to external services, such as laboratories, machinery suppliers, delivery and logistics services, etc."[10]

8 ATEVAL is the association of textile industries of the cluster, having offices in Ontinyent and Alcoi.
9 AITEX is an acronym of the Research Institute for the Textile Industry, an institute formed by the Government of the Valencian Region in the '90s whose objective involved the diffusion of technical expertise among its members.
10 Without doubt, profiting from the close cognitive proximity between these actors.

Beta company

"The innovations were carried out by using our own resources, that is, internally and also with the help of external services such as laboratories, machinery suppliers, software, etc."

From both quotes, we can conclude that even though the companies are located in the same territory, they preferred to pursue their innovations by utilizing their own resources. The only external resources used by the firms included suppliers or laboratories, and they did not cooperate with other textile firms. In our opinion, after reviewing additional comments by these firms and by applying our own experience from other research studies of this territory, this finding could be attributed to a general attitude of industrial secrecy which arises due to the geographical proximity of competitors and the lack of collaboration between companies. In other words, this highlights one of the most obvious consequences of too much geographical proximity and too little social proximity (Molina-Morales & Martinez-Fernández, 2009).

The utilization of internal resources offers advantages and disadvantages (Cainelli, De Marchi, & Grandinetti, 2015). Some of the advantages include the possibility to integrate the results more easily, and the development process is quicker, as engineers and designers form part of the firm's staff (design is a fundamental part of product differentiation). However, all of this occurs without actively profiting from the aforementioned facilitating agents (e.g., universities and technological institutes), or from the creation of synergies between firms, in respect to R&D activities, for example. For firms, this process requires significant economic effort, and the implementation of innovations is undertaken at a slower speed, which therefore affects their overall competitiveness. In addition, we should not forget that there is a lack of appropriation in terms of the efficiency of the intervention when several organizations carry out a project. Moreover, it should be acknowledged that product innovation also leads to necessary innovations in respect to the firm's processes, and in many cases, this involves innovations in the areas of marketing and organizational issues. Therefore, such forms of innovation necessarily arise from the changes that are introduced in product lines (Grabher et al., 2008).

In line with previous studies, such as the OECD's study (2005), it is interesting to note that these firms acknowledged the factors that foster and hinder innovation, as shown in Table 4. Among the factors which foster innovation, the firms mentioned a quick adaptation to customers' needs, a broader product portfolio, enhancing the level of quality, and knowledge exchange between other firms. Furthermore, both firms agreed that factors which hinder innovation include the high costs of innovation development and a lack of necessary knowledge and technologies. It must be mentioned

that both of the firms which took part in this study were SMEs, and these factors might not be observed in the case of bigger firms.

Table 4. Summary of factors related to innovation cited by the interviewed firms

Company	Type of innovation developed	Resources used in the process	Factors mentioned that fostered innovation	Factors mentioned that hindered innovation	Proximity factors mentioned by companies
Alpha	Product Process (Industry 4.0) Organizational (Lean Manufacturing) Commercial (Online sales, new channels, low quantities orders) Servitization	Own resources External resources (both from inside and from outside the cluster)	Increase market share Adapt more quickly to customers' needs Widen the product portfolio Enhance the quality level Diminish costs (Lean manufacturing) Increase efficiency and capacity Knowledge exchange with other organizations To follow the rules	High innovation costs Lack of necessary knowledge Lack of necessary technology	Social proximity: firm comments about low levels of trust among industry firms, despite high geographical proximity Institutional proximity: firm reports they use cluster institutions, but complain about their low level of dedication; they prefer playing "petty politics" rather than keeping close to the cluster firms No comments about organizational proximity Cognitive and geographical proximities, although not mentioned, were implicit in the interviews

Company	Type of innovation developed	Resources used in the process	Factors mentioned that fostered innovation	Factors mentioned that hindered innovation	Proximity factors mentioned by companies
Beta	Product (New technical textiles for sports) Process (Industry 4.0, New raw materials, new technology) Organizational (Industry 4.0) Commercial (New brands, product lines, and channels, Internationalization, Technical Assistance) Servitization	Own resources External resources (both from inside and from outside the cluster Attendance to fairs Technological institutes	Adapt more quickly to customers' needs Widen the product portfolio Enhance the quality level Knowledge exchange with other organizations Enhance internal communication in the firm	High innovation costs Lack of necessary knowledge Lack of necessary technology Uncertainty: Demand can be low, and hence, innovation costs cannot be recovered	Social proximity: firm comments about low levels of trust with industry firms, despite high geographical proximity Institutional proximity: firm reports they use cluster institutions but complain about their low level of implication and lack of effectiveness. No comments about organizational proximity Cognitive and geographical proximities, although not mentioned, were implicit in the interviews Geographical proximity: Firm maintains extra-cluster linkages

Clustering effect on innovation: Opinions

The firms' perceptions about the influence of their territorial location when innovating were described as follows:

Alpha company

"The cluster is valid to create synergies because we are in a territory where rivalry is very strong among companies that are dedicated to the textile industry. A few years ago, it was unthinkable that two competing companies located in the same industrial area would meet at an exhibition fair, an event, or even a meeting."

"In principle, it is favorable for everyone, but lately, and from our point of view, these entities (Cluster Innovall, AITEX, ATEVAL ...) are more focused on representativeness, and they have not made an effort to be closer to companies[11]*. When we have had to make an important change, we undertook the first step alone, it would be convenient that they were closer to the activity of the companies so that this happens as little as possible."*

Beta company

"In general terms, the textile cluster of Ontinyent is favorable, but in my opinion, today, it does not have the media repercussion or the necessary impact for companies, that is, it does not mean an increase in market share or turnover. We created sportswear long before well-known brands like NIKE and ADIDAS, and due to a lack of media coverage, we were not able to sell them until these big companies put the same product on the market."

After analyzing the responses of both companies and reviewing the previous notes, we can conclude that both cases agree on the following aspects:

- belonging to a territorial cluster is important to carrying out innovation processes;
- innovation is carried out individually by internal mechanisms, with the help of external agents, but not other textile firms;
- there is a lack of coordination among the territory's institutions.

DISCUSSION

By considering the results of our research, and comparing them with the factors outlined in the literature review, we can state the following:

Cognitive proximity

The firms that participated in this study did not comment on cognitive proximity. Nevertheless, this type of proximity is understood to represent the shared knowledge base that enables communication between actors (Boschma, 2005), and it is regarded as a prerequisite for the cooperation of institutions within the cluster. At both the firm-level and the institutional-level (e.g., ATEVAL, AITEX, or universities), this knowledge base formed part of the common ground between the actors.

11 We wish to note that the firm undoubtedly refers to a low level of institutional proximity. For example, while firms are demanding technical support to the institutions, the institutions only offer lobby influence in upper instances.

Social proximity

We found that innovation development was carried out by the firms with the help of external suppliers, though not by cooperating with other textile firms. The competence level in the sector prevented the building of trust among the firms, which in turn negatively affected their level of cooperation. Beta company argued that an institution in the cluster, namely, ATEVAL, had the task of acting as a catalyzer for the development of trust among firms in the sector. Firms complained that this lack of social proximity was a deterrent to the formation of inter-firm linkages, which is in line with the conclusions of Molina-Morales et al.'s (2015) research involving another mature cluster that produced footwear products in Spain.

Organizational proximity

As a probable consequence of the low level of trust among firms, a low level of organizational proximity existed among them, which explained the lack of inter-firm cooperation when developing innovations. The manager of one of the firms in this study expected ATEVAL to act as a catalyzer to develop trust between the firms, by promoting trust-based networks of firms that could enhance organizational proximity. In this sense, it was implied that institutions, which are a key tenet of institutional proximity, could be used to promote organizational proximity, thus confirming Boschma's (2005) proposition regarding the substitutive effect, whereby some dimensions of proximity could be substituted for others.

Institutional proximity

Institutional proximity was not mentioned by the firms that were interviewed in this study, but it was "in the air." Sharing the same institutional framework ensured the stability of the industry (Bramwell et al., 2008), but firms were aware that some of the changes were prompted by actors who adopted this framework, namely, competing firms from Asian countries, which rendered useless the routine and conservative reaction to change (Herrigel, 1993). One firm complained about the lack of a "safety net" within this institutional framework, citing an instance related to their industrial property in an Asian country to which they exported.

Geographical proximity

Both firms are located within the cluster, whose geographical spread is reduced, though they keep extra-cluster linkages. These linkages help to

reduce excessive geographical proximity, thus encouraging the firms to adopt a less inward-looking approach (Boschma, 2005). Both firms agreed that attending exhibition fairs helped them to keep up-to-date with technical developments within the sector, which decreased their need to engage with institutions in the cluster (AITEX, ATEVAL or Innovall)

Development of innovation

This study found that the two firms were concerned about innovation. However, in our opinion, their main objectives and challenges were to modernize their production processes, adopt more efficient production methods to reduce costs, acquire new machinery, develop more advanced production techniques, become more competitive, and aim to reduce their costs and prices. Both companies agreed on the following points: enhancing added value in their activities; applying the concept of servitization[12]; adding and integrating services to the supply of products, is a strategy that can be adopted by manufacturing companies to improve their competitive position. The representatives of these companies understand the importance of implementing technological innovations and organizational changes by means of the so-called Industry 4.0[13] technology, which increases their efficiency and flexibility when faced with market needs.

CONCLUSIONS

By focusing on the implementation of innovation strategies, this study aimed to determine the mechanisms and level of coordination that exist in the most relevant textile cluster in Spain. As a result of the review and the fieldwork that were carried out, we can confirm that the innovations in the firms were developed in an isolated, discontinuous, marginal, and uncoordinated way, which suggests that clustering had a marginal effect.

However, by carrying out a detailed analysis of the information extracted from the interviews as well as our own observations, we found that both membership of a cluster and access to institutions (e.g., Innovall, AITEX, ATEVAL, universities, etc.) acted as an accelerator for these types of

12 Vandermerwe and Rada (1988) introduced this concept in a seminal article. Servitization is defined as a trend by which corporations are increasingly offering fuller market packages or "bundles" of customer-focused combinations of goods, services, support, self-service, and knowledge. The trend continues to pervade almost all industries. It is customer demand-driven, and corporations believe that it sharpens their competitive edges and helps them to establish new relations with customers.

13 Industry 4.0, referred to as the "Fourth Industrial Revolution", also known as "smart manufacturing", "industrial internet" or "integrated industry", is currently a much-discussed topic that supposedly has the potential to affect entire industries by transforming the way goods are designed, manufactured, delivered and paid. Curious readers can grasp a clear idea in Hofmann and Rüsch (2017).

companies in regard to their innovation processes, as they are in a better position to generate synergies and information for their projects (Heinonen & Ortega-Colomer, 2015).

Furthermore, we must outline another conclusion which highlights room for improvement among companies and institutions alike, and this point should be given adequate attention. The companies in the sample innovated without cooperating with other textile firms, which shows a lack of coordination between the companies and the cluster institutions (Sydow and Staber, 2002). We can only conclude that firms are not well-enough informed about how these institutions can contribute. The low level of trust that is present between longstanding competing firms, which is a by-product of too little social proximity, has not encouraged these firms to develop synergies among them. This situation should be redressed by the cluster institutions as well as by intelligent use of the tools available in the cluster, which would encourage cooperation and promote a win-win mindset that is aimed at establishing an entrepreneurial ecosystem (Jankowska, Götz, & Główka, 2017).

We wish to emphasize the need to reinforce awareness among companies of the opportunity that is offered to them by virtue of their being located in a territorial cluster. This could encourage an increased level of specialization that would not be made possible in another location. In other words, by reinforcing awareness among companies of the advantages that arise from being located in a cluster, companies can appreciate that they possess a valuable strategic resource that other companies do not. They can gain a better appreciation of their position within an important network of scientific, financial, and support institutions that would render feasible a profitable knowledge transfer process. Thus, the seeds of the creation of an intelligent region would be sown, creating a continuous territorial development capable of outperforming many others (such as the Galician-Portuguese Fashion Cluster)[14], because of the stable relationship between the scientific system and the productive system.

In short, the contributions of our study go beyond the academic (as evidenced by the innovation-territory relationship) to offer managerial and political insights. On the one hand, although the results show that being located in a cluster is a key factor for firms' survival in the textile industry, location, in itself, is not sufficient, as firms also need to cooperate and share ideas and experiences. On the other hand, in order to fully use the services provided by institutions (e.g., technological institutes, universities, or business associations) in their innovation processes, there should be

14 This cluster, EuroClusTex, was formed in 2009 and it is composed of 3,800 Portuguese firms and about 500 Spanish firms from several subsectors, all of which operate in the textile and fashion industry. Further information can found at: http://www.atp.pt/fotos/editor2/Ficheiros%202010/Euroclustex_esp%20(2).pdf

greater interaction between institutions and companies[15], and institutions should speak the language of companies and meet their needs. In other words, strong cluster initiatives are required (Freije, 2015; Lis, 2019) to reinforce the associative networking of the textile sector and thus avoid the "uncoordinated dance" in which it seems to be immersed.

Finally, we must recognize the limitations of our study in terms of the sample size employed. The sample consisted of only two companies. Although these companies belonged to different subsectors and had different governance schemes and product lines, this small sample can hardly be representative of a rich and varied industry such as the textile sector. This limitation highlights how further research can focus on institutions and workers that represent all of the actors that form the territory. One possible direction for future research would be to examine the effect of the different dimensions of proximity in the creation of linkages between entities, the relationships between this creation of linkages and the development of innovations, and to determine the extent to which diverse policies have contributed to innovation development. Another possible direction for future research would involve innovations that go far beyond the product and process innovations. While such innovations were developed and implemented in the cluster, organizational and marketing innovations remain less transparent. Therefore, studying the influence of the different dimensions of proximity in the development of these types of innovations would be a rich avenue of investigation.

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Abstrakt

Biorąc pod uwagę proces rozwoju innowacji, celem niniejszego artykułu było zbadanie wpływu różnych wymiarów bliskości i poziomu koordynacji istniejącej w klastrze włókienniczym. W badaniu zastosowano metodę jakościową, opartą na pogłębionych wywiadach przeprowadzonych z dwoma wiodącymi firmami w klastrze tekstylnym w Walencji, w Hiszpanii, który jest przedmiotem intensywnej konkurencji producentów z Azji. Firmy zostały wybrane według kryteriów rozwoju innowacji i możliwości. Jest to badanie pilotażowe, które poprzedza bardziej zaawansowane. Wyniki sugerują, że innowacje firm są rozwijane w sposób izolowany, nieciągły, marginalny i nieskoordynowany, a grupowanie ma marginalny wpływ. Ponadto, pomimo dużej bliskości geograficznej i poznawczej, niewielką bliskość społeczną utrzymuje się niski poziom zaufania między firmami. Te ustalenia mogą mieć znaczącą wartość praktyczną dla praktyków i instytucji. Firmy mogą lepiej zrozumieć znaczenie lokalizacji w klastrze, ponieważ jest to kluczowy czynnik ich przetrwania w warunkach intensywnej konkurencji. Jednak bliskość geograficzna nie jest wystarczająca, a firmy muszą ze sobą współpracować i dzielić się swoimi pomysłami i doświadczeniami. Ponadto instytucje powinny w większym stopniu współdziałać z firmami, mówić ich językiem, zaspokajać ich potrzeby i opracowywać silne inicjatywy klastrowe. Badanie to zapewnia pełniejsze zrozumienie tego, w jaki sposób instytucje i firmy współdziałają w ramach klastra w procesie rozwoju innowacji, oraz opracowuje różne wymiary bliskości między firmami.
Słowa kluczowe*: klaster, innowacje, bliskość, Hiszpania, terytorium, odzież tekstylna*

Biographical notes

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Francisco Puig is a Senior Lecturer in the Department of Management of the University of Valencia (Spain). He completed his Ph.D. in Economics and Business (with honors). He has been an international visiting lecturer in many universities, such as Kings College London and Manchester Business School. He specializes in international strategy and clustering and has published articles in leading journals as well as co-authored books and chapters in collective volumes.

Conflicts of interest

The author sdeclare no conflict of interest.

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Inter-organizational trust as a statement of social proximity

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Abstract

Bearing in mind the important role of trust in the creation and development of networks, including clusters, the main purpose of the paper was to assess the level of trust of the surveyed enterprises to competitors and cooperators, as well as to identify factors, which have an impact on the trust level. The text presents the results of the research collected in 317 Polish enterprises operating in four industries: construction, food, metal, and machinery, as well as wood and furniture. The basic method of data collection was a survey. The respondents in the study were only representatives of the management or owners of enterprises qualified for the study, possessing knowledge about inter-organizational cooperation, the so-called key informants. The results presented in the text indicated low trust among both competitive and cooperating enterprises. The presented results do not inspire optimism in the scope of possibilities of creating and developing other network connections beside clusters. The deficit of Polish enterprises in terms of trust in other companies that are not even their competitors will limit not only their ability to establish cooperation with domestic but also foreign companies. The considerations carried out in the text contribute to better recognition of inter-organizational trust issues in the context of networking, including clusters. Still, they are not free from certain restrictions, which result, in particular, from the methodological approach used and, primarily, from the inability to generalize the results. Therefore, an additional direction of further scientific research may be to undertake replication studies carried out on a representative sample. Interesting research topics also include conducting similar research not only in Poland but also in other countries, both similar and completely different from Poland. They would allow a better recognition and understanding of the impact of culture and context on building trust. It may also be interesting to identify universal contextual factors affecting trust and their impact on changes in the meaning and intensity of trust.

Keywords: *inter-organizational trust, social proximity, networks, business cluster*

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INTRODUCTION

Contemporary management is distinguished by tensions, duality, contradictions, dialectics, and paradoxes (Bratnicka-Myśliwiec, 2016). On the basis of management sciences, inter-organizational cooperation is mentioned among the main and still current areas of scientific exploration. In a dynamically changing environment, cooperation is not seen as just one of the possible strategic options, but as an essential measure taken for survival and development (Tristão, 2016; Wasiluk & Tomaszuk, 2018). Inter-organizational relationships are established and maintained with various partners, as well as with direct or indirect competitors (Wasiluk, 2017; Klimas & Czakon, 2018). This type of relationship between entities, consisting of simultaneous occurrence of cooperation and competition, is called coopetition in the literature on the subject (Zakrzewska-Bielawska, 2014; Widelska, Michalczuk, & Moczydłowska, 2014). It can, therefore, be assumed that this is an intermediate concept between "pure cooperation and pure competition" (Osarenkhoe, 2010; Gómez-Diaz, García-Garnica, & Curiel-Avilés, 2019).

The 21st century was hailed as a century of networking, and this applies to both social and organizational relationships. The development of network structures and connections has become clearly noticeable in socio-economic systems (Czerewacz-Filipowicz, 2019). Besides technical and social infrastructure and efficient strategic management, a strong and widely developed network of internal and external links of entities is considered as one of the important factors conditioning their international competitiveness. Clusters are certainly the answer to contemporary challenges, often defined precisely by the criterion of network connections (van Dijk & Sverisson, 2003; Lis & Lis, 2014, p. 81). Willingness to cooperate by companies operating in the same industry is a prerequisite to create and develop clusters. These structures are currently perceived as carriers of innovation (Daniluk & Tomaszuk, 2016) and improvement of the competitive position of both enterprises and the entire regions (Lis & Lis, 2019).

"Networks" is a research space that is a part of a new network paradigm in management sciences. One of the important research implications is the challenge associated with the methods of initiating and coordinating the cooperation of all network actors (Czakon, 2015; Tomaszuk, 2017a). The related literature points out that the practice of inter-organizational cooperation is very difficult to implement (Fedorowicz, Gogan, & Williams, 2007; Kaiser, 2011). Despite the entrepreneurs' awareness of the role and importance of cooperation, the relationships among cooperating entities are often weak, impermanent, and above all, characterized by an attempt to use and exploit a partner (Nowak, 2015; Jakimowicz & Rzeczkowski, 2019). Legal

requirements or contracts are not sufficient conditions to ensure effective cooperation. Its course is influenced by many factors with characteristics pertaining to both external and internal conditions (Daniluk, 2019). Among many effective factors which are investigated by many studies, the literature has highlighted the inter-firm trust as one of the most important factors (Wasiluk, 2018a; Saadatyar, Al-Tabbaa, Dagnino, & Vazife, 2019).

Trust plays an important role in the concept of social proximity (Huber, 2012; Heringa, Horlings, van der Zouwen, van den Besselaar, & van Vierssen, 2014). Although social proximity should not be seen as a key factor in the development of business operations, it can fundamentally facilitate (Paci, Marrocu, & Usai, 2014) and make it difficult (Uzzi, 1997) to achieve the goals set by business entities. It should be emphasized, however, that being close to social proximity is a key factor for the transmission of tacit knowledge, which may be more critical for the development of enterprises compared to codified knowledge. As noted by Lis (2018, p. 113), social proximity – which was previously underestimated – is currently the second dimension of closeness in terms of the number of published works.

There is no doubt that trust between different market actors affects the value of the relationship between them. It should be emphasized, however, that it is not permanent but changes under the influence of various factors. Therefore, it seems important not only to conduct continuous research on it but also to analyze it taking into account many differentiating variables such as industry, age, or the size of entities that are parties to inter-organizational relations. The presented text contributes to filling this research gap. Bearing in mind the above considerations and the need to better recognize the problems related to inter-organizational trust in the context of creating network structures, including clusters, the main purpose of the paper was to assess the level of trust of the surveyed enterprises to competitors and cooperators, as well as to identify factors, which have an impact on the trust level. The presented analysis of the results includes divisions due to such variables as industry, age and size of the surveyed entities.

The article is theoretical and empirical. The structure of the paper is as follows: the second section reviews the theoretical and empirical literature on trust and business clusters as a type of network. The third section presents the research methods. The fourth section deals with the results of the empirical analysis and discusses those results. The last section concludes the whole paper, offering policy recommendations, and giving directions for further research.

LITERATURE REVIEW

The literature review illustrates that firms belonging to clusters are likely to achieve superior innovation and economic performance (Marshall, 1920; Scott, 1998; Capello & Faggian, 2005, Pe'er & Keil, 2013; Negrusa, Rus, & Sofica, 2014; Burger, Karreman, & van Eenennaam, 2015; Garcia-Villaverde, Elche, Martinez-Perez, & Ruiz-Ortega, 2017). However, within the extended literature, there was a lack of consensus about what makes this happen. A basic focus of contemporary studies on clusters was that geography, per se, does not guarantee firm success (Porter, 2000). In other words, co-localization is not the only reason for enhancing the clusterized firms' competitiveness (Boschma, 2005). Indeed, a wealth of empirical literature shows that one of elements of success for regional clusters is the fact that they facilitate the formation of local inter-organizational networks, which act as conduits of knowledge and innovation (Balland, 2012; Garcia-Villaverde et al., 2017; Wasiluk, 2016).

The literature review suggests that, during past years, researchers have sought to identify the mechanisms and drivers which build competitive advantages for clustered firms compared to the firms outside the clusters (Tan, 2006; Molina-Morales, Belso-Martinez, Mas-Verdu, & Martinez-Chafar, 2015; Hervas-Oliver, Lieo, & Cervello, 2017). Therefore, these studies have focused on the advantages and characteristics of networks formed in the clusters. In this regard, they have already zoomed out on knowledge management and innovation subjects aiming to understand the knowledge transfer process in networks and clusters (Hoffman, Lopes, & Medeiros, 2014; Lai, Hsu, Lin, Chen, & Lin, 2014; Tomaszuk, 2017b). Since, as one of the most important potentials of clustering, "innovation" has declared that SMEs are interested in the underlined competitive advantage of clusters (Elexa, Lesáková, Klementová, & Klement, 2019). Because the knowledge transfer is specified as the main driver of innovative clusters (Casanueva, Castro, & Galán, 2013), the focus of a volume of the literature has been on the facilitators of knowledge transfer (Hoffman, Lopes, & Medeiros, 2014; Lai et al., 2014; Balland, Belso-Martínez, & Morrison, 2016). The studies have explained that one of the irrefutable factors facilitating knowledge transfer and innovation is the proximity and cooperation which take place within co-localized companies (Porter, 2000; Felzensztein & Gimmon, 2009; Molina-Morales et al., 2015). It means that the existing literature has confirmed the role of joint actions among co-localized firms in enabling them to better compete globally (Schmitz, 1995; Geldes, Felzensztein, Turkina, & Duard, 2014).

Researchers have provided different definitions of proximity. In accordance with proximity definitions, several dimensions like social, cognitive, geographical, organizational, and institutional proximity were

presented as well. Yet, some researchers have claimed that the geographical proximity is only one of several dimensions of proximity and that all the dimensions are essential in explaining positive externalities for co-localized companies (Boschma, 2005; Boschma & Frenken, 2010). Recently, some research have highlighted the role of social proximity in promoting innovation and knowledge sharing (Geldes et al., 2014; Molina-Morales et al., 2015). These results stress the importance of social capital and trust in network dynamics within clusters, which has been emphasized as a factor for success leading to positive potentials in a cluster (Wasiluk, 2017). Those potentials include innovation and sharing information, knowledge, and ideas (Wasiluk & Daniluk, 2013; Hoffman, Lopes, & Medeiros, 2017; Hervas-Oliver, Lieo, & Cervello, 2017). Studies underline that all of the cluster's positive potentials rely on trust as an essential base of social capital. Without this element, the cluster becomes dysfunctional in meeting the expectations and/or complying with its tasks (Kong, 2005; Garcia-Villaverde et al., 2017). Therefore, it is obviously the role of social capital and coopetition that has recently attracted great attention of different studies pertinent to clusters (Brekke, 2015). That is also because the results on the formation and development of effective links within clusters have not been optimistic. It has been firmly identified that the mere creation of a cluster does not release its innovative potential (Saadatyar et al., 2019). To make it happen, it is necessary to reach an openness to establish cooperation with all its actors, including competitors.

The contemporary increase in interest toward trust is both an effect of the development of the concept of social capital as well as the need to take into account the impact of the social environment on the results of the functioning of various entities operating in a complicated business environment (Moczydłowska, 2012). As Czakon (2012, p. 27) rightly stated, "economic activity is immersed in a social context, and social structures – next to norms – determine the economic behavior." Trust is presented as a source and a basic element of social capital that facilitates cooperation and enables access to shared resources (Sztompka, 2007). Without trust, almost no socio-economic system can work properly (Gilbert, 2010, p. 169; Moczydłowska, Korombel, & Bitkowska, 2017).

Despite the great interest in the issue of trust, there is no comprehensive definition of trust (Smarżewska, 2018, p. 187). The lack of a perfect definition of this concept is primarily due to the multidimensionality, complexity, and multifaceted nature of the analyzed concept (Wasiluk, 2018b). Consideration is given to such issues as what the concept of trust is. Is trust an action or rather an attitude, feeling, strategy, or behavior? Or is it a tactic that is geared towards a specific goal, or is it a kind of advance payment for future expected profits, connections, and benefits? Is the trust given to organizations, institutions,

systems the same as the trust given to people in a family or circle of friends? (Lenk, 2010, pp. 28-29) The term trust is currently the subject of interest of representatives of various scientific disciplines such as philosophy, sociology, psychology, economics, management sciences, political sciences, and, more and more often, technical disciplines in particular (Ejdys, 2018, pp. 42-43).

Many empirical and statistical research results convey that mutual trust in business relationships promotes cooperation (Clases, Bachmann, & Wehner, 2003; Gilbert, 2007; Gilbert & Behnam, 2013; Brattström, 2018). Knowledge exchange and cooperation in networks, including clusters, are based on trust, and network actors play an important role in creating trust-based relationships. (Kumar, Banerjee, Meena, & Ganguly, 2016; Giest, 2019). Trust between partners leads to a reduction of transaction costs (Dyer & Chu, 2003; Paliszkiewicz, 2010) and the need for a precise specification of contracts and ultimately saves their excessive control (Gilbert, 2010, p. 186). It also positively affects the coordination of activities between members of a given organization (Fainshmidt & Frazier, 2017). It should be emphasized that even effective trust can only partially replace the need for control, but it does not make it unnecessary (Lenk, 2010, p. 36).

Although the literature on the subject states that trust can be considered as an indispensable element of any network and a lack of trust is considered as a threat to network stability (Naramski & Szromek, 2019, p. 4), some researchers recommend a critical approach to the level of trust. The fact that how much trust is optimal for a partner in a given case depends on his willingness to take risks, the context of the situation, and the duration and intensity of the current cooperation (Prisching, 2009). One should not accept the verdict that in all cases, the higher the level of trust, the better. Some examples can be cited when distrust was a better option for the behavior and brought positive results (Oomsels & Bouckaert, 2014).

Despite the universal recognition of the importance of trust in inter-firm relations, it remains a highly contextual phenomenon, sensitive to industrial and cultural contexts (Jucevicius & Juceviciene, 2016). In addition, the literature on the subject points out that trust in inter-organizational relationships is variable. The importance and intensity of trust may vary, which relates to the probability with which expectations and the obligations of the other party can be met. In addition, trust is created and develops in conditions of voluntary and unforced cooperation. The existence of trust requires at least two acceptable solutions: positive and negative, the possibility of profit, but also the risk of loss (Grudzewski, Hejduk, Sankowska, & Wańtuchowicz, 2009, p. 20). Trust is fragile. It takes a long time to build, but it is easily destroyed and difficult to recover (Wasiluk, 2015).

RESEARCH METHODS

The analyses were to answer the following research questions (RQs):

RQ1. What is the level of trust of the surveyed enterprises for competition?
RQ2. What is the level of trust of the surveyed enterprises to subcontractors?
RQ3. Is there a relationship between the declared level of trust in competitors and the declared level of trust in subcontractors?
RQ4. Do variables such as the industry in which the enterprise operates, its age and size affect the declared level of trust in both competition and cooperators?
RQ5. What is the impact of the identified factors on the confidence level of the surveyed companies in competition?

The presented analyses are based on the results of extensive research (the co-author of this text was a member of the research team) conducted within an international research project implemented as part of an agreement between the Polish Academy of Sciences and the National Academy of Sciences of Belarus (in 2014-2016) entitled "*Readiness of enterprises to create cross-border networking*." The results of the quantitative research presented in this text relate to research carried out among 317 Polish enterprises operating in the industries of construction, food, metal, and machinery as well as wood and furniture. They were selected on the basis of data obtained at the Statistical Office in Bialystok. Most of them are micro and small enterprises – around 60% of surveyed companies. Considering the length of operation on the market, the enterprises operating for over 10 years showed the highest percentage (Table 1).

The results presented in the text apply only to quantitative research conducted using a questionnaire. The respondents in the study were only representatives of the management or owners of enterprises qualified for the study, possessing knowledge about inter-organizational cooperation, the so-called key informants (Kumar, Stern, & Anderson, 1993). Identification of factors affecting trust was made on the basis of literature analysis as well as the results of discussions with experts representing both the scientific and business community. Finally, respondents were submitted for assessment of reliability and timeliness of information provided by competitors, corruption among competitors, competencies of employees of competitive companies, willingness to cooperate with competitors, reputation of competitors, experience from previous cooperation, credibility of competitors, reliability of competitors, competitiveness of competitors' activity, social responsibility of competitors, and emotionalities with competitors.

Table1. Characteristics of the studied enterprises

Enterprises				
Industry of the studied enterprises	construction N (%)	food N (%)	metal and machinery N (%)	wood and furniture N (%)
Enterprises total N (%)	76 (19.95)	83 (21.78)	76 (19.95)	82 (21.52)
Size of the studied enterprises (number of employees)				
Up to 9 people	20 (26.32)	8 (9.64)	10 (13.16)	25 (30.49)
10 ≤ S≤ 49 people	23 (30.26)	40 (48.19)	26 (34.21)	42 (51.22)
50 ≤ S ≤ 249 people	27 (35.53)	26 (31.33)	23 (30.26)	10 (12.19)
250 people and more	6 (7.89)	9 (10.84)	17 (22.37)	5 (6.10)
Age of the studied enterprises (number of years on the market)				
Up to 1 year	1 (1.31)	0 (0.00)	0 (0.00)	0 (0.00)
1 ≤ A≤ 3 years	12 (15.79)	0 (0.00)	2 (2.63)	8 (9.76)
4 ≤ A≤ 10 years	15 (19.74)	13 (15.66)	13 (17.11)	13 (15.85)
More than 10 years	48 (63.16)	70 (84.34)	61 (80.26)	61 (74.39)

The respondents assessed the impact of individual factors on a seven-point scale, with 1 - indicating completely no impact, and 7 - being very large.

The collected empirical materials have been encoded and then subjected to conversion to numerical forms to allow carrying out detailed analyses of the surveyed group. The following statistical measures were used to interpret the results of the research: measures of central tendency – mean (x), median (*Me*), dominant (*D*), and measure of dispersion - the coefficient of variation (*V*). To indicate the strength of interdependence between the ratings, Spearman's rank correlation coefficient was used. To identify statistically significant differences in the ratings between the analyzed groups, the Kruskal-Wallis test was used. Statistical calculations were made with the use of STATISTICA program version 13.1.

RESEARCH RESULTS

The respondents rated the level of trust of their enterprises to competition as low (RQ1). Average scores oscillated around 3. The lowest values occurred in the group of enterprises operating in the construction and metal and machinery industries, micro and medium enterprises, as well as those on the shortest market. The results indicated a poor diversity of respondents' opinions, and in the case of the youngest companies, it is even much weaker (Table 2). The average scores in the individual groups differ only slightly, and the results of the Kruskal-Wallis test specified that these differences are not statistically significant (RQ4).

Such results can be surprising, especially in the case of construction activities. Enterprises in this industry are forced to cooperate with competing companies, entering into consortia with them to implement investments, and it is often the only way to win a tender or receive an order to carry out an undertaking. However, the results of the analyses presented in other publications indicated a large deficit in terms of both current cooperation and readiness to tighten it in the near future, among industrial and construction enterprises. Therefore, it can be assumed that both the lack of skills to cooperate with other companies and the low level of trust among them can restrict their development opportunities and make it difficult to take advantage of emerging opportunities. It also negatively affects their competitive position on the international market. The low level of confidence in competition, as well as the lack of cooperation and the desire to strengthen it in the near future, will result in the inability to both create and develop existing clusters.

Table 2. Trust of surveyed enterprises to competition

Statistical measures	**x**	**Me**	**D**	**V**
Industry of the studied enterprises				
construction	2.94	3	3	43.23
food	3.12	3	3	40.78
metal and machinery	2.96	3	3	44.28
wood and furniture	3.13	3	3	46.97
	Kruskal-Wallis test H = 1.1273 p = 0.7298			
Size of the studied enterprises (number of employees)				
Up to 9 people	2.96	3	3	43.68
10≤ P≤ 49 people	3.07	3	3	46.19
50≤ P ≤ 249 people	2.93	3	3	45.27
250 people and more	3.35	3	5	41.97
	Kruskal-Wallis test H= 3.5211 p = 0.3180			
Age of the studied enterprises (number of years on the market)				
up to 1 year	2.33	2	2	24. 74
1 ≤ A≤ 3 years	3.04	3	2	43.45
4 ≤ A≤ 10 years	2.94	3	3	49.49
more than 10 years	3.06	3	3	44.19
	Kruskal-Wallis test H = 1.7631 p = 0.6230			

Note: **Kruskal-Wallis test is relevant at p < 0.05000.**

It was interesting to check whether the level of trust among business partners differs from the level of trust among competitors (RQ2). The average rating was at level 4. The lowest values occurred in the group of food enterprises, the smallest and the youngest. The summary of the results of the analysis (Table 3) showed that the respondents rated their companies'

confidence among their partners higher as compared to their confidence confronting their competitors. Nevertheless, given the seven-point scale of the assessment, it is also not really high. The median in all analyzed groups is at level 4, and the coefficient of variation indicates a weak differentiation in the respondents' ratings. Although, as in the case of assessments of confidence in competition, the average rating indicates there is a differentiation between individual groups. However, the results of the Kruskal-Wallis test indicated that these differences are not statistically significant (RQ4).

Table 3. Trust of the surveyed enterprises to subcontractors

Statistical measures	**x**	**Me**	**D**	**V**
Industry of the studied enterprises				
construction	4.08	4	5	35.53
food	3.98	4	4	34.24
metal and machinery	4.34	4	5/6	31.59
wood and furniture	4.11	4	4	38.04
	Kruskal-Wallis test (relevant at $p < 0.05000$) H = 2.9327 p = 0.4021			
Size of the studied enterprises (number of employees)				
up to 9 people	3.81	4	3	38.08
$10 \leq P \leq 49$ people	4.25	4	4	33.94
$50 \leq P \leq 249$ people	4.25	4	5	33.94
250 people and more	4.33	4	4	31.15
	Kruskal-Wallis test (relevant at $p < 0.05000$) H = 6.623712 p = 0.0849			
Age of the studied enterprises (number of years on the market)				
up to 1 year	3.81	4	3	38.08
$1 \leq A \leq 3$ years	4.29	4	4	35.28
$4 \leq A \leq 10$ years	3.96	4	3	37.97
more than 10 years	4.20	4	4	33.77
	Kruskal-Wallis test (relevant at $p < 0.05000$) H = 3.0653 p = 0.3817			

Note: Kruskal-Wallis test is relevant at $p < 0.05000$.

The presented results do not inspire optimism in the scope of possibilities of creating and developing other network connections beside clusters. The deficit of Polish enterprises in terms of trust in other companies that are not even their competitors will limit not only their ability to establish cooperation with domestic but also foreign companies. As mentioned earlier, the modern

economy is network-based, and the competitive advantage of enterprises is determined by their ability to enter into cooperative systems.

The correlations of Spearman's ranks (Table 4) indicate that there is a positive relationship between the level of confidence among competitors and cooperators reported only in the group of the oldest enterprises operating in the construction and food industries and employing up to 249 people. This means that the higher the level of trust in competitors, the higher the level of trust in subcontractors. However, it should be noted that this relationship is very low (RQ3).

Table 4. Correlations of Spearman's ranks for evaluation of the trust of surveyed enterprises to competition and to subcontractors

Companies	**Correlations of Spearman's ranks** (relevant at p < 0.05000)*
Industry of the studied enterprises	
construction	**0.233910**
food	**0.265175**
metal and machinery	0.148443
wood and furniture	0.206551
Size of the studied enterprises (number of employees)	
up to 9 people	**0.282008**
10≤ P≤ 49 people	**0.175660**
50≤ P ≤ 249 people	**0.310596**
250 people and more	0.226755
Age of the studied enterprises (number of years on the market)	
up to 1 year	-
1 ≤ A≤ 3 years	0.329875
4 ≤ A≤ 10 years	0.091649
more than 10years	**0.266342**

Note: * values in bold.

Table 5. Assessment of the impact of individual factors on the level of confidence in competition

Statistical measures	x	Me	D	V	
Factors					
Reliability and timeliness of information provided by competitors	3.80	4.00	2/4	45.25	
Industry of the studied companies - Kruskal-Wallis test H = 2.057161					p = 0.5606
Size of the studied companies -Kruskal-Wallis test H = 5.543020					p = 0.1361
Age of the studied entities - Kruskal-Wallis test H = 6.231096					p = 0.1009
Corruption among competitors	3.30	3.00	1	61.56	
Industry of the studied companies - Kruskal-Wallis test H = 0.5239213					p = 0.9136
Size of the studied companies - Kruskal-Wallis test H = 1.056226					p = 0.7877
Age of the studied entities - Kruskal-Wallis test H = 0.1419603					p = 0.9864
Competencies of employees of competitive companies	3.72	4.00	4	41.97	
Industry of the studied companies - Kruskal-Wallis test H = 2.824809					p = 0.4194
Size of the studied companies - Kruskal-Wallis test H = 7.542507					p = 0.0565
Age of the studied entities - Kruskal-Wallis test H = 5.125762					p = 0.1628
Willingness to cooperate with competitors	3.66	4.00	4	43.64	
Industry of the studied companies - Kruskal-Wallis test H = 2.706251					p = 0.4392
Size of the studied companies - Kruskal-Wallis test H = 4.290678					p = 0.2317
Age of the studied entities - Kruskal-Wallis test H = 6.531526					p = 0.0884
Reputation of competitors	4.05	4.00	5	40.87	
Industry of the studied companies - Kruskal-Wallis test H = 1.204434					p = 0.7519
Size of the studied companies - Kruskal-Wallis test H = 4.683535					p = 0.1965
Age of the studied entities - Kruskal-Wallis test H = 3.364538					p = 0.3388
Experience from previous cooperation	4.12	4.00	4	43.61	
Industry of the studied companies - Kruskal-Wallis test H = 2.758408					p = 0.4304
Size of the studied companies - Kruskal-Wallis test H = 2.778887					p = 0.4270
Age of the studied entities - Kruskal-Wallis test H = 2.152367					p = 0.5414
Credibility of competitors	4.17	4.00	5	44.53	
Industry of the studied companies - Kruskal-Wallis test H = 4.297808					p = 0.2311
Size of the studied companies - Kruskal-Wallis test H = 3.827791					p = 0.2807
Age of the studied entities - Kruskal-Wallis test H = 1.716460					p = 0.6333
Reliability of competitors	4.14	4.00	4	43.47	
Industry of the studied companies - Kruskal-Wallis test H = 3.012930					p = 0.3896

Statistical measures	x	Me	D	V	
Factors					
Size of the studied companies - Kruskal-Wallis test H = 3.899660					p = 0.2725
Age of the studied entities - Kruskal-Wallis test H = 4.166245					p = 0.2441
Competitiveness of competitors' activity	4.11	4.50	5	41.45	
Industry of the studied companies - Kruskal-Wallis test H = 2.035050					p = 0.5652
Size of the studied companies - Kruskal-Wallis test H = 7.709001					p = 0.0524
Age of the studied entities - Kruskal-Wallis test H = 3.923912					p = 0.2698
Social responsibility of competitors	3.66	3.00	3	45.87	
Industry of the studied companies - Kruskal-Wallis test H = 4.228616					p = 0.2378
Size of the studied companies - Kruskal-Wallis test H = 7.005691					p = 0.0717
Age of the studied entities - Kruskal-Wallis test H = 8.665926					p = 0.0341
Emotional ties with competitors	2.80	2.50	1	57.98	
Industry of the studied companies - Kruskal-Wallis test H = 7.588709					p = 0.0553
Size of the studied companies - Kruskal-Wallis test H = 8.362676					p = 0.0391
Age of the studied entities - Kruskal-Wallis test H = 6.205087					p = 0.1020

Note: Kruskal-Wallis test is relevant at $p < 0.05000$.

Investigating the impact of individual factors on the respondents' confidence in competition (RQ5), it was found that the transparency of competitors' activities (x=4.11), their credibility (x=4.17) and reliability (x=4.14), as well as the experience from previous cooperation (x = 4.12) have the highest impact on the level of their enterprise's confidence among competing companies (Table 5). On the other hand, emotional ties with competitors (x=2.80) and corruption among competitors (x=3.30) were the least important factors. The volatility index indicates a moderate diversity in the respondents' ratings. The diversity of ratings was only high while assessing the impact of corruption among competitors. The results of the Kruskal-Wallis test carried out for the assessment of individual factors within the analyzed groups of respondents indicate that the differences in the assessment of individual factors are not statistically significant (RQ4).

It is surprising that the impact of emotional ties with competitors on the level of respondents' trust in these companies is low. The explanation for this state of affairs may be the fact that the surveyed enterprises rarely cooperated with competing enterprises, which certainly resulted in a lack of relations between them.

DISCUSSION

The conducted analyzes allowed the realization of an answer to the research questions posed (RQ1). The surveyed entities rated their trust in competition low. The average scores oscillated around 3 on a seven-point scale. Higher respondents rated the level of trust of their companies to business partners - on average, at level 4 (RQ2). A positive correlation between the amount of assessment of the level of trust in competitors and cooperators occurs only in the group of the oldest enterprises operating in the construction and food industry and employing up to 249 people. The higher the level of trust in competitors, the higher the level of trust in subcontractors (RQ3). The transparency of their operations, credibility, and reliability, as well as experience from previous cooperation, had the highest impact on the level of trust of the surveyed enterprises in competing companies. Emotional ties with competitors and corruption among competitors (RQ5) were the least important. It should be noted that there are no statistically significant differences both in the assessment of the level of trust in competitors and contractors, and in the impact of individual factors on the level of trust within individual groups of enterprises (RQ4).

The research results presented in the text confirm the image presented in other publications. As noted by Czapliński (2015), one of the biggest weaknesses of the Polish economy is the low level of social capital. Although in the Legatum Institute report from 2018 (Legatum Institute, 2018), Poland is in the 33rd position in the general classification of countries, it is only 76th in terms of social capital development. Meanwhile, as the literature emphasizes, social capital is a necessary condition to unleash the innovative potentials in clusters and other networks of enterprise connections. Sharing information, knowledge, and ideas requires trust (Hoffman, 2014; Lai et al., 2014; Garcia-Villaverde et al., 2017; Saadatyar, Al-Tabbaa, Dagnino, & Vazife, 2019) and these structures become dysfunctional without this element, leading to failure in meeting expectations or fulfilling tasks. As emphasized by Chen, Haga, and Fong (2016), the lack of social capital means that the cooperation structures created are usually short-lived, because social capital is a kind of “glue” that holds them together.

The ability to cooperate is currently among the key factors to success for enterprises. Many authors have given emphasis to a lack of confidence in potential partners as the most important barriers to cooperation (Cook, Hardin, & Lev, 2005; Fawcett, Magnan, & McCarter, 2008). The literature on the subject emphasizes that participation in networks, including clusters, is based on voluntariness and not on coercion. That is why trust is such an important factor influencing the development of these structures. As

mentioned in earlier parts of the text, cooperation is now seen not just as one of the possible strategic options, but as a necessary action to survive and develop companies. That is because the innovations rarely arise in individual enterprises. The ability of companies to create and introduce innovations increasingly depends on their ability to cooperate with other entities, including competitors (Cui & Wei, 2012; Hemert, Nijkamp, & Masurel, 2012). Inter-organizational cooperation in the sphere of innovation in both the value chain system and coopetitive cooperation increases the innovative efficiency of enterprises (Garanti & Zvirbule-Berezina, 2013; Chick, Huchzermeier, & Netessine, 2014). Network connections, in particular cluster networks, which facilitate access to innovation, even to enterprises with small financial and competence resources (Romanowska, 2016, p. 34), play a significant role in this regard. The results presented in the text indicated low trust among both competitive and cooperating enterprises. Therefore, one can conclude that this situation is not optimistic.

Seeking possible solutions to the problem, and bearing in mind both the literature analyses and the presented research results, it is worth paying attention to the Convoy model. This is a relatively new approach to the problem of increasing competitiveness in the region and is an attempt to develop and improve cluster theory. This model was created in response to the ineffectiveness of classical clusters, in the sense of Porter, in regions with low resources conducive to the development of innovative entrepreneurship (Bertolin, 2010). The main difference between a classic cluster and a grouping of companies in the Convoy model is that the network of companies is formed around a central company or institution within this model, in contrast to the classic model in which the cluster was defined as a relatively chaotic and even grouping of companies. The essential element of clusters in the Convoy model is the so-called "Locomotive," i.e. a leader in a given network (company or institution), which supplements deficiencies among companies in the environment regarding the factors determining their innovation. These are mainly resources, knowledge, and infrastructure. Unlike a classic cluster, the Convoy is a dynamic object thanks to the "locomotive" that triggers operations inside the network. It is also less chaotic. The central entity harmonizes the activities of all companies and tries to pull the whole group towards their long-term goals, which, given the limited resources of small companies operating alone, are often not even formulated (Rokosz, 2019).

CONCLUSION

The issue of inter-organizational trust is an issue that is both current and relevant on the basis of both theoretical considerations and practical actions. The literature review carried out in the text allowed for the juxtaposition of both older and latest publications on the subject discussed. The new approach to the presented content allows a different view on the issues raised in the text and their different interpretation. The conducted considerations (both theoretical and empirical) contribute to filling the existing gap in research on inter-organizational trust in the context of networking, including clusters. This is especially about research that will allow you to understand the impact of context on building trust. Therefore, they can be a valuable source of inspiration for undertaking specific actions by various decision makers, including animators of various types of networks, including clusters. These activities should primarily focus on arranging face-to-face meetings. Direct contacts between network actors are conducive to strengthening personal relationships. The more frequent the contacts, the greater the chance for developing trust between the parties. It should be emphasized, however, that the research results presented in the text are not free from certain restrictions, which result, in particular, from the methodological approach used and, primarily, from the inability to generalize the results. Hence, an additional direction of further scientific research may be to undertake replication studies conducted on representative samples not only in Poland but also in other countries. Interesting research threads also include the identification of universal contextual factors affecting trust and their impact on changes in essence and intensity of trust. It is also necessary to undertake research on the directions of activities that facilitate building trust between various actors in the market game.

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Abstrakt

Biorąc pod uwagę istotną rolę zaufania w tworzeniu i rozwoju sieci, w tym klastrów, głównym celem tekstu było zidentyfikowanie związku między poziomem zaufania badanych przedsiębiorstw do konkurentów i kooperantów oraz określenie wpływ zidentyfikowanych czynników na poziom tego zaufania. Tekst prezentuje wyniki badań zebrane w 317 polskich przedsiębiorstwach działających w czterech branżach: budowlanej, spożywczej, metalowej i maszynowej oraz drzewnej i meblarskiej. Podstawową metodą gromadzenia danych była ankieta. Respondentami w badaniu byli przedstawiciele kierownictwa lub właściciele przedsiębiorstw zakwalifikowanych do badania, posiadający wiedzę na temat współpracy międzyorganizacyjnej, tzw. kluczowi informatorzy. Wyniki przedstawione w tekście wskazują na niskie zaufanie zarówno wśród przedsiębiorstw konkurencyjnych, jak i współpracujących. Prezentowane wyniki nie budzą optymizmu w zakresie możliwości tworzenia i rozwijania połączeń sieciowych, w tym również klastrów. Deficyt polskich przedsiębiorstw pod względem zaufania do innych firm, które nawet nie są ich konkurentami, ograniczy nie tylko ich zdolność do nawiązania współpracy z firmami krajowymi, ale także zagranicznymi. Należy podkreślić, że choć rozważania przeprowadzone w tekście przyczyniają się do lepszego rozpoznawania problemów związanych z zaufaniem

między organizacjami w kontekście tworzenia sieci, w tym klastrów, to nie są one wolne od pewnych ograniczeń. Wynika to w szczególności z zastosowanego podejścia metodologicznego i skutkuje przede wszystkim niezdolnością do uogólnienia wyników. Dlatego dodatkowym kierunkiem dalszych badań naukowych może być podjęcie badań replikacji przeprowadzonych na reprezentatywnej próbie przedsiębiorstw. Interesujące tematy badawcze obejmują również prowadzenie podobnych badań nie tylko w Polsce, ale także w innych krajach, zarówno podobnych, jak i zupełnie innych niż Polska. Umożliwiłyby one lepsze rozpoznanie i zrozumienie wpływu kultury i kontekstu na budowanie zaufania. Interesujące może być również podjęcie próby określenia uniwersalnych czynników kontekstowych wpływających na zaufanie oraz ich wpływ na jego zmiany i intensywność.
Słowa kluczowe: *zaufanie międzyorganizacyjne, bliskość społeczna, sieci, klastry*

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Conflicts of interest

The authors declare no conflict of interest.

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Innovation by proxy – clusters as ecosystems facilitating open innovation

Marita McPhillips[1]

Abstract

Open innovation is a concept, whose attributes can be perceived as naturally complementing the proximity-based offer of clusters. The purpose of this paper is to investigate the potential role of clusters as intermediaries of open innovation for cluster members. A literature review and an exploratory study were performed, involving in-depth interviews with experts in the field of innovation and clusters in Poland. This article conceptually links open innovation and clusters, proposes and categorizes roles of clusters as open innovation intermediaries, as well as indicates factors that might affect the successful adoption of this role. Furthermore, it points out that clusters could not only manage and mediate their network of members but also shape and co-create a broader open innovation ecosystem. The findings contribute to a comprehensive understanding of the potential roles of open innovation intermediaries in regard to clusters in the context of transitioning economies. With clusters playing the role of an open innovation intermediary, public support at cluster level could increase the openness to cooperation not only for member companies but all participants in the regional innovation ecosystem.

Keywords: *clusters, cluster initiative, open innovation, innovation ecosystem, innovation intermediary, open innovation intermediary, innovation policy*

INTRODUCTION

The strategic documents of the European Union and Poland (the Horizon 2020 Research Program and the Strategy for Responsible Development, respectively) point to the need to support economic development based on regional and local specializations, especially through clusters. Clusters defined as "a geographical concentration of interrelated companies, specialized suppliers, service providers, companies operating in related sectors and

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related institutions in specific fields, cooperating and competing with each other" (Porter, 1990) gained importance by generating positive external effects and increasing the competitiveness of regions. The beneficial role of geographical, cognitive, and social proximity in relation to industrial clusters has long been apparent. Clusters seem to play a significant role in creating the conditions necessary for successful integration of enterprises, in particular in innovation cooperation. One of the concepts that is gaining importance in the context of innovation cooperation between various entities is open innovation. Chesbrough (2003) defines open innovation as "using intentional inflows and outflows of knowledge to accelerate internal innovation and expand markets for external innovation applications." Therefore, it is an approach to innovation in which partnerships, and combining the internal and external resources of the company are used to create new ideas and technologies. In recent years there has been a significant increase in the number of scientific publications in the field of open innovation, presenting the results of quantitative and qualitative research (e.g., Dahlander & Gann, 2010; Chesbrough & Bogers, 2014). Various authors have accumulated and listed numerous potential benefits from implementing an open innovation model at the forefront with an increase in the ability of companies to implement innovation.

In this context, the management of innovation cooperation in multi-stakeholder relations becomes a key issue. Several studies indicate a special role of network intermediaries supporting innovation cooperation and open innovation among enterprises (Lee et al., 2010).

This article refers to the concept of a proxy – an intermediary organization – to be a defining feature of cluster initiatives, which carry out various intermediary roles on behalf of their members. Howells (2006) characterizes intermediaries as organizations that act as brokers in the innovation process between two or more parties by providing services, including provision of information about potential collaborators; as mediators between already collaborating actors; and as monitors, funders and supporters by other means of their network members. Scholars have called cluster initiatives "innovative intermediaries" because of their mediating position between regional authorities, business, and academia (Kivimaa et al., 2019). Those type of intermediaries may especially originate in response to market restructuring and new modes of regulation, and to fill institutional gaps (Moss, 2009). On the other hand, more and more researchers argue that cluster initiatives should not be understood as fitting into the narrow sectoral view of an intermediary organization but be considered as regional ecosystems of related industries with a broad array of inter-industry interdependencies (Delgado et al., 2016). These linkages tend to show, for instance, in terms of similar location patterns, occupational and technological needs and knowledge spillovers,

and cross-sector investments. Innovation intermediaries are, therefore, seen to be central to creating and maintaining a successful innovation ecosystem (Sieg et al., 2010; De Silva et al., 2018).

The direct relationship between clusters and open innovations has not yet been the subject of special attention in the literature, with a few exceptions like Chesbrough and Bogers (2014) who identified some higher levels of analysis such as networks and regions as important research opportunities and described a strong need to better understand intra- organizational attributes of open innovation, and Di Minin and Rossi (2016) who underline the significance of clusters for a stimulating innovation ecosystem and argue that clusters are particularly suitable as vehicles and vectors of open innovation.

Moreover, despite several extensive studies on open innovation in a Polish context (Sopińska & Mierzejewska, 2016; Stanisławski, 2017), the phenomenon of open innovation generally seems to be under-researched in comparison with the number of studies on this topic in the foreign literature. In addition, not all applications and comments regarding the use of open innovations in other European countries can be adapted to a Polish context. This is due to the specifics of the domestic market and entities operating on it, including the low level of social trust.

The purpose of this paper is to investigate the potential role of clusters as intermediaries of open innovation for cluster members. It was, along with the above considerations, the basis for formulating the research questions for the exploratory study, which are:

RQ1. Could clusters become intermediaries of open innovation for cluster members?
RQ2. What roles could clusters take as intermediaries of open innovation for cluster members?
RQ3. What factors might affect the successful adoption of a role of an intermediary of open innovation by clusters?

From a theory point of view, considerations of open innovation in the context of clusters can be based on various approaches. This article refers to the theory of dynamic capabilities (Teece, 2014; Bogers, 2011), providing perspectives for understanding the role of open innovation, connecting the activities of various stakeholders, taking place across organizational boundaries of enterprises.

The paper proceeds as follows. In the next section, the basic premises and the connections of open innovation and cluster concepts with regards to innovation ecosystems, and the role of intermediaries are discussed. Thereafter, the qualitative research design is presented. In the next sections,

the clusters' potential role as open innovation intermediaries is analyzed and discussed. Finally, conclusions, contribution, and limitations are presented.

LITERATURE REVIEW

Open innovation – basic premises

Open innovation is defined as "a distributed innovation process that involves purposively managed knowledge flows across the organizational boundary" (Chesbrough & Bogers, 2014). Put simply, it describes the phenomenon of companies making use of externally generated ideas and technologies in their own businesses and allowing unused internal ideas and technologies to be applied by others in their businesses. The idea that companies should leverage external knowledge sources and engage a broad network of external partners in order to promote innovation has prevailed in the discourse of academia and the business press for the past decade or more (Laursen & Salter, 2006). In expanding firm boundaries, open innovation affects companies' business models and strategies (Chesbrough & Appleyard, 2007; Chesbrough & Bogers, 2014). Open innovation is also expected to facilitate access to resources, knowledge and competencies otherwise unavailable to the firm, as well as to enable companies to better realize the strategic potential of the active commercialization of knowledge (Faems et al., 2010; Gassmann et al., 2010; Huizingh, 2011).

There is no specific definition of open innovation activities, but rather there exists a wide range of cooperative undertakings – with different levels of maturity and openness. Open innovation suggests the execution of practices related to external knowledge acquisition and commercialization which range from the involvement of lead users, through R&D purchases, venturing, and licensing agreements to even the free revealing of inventions (Burcharth et al., 2014, Stanko & Henard, 2017). 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. The logic of openness integrates knowledge flows with pecuniary and non-pecuniary mechanisms, as well as inward and outward flows. Most studies distinguish between the dimensions of inbound – the outside-in perspective related to in-licensing agreements, crowdsourcing, customer involvement, and R&D purchases – and outbound – the inside-out perspective related to out-licensing agreements, free revealing and spin-offs. A third dimension is the coupled one, which implies combined knowledge inflows and outflows

between partners in the innovation process – a perspective that involves any combination of the above-mentioned practices, alongside strategic alliances, consortia, networks, ecosystems, and platforms (Chesbrough & Bogers, 2014; Dahlander & Gann, 2010).

Despite the expected gains of open innovation, there are several challenges involved. Many companies struggle with the implementation of open innovation. This is due to many interrelated factors that go beyond the macroeconomic or societal context to encompass organizational and individual factors. There are industrial differences with regard to the practice of open innovation too. Existing evidence suggests that companies are more prone to engage in open innovation if they belong to high technology-intense, globalized, and manufacturing sectors. Furthermore, larger companies seem to be more open as they enjoy the benefits of having more diversified innovation portfolios, access to funds and formal structures for licensing intellectual property and external participations, in comparison to their small and medium-sized counterparts (Van de Vrande et al., 2009).

In the open innovation model, companies search for knowledge, which is a source of competitiveness and a prerequisite for successful participation in international trade and investment. However, it requires specific circumstances in which to be created, modified, and diffused. Much knowledge remains in a tacit form, limited to certain places. Such open innovation also requires social interactions, which are more efficient in the proximity since tacit knowledge is not well transmitted over distance. The more tacit the knowledge is, the more important spatial proximity and direct, face-to-face contact becomes.

Clusters – main features

From a theoretical point of view, the idea that a certain number of firms and industries within a defined geographical space can join forces and improve their productivity by gathering together or, in other words, by "clustering," is hardly new or peculiar to contemporary literature. According to Porter (1990), proximity might create a stimulating business environment where companies can thrive, while at the same time drawing from each other's pool of skilled labor and expertise to source inputs, acquire knowledge and information and, therefore, generate complementarities.

Clusters are often facilitated by cluster initiatives led by cluster coordinators (Solvell, 2003). The concepts of cluster and cluster initiative are interrelated, and the word cluster is also commonly used to describe cluster initiative. Scientific literature points to this duality (Jankowska & Gotz, 2017), explaining that such simplification seems inevitable and is commonly used.

The benefits obtained by companies located in a developed cluster are widely discussed (Porter, 1998; Morosini, 2004; Bembenek & Kowalska, 2016), among others: a larger local market for products and services, reduction of transport costs, easier access to resources, competitive environment that increases motivation, specialized human resources. It is emphasized that the proximity of companies in the same industry enables them to exchange knowledge and ideas through direct contact and the flow of employees (Carlino, 2001). The results of empirical studies confirm a higher level of innovation in companies located in clusters (Zimmermann, 2001; Gorynia & Jankowska, 2008; Kowalski, 2013). The cluster is seen as a source of many benefits for members operating in its structures. The scale of these benefits depends on many external and internal factors towards the cluster, but they all seem to relate to various forms of broadly understood knowledge spillovers.

The key feature of clusters is their heterogeneity. It is often stated that each cluster is so specific that one cannot draw far-reaching conclusions based on its analysis as to the functioning of other systems (Mariotti et al., 2008). This is a significant challenge for researchers. There have been repeated attempts to conduct research based on a comparative analysis of many cluster cases, including at the European level (NGPExcellence – Cluster Excellence in the Nordic Countries, Germany, and Poland, 2011) and Polish (PARP, 2012, 2014). The diversity of cluster structures resulting from local, industry, public policy, etc. is, however, so significant that the results of these studies cannot be generalized. In this context, researchers encounter a number of problems: from defining the categories of tested attributes, difficulties in determining measurement ranges, to issues of usefulness of results for practical purposes. The benefits of clustering may either be passive externalities, derived from companies simply being co-located or be active externalities, for which co-located companies have to engage in actual collaboration with one another. However, none of these proximity dimensions necessarily grant firms automatic access to locally residing tacit and explicit knowledge, nor do they straightforwardly lead to active externalities, as these require collective action of clustered firms. Hence, firms have to form and maintain trustful and cooperative social relationships. Without these kinds of relationships, firms in clusters may have a difficult time attaining cluster benefits. Link et al. (2007) and Engel (2015) present the essential role of cluster organizations in creating the conditions necessary for the successful integration of enterprises, in particular, SMEs in external cooperation. There is empirical evidence highlighting the impact of cluster management in building specific networks for innovation based on cooperation and knowledge sharing (Bahlmann & Huysman, 2008; Castro, 2015). In particular, research on French, German, and Swedish clusters

confirms the positive impact of cluster management on the innovativeness of member companies, for example, Berthiner-Poncet et al. (2018).

Benefits resulting from the cluster's innovation can be analyzed at various levels (cluster members, cluster as an organization, region, and country) and from different perspectives. By their very nature, clusters create an environment for effective cooperation between partners. The effects of innovation activities are understood broadly, not only through the direct results of cooperation, but also from the perspective of partners' involvement, actions taken, and resources mobilized. Veeckman et al. (2013) indicate that the result of innovation, such as a product or service, is closely related to the innovation environment and the chosen innovation approach. In addition, Femenias and Hagbert (2013) indicate that innovation networks can create different values for different entities. The authors suggest a wide spectrum of results that include tangible and intangible innovations. The effects of innovation activity within clusters are directly available to cluster members participating in them, thus increasing their innovation potential. Nonetheless, it is not always easy for cluster initiatives to cross the organizational, cognitive, and cultural boundaries of each actor to create a common identity or a new area of shared knowledge (Castro Gonçalves, 2012). Cluster initiatives, improving the cooperation between different types of entities in clusters, improve innovation, and financial results of the involved cluster companies. The effects of the activities depend, to a large extent, on the cluster organization. Research shows significant differences in the effectiveness of cluster initiatives, leaving room for benchmarking, and learning between clusters (Morgulis-Yakushev & Sölvell, 2017). Brosnan et al. (2016) even suggest viewing clusters through the prism of the process of clustering and hence regard them as a process rather than an organizational form. The knowledge environment present in clusters can thus be defined as an ecosystem conducive to broadly defined knowledge processes.

Notwithstanding differences in approaching the issues of financing, externalities, and learning, all the analyses agree upon the fact that persistent communication, knowledge sharing, and transparency are at the heart of successful clustering. Unsurprisingly, this aspect might well turn clusters into enablers of dynamics that Henry Chesbrough defined as open innovation (2003; 2006).

Clusters and open innovation – searching for relations

Open innovation is foreseen as a tool for tackling the key issues that prevent Europe from exploiting its full potential in connection to innovation performance, innovation transfer and innovation scale-up. (European

Commission, 2018) Given the surrounding uncertainty and yet high expectations for open innovation, researchers, policymakers, and industry-insiders tend to attribute an important role in its development to clusters (West & Bogers, 2014). The complementarity of cluster concepts and collaborative innovation seems indisputable. Clusters use inter-organizational network effects, knowledge flows, and external effects, in addition to cooperation in groups of companies as well as between companies and other institutions. Monfardini et al. (2012) prove that the innovation capacity of companies can be supported by external entities, such as innovation agencies, technology transfer institutions, incubators, and cluster organizations. In this light, we can assume that clusters can potentially play an important role in supporting open innovation (Chiaroni et al., 2011; Huang et al., 2015; Lee et al., 2010). One of the very few empirical studies directly addressing the topic of open innovations and cluster activities (Berthinier-Poncet, 2014) showed that the implementation of these practices in the cluster positively affects the dynamics of learning and innovation of member companies.

Geographical proximity is one of the distinctive features of cluster systems that seem designed to benefit from and, at the same time, to productively channel the advantages offered by open innovation (Di Minin, & Rossi, 2016). For example, local companies can exploit geographical proximity to maximize the advantages offered by promoting greater openness and a culture of exchange. Much in the same way, the accurate knowledge of the local context and the presence "on the ground" of many firms involved in a cluster can allow them to quickly scout for new innovative initiatives and immediately capitalize on them, as well as to exploit each other's pool of qualified and professional expertise. In addition, since open innovation is largely reliant on mutual exchanges of sensitive information – turning trust into a key factor – local connections promoted by clusters can significantly encourage firms to exchange knowledge without excessive reserves and, therefore, favor circulation of innovative solutions and best practices alike.

In the Polish context, Sopińska and Mierzejewska (2017) argue that innovation companies operating on the Polish market are only at the beginning of the process of opening their innovation activities. Moreover, initiating open innovation activities means, among other things, the need to take greater than usual risk. Researchers describe phenomena that affect the reluctance to use open innovations in companies, including not-invented-here syndrome, not-sold-here, or only-used-here.

These barriers apply in particular to SME companies, although research shows that SMEs can potentially benefit more from open innovation activities than large companies (Parida et al., 2012). Pichlak (2012) emphasizes that most large and medium-sized enterprises simultaneously generate and

acquire new technical knowledge or buy and sell intellectual property rights (licenses, patent and copyright or trademarks). However, the exploration of the environment by SMEs is largely due to the lack of available resources, and therefore the relatively low propensity of these companies to conduct their own research and development activities. The specifics of SME entities include relatively low capital intensity of projects, low knowledge in the field of management, lack of permanent R&D departments, short-term research and development projects, limited access to external financing, reluctance of entrepreneurs to exchange information and new technical solutions and technology. (Stanisławski, 2014). The above-mentioned conditions indicate rather "closed" nature of companies in the SME sector. Eliminating barriers might be a decisive condition for an increase in the propensity of SMEs to apply the concept of open innovation. Teirlinck and Spithoven (2013) confirm that SMEs seem to be more likely to launch new products or services if they work with external partners. Unlike large companies, SMEs use different types of open innovation simultaneously during this process. To absorb external knowledge, SMEs must be able to find the right partners. In practice, this means that organizations need to move away from closed models to more open attitudes in which cooperation and exchange of experience between various market participants dominate, e.g. as part of cluster initiatives, regional innovation systems, and relationships between business and science, administration and society (Carayannis & Campbell, 2011). The more external the sources of knowledge acquisition, the greater the enterprise's willingness to reach for the benefits of the open innovation model and knowledge transfer from/to the environment (Laursen & Salter, 2004), and the greater the likelihood of finding a suitable partner for new innovations if there are many potential partners in the network (Katzy et al., 2013; Sisodiya et al., 2013).

From an inter-organizational perspective, the effectiveness of open innovation depends on more than just the flow of knowledge in the early stages of the innovation process (e.g., Dahlander & Gann, 2010; Huizingh, 2011; Chesbrough & Bogers, 2014). The open innovation model often requires companies to organize or to actively participate in innovation ecosystems that integrate a diverse set of entities at different stages of the innovation process (West & Bogers 2014). Therefore, the key issue is managing cooperation in these dynamic relationships.

Researchers indicate the special role of network intermediaries supporting innovation cooperation and open innovation among enterprises (Lee et al., 2010). Studies especially highlight the impact of cluster management in building specific networks for collaborative innovation and knowledge sharing (Bahlmann & Huysman, 2008; Bell, 2009; Castro, 2015). In particular, research

on French, German, and Swedish clusters has confirmed the positive impact of cluster management on the innovation potential of member companies (e.g., Berthinier-Poncet, 2014). In this sense, clusters seem to be a privileged space for observing the inter-organizational dynamics of innovation cooperation. If the cluster's goal is to strengthen the innovation capacity of the actors involved, activities aimed at achieving this goal must be initiated as part of the cluster initiative. In this case, the cluster initiative often takes over the task of coordinating innovation processes for its participants. Some methods used in a cluster initiative in this context do not differ much from the classic methods of managing innovation used internally by companies; others are specific to the cluster context, mainly in terms of the networking component. Nevertheless, the functioning of an open innovation network is related to expenditure as well as to potentially negative aspects (Czakon, 2014). That could include coordination costs, as cooperation within a growing group of companies increases the needs for communication and control. Cluster support may contribute to reducing the significance of the above barriers and making better use of opportunities related to undertaking open innovations.

Recommendations for undertaking innovation activities in clusters were reflected in the cluster management standards, which were developed in 2014 by a group of experts, in cooperation with the Polish Agency for Entrepreneurship Development (PARP). Standards related to the innovation of clusters assume that the cluster coordinator will actively engage in innovation processes in the cluster, including processes of Open Innovation and User-Driven Innovations (Piotrowski, 2014). According to the standard, the scale of the coordinator's activity should be adequate for the level of cluster development and the needs of its members (Kępka & Kacperek, 2017). However, there is an opinion among Polish researchers (e.g., Moszkowicz & Bembenek, 2017) that although Polish cluster initiatives implement more and more actions aimed at improving the innovation of their members, the potential of clusters in this respect does not seem to be fully used. It seems that Polish clusters have significant potential to undertake open innovations for the benefit of their members but have not yet included them in a permanent system of initiation, coordination and evaluation, necessary not only for the effectiveness but also for the repeatability of joint innovation processes.

METHODOLOGY AND RESEARCH METHODS

This article is laying the ground for linking the concepts of clusters and open innovation. In order to underline the theoretical conclusions in the context

of Poland, an empirical study was performed, where a qualitative research method was used. The research questions were:

RQ1.Could clusters become intermediaries of open innovation for cluster members?
RQ2. What roles could clusters take as intermediaries of open innovation for cluster members?
RQ3. What factors might affect the successful adoption of a role of an intermediary of open innovation by clusters?

This study was exploratory, planned as the first step in a three-part, nationwide mixed methods project, which has been undertaken subsequently. The data gathered through interviews were checked against theoretical explanations to validate the conceptual framework and to develop the next stage of the project, which was important since the paper addresses an underexplored topic (Edmondson & McManus, 2007).

The study was conducted through 12 in-depth semi-structured expert interviews since there has not been any in-depth analysis made in Poland on this topic yet. The major advantage of this approach is the possibility of the synergistic use of the knowledge and the experience of experts to solve problems that are not answered in the currently available literature. Semi-structured interviews were carried out to enable the researcher to answer one or more of their research questions (Taylor et al., 2015). Open-ended questions allowed the experts to freely voice their experience and to minimize the influence of the researcher's attitudes and previous findings (Creswell et al., 2007). The analysis of the interview data followed a simplified version of the general steps of qualitative data analysis described by Creswell (2009).

Interviews were conducted with 12 experts, "handpicked" and selected on the basis of their wide experience in the field of clusters and innovation. The sampling method ensured that the chosen experts were all suited to the purpose of the research. The experts had science, business, or government administration backgrounds and broad theoretical and practical knowledge on issues connected to cooperation and innovation processes. The selection of experts was purposeful and was based on predefined criteria, tailored to the specific backgrounds of the experts. Four representatives of academia were chosen on the basis of significant scientific achievements in the area of clusters and innovation as well as on the basis of their experience in empirical research on Polish cluster initiatives. Four representatives of administration were chosen on the basis of their broad experience in implementing cluster and innovation-based policy at the national or local level. Four

representatives of the business support sphere were chosen on the basis of their substantive experience in direct support of cluster initiatives in terms of their innovation activity. All 12 experts were subject to additional criteria connected to their authority, national recognition and influence in the field of the study assessed, i.e. through their involvement in committees actively working towards cluster development in Poland: The Cluster Policy Working Group at the Polish Agency for Enterprise Development, Clusters Club at the Ministry of Economy, Benchmarking of Clusters in Poland, Polish Clusters Association, etc. Experts were "cherry picked" from a pool of the most recognized individuals within the research area.

Table 1. Selection criteria for experts taking part in the study as respondents of semi-structured interviews

Background of experts	Academia	Administration	Business support
No of experts in the study	4	4	4
Common selection criteria	broad theoretical and practical knowledge on clusters, cooperation and innovation processes authority, national recognition, and influence in the field of the study.		
Selection criteria specific to the area	significant scientific achievements in the area of clusters and innovation experience in empirical research on Polish cluster initiatives	broad experience in implementing cluster and innovation-based policy at national or local level	substantive experience in direct support of cluster initiatives in terms of their innovation activity

Interviewed experts answered questions according to an open interview scenario prepared for this study but were encouraged to make broad statements associated with the study area. The interview questions concerned matters including: the understanding of the notion of open innovation, the readiness of cluster initiatives in Poland to become intermediaries of open innovation for their members, the roles that cluster initiatives could take as open innovation intermediaries and factors that could influence the process of taking on such a role by cluster initiatives.

ANALYSIS

The first matter in the study concerned the definition of the concept of open innovation as understood by experts. All of the experts (12 of 12) had earlier encountered this concept and were able to define it. However, experts from different backgrounds presented differences in their responses, emphasizing different elements of the concept. In particular, representatives coming from administration highlighted the importance of outbound processes within the framework of open innovation, i.e. the commercialization of solutions generated within the company that do not fit into their current strategy, e.g. through sharing or selling the solution to a third party. Representatives coming from academia or business rather tended to underline the importance of inbound processes of open innovation, i.e. companies using external knowledge as a source of internal innovation.

All of the interviewed experts (12 of 12) agreed that cluster initiatives can form an environment that supports open innovation activity and cluster initiatives are, or could become, open innovation intermediaries for their members. Experts listed activities which, according to them, could comprise potential open innovation activities in cluster initiatives, including: advanced methods of supporting open innovation processes such as living labs and user-driven innovation, but also simpler activities aimed at enhancing the usage of the innovation ecosystem by cluster companies such as organizing cooperation projects.

The cluster initiative's main role as an open innovation intermediary, according to all experts, is to be an active organization and to collaborate with universities, large and medium-sized firms, but also with small or micro firms, which constitute the majority of most cluster initiatives in Poland. The role implies activities such as engaging in basic communication activities and associated training connected to innovation, acting as a networking agent, and engaging in applied research to technology service provision. This article proposes that cluster initiatives fulfilling this role can be categorized as Ecosystem Agents.

Another role of the cluster initiative as an open innovation intermediary was associated with working towards strengthening connections in the innovation ecosystem, in which knowledge and relations with the ecosystem actors enable cluster initiatives to bring together key players for projects, especially those that are EU funded. Another example is creating a product/service platform for engaging technological partners from within and from outside of the initiative. Those types of activities increase the chances of being successful both in terms of securing funding as well as delivering

output. This article proposes that cluster initiatives fulfilling this role can be categorized as Ecosystem Builders.

For 8 of 12 experts interviewed, an important next step for the cluster initiative is to actively shape the innovation ecosystem, enhancing its reach and its significance through written strategic communication, expert advisory groups, and influence made through external bodies. Those activities potentially have the most positive impact on network value generation. Such influences should also be made in collaboration with other types of innovation intermediaries and like-minded organizations, which in turn become project collaborators leading to strengthening the innovation ecosystem. This article proposes that cluster initiatives fulfilling this role can be categorized as Ecosystem Shapers.

Table 2. Analysis of roles of cluster initiatives as open innovation intermediaries indicated by experts in the study (coding) and category proposed in this article

2nd stage coding	**Category proposed in the article**
acting on behalf of cluster member companies as a consulting intermediary brokering between two or more parties by providing services, including provision of information about potential collaborators	Cluster initiative as an open innovation Ecosystem Agent
strengthening connections between cluster member companies and ecosystem actors, creating new connections mediating between already collaborating actors, bring together key players for projects monitoring, funding and supporting the connections in the ecosystem	Cluster initiative as an open innovation Ecosystem Builder
enhancing the reach of the ecosystem, its significance, influence and potential gains of its members	Cluster initiative as an open innovation Ecosystem Shaper

The role of the cluster initiatives as an open innovation intermediary and the scope of activities will certainly be different according to external and internal factors that affect a particular initiative. External factors with a potential influence were ascertained by the experts: the most obvious of these factors being the type of industry. Other factors identified in the study included: the relative importance of stages within the innovation process and the organization of a regional innovation ecosystem. Experts indicated regions in which a lack of active technology transfer institutions resulted in cluster initiatives filling the gap in the market for this type of

service (and, thus, taking on the responsibility of being the active technology transfer institution for that region and becoming the most important node in a regional innovation ecosystem). In other cases, there was high activity of technology transfer institutions, and cluster initiatives cooperated with those institutions rather than replaced them. According to the experts, the size of a company and whether the company is an SME is not an important factor which affects the process of open innovation in clusters, since most of the companies in Polish initiatives are rather small. While most of the firms described in early works on open innovation were large multinational firms, it has become apparent that small and medium-sized firms (SME) are also opening up their innovation process.

Experts believed that some internal factors might be important for the cluster initiatives to take on a role as an intermediary, the two most commonly named being: the maturity of the cluster initiative and the organizational activity of the cluster initiative. A complex of indicators can fall within the scope of maturity with experts indicating the "age" of the initiative, its size, and what proportion of its members were SMEs. The scope of organizational activity included: the significance of innovation in the initiative's strategy, what proportion of member companies were involved in innovation activities organized by the cluster initiative, and the lead role of cluster managers in initiating innovation projects.

Table 3. Factors that might influence a cluster initiative as an open innovation intermediary according to the experts in the study

Most important factors external to cluster initiative as indicated by respondents	**Most important factors internal to cluster initiative as indicated by respondents**
type of industry the relative importance of stages within the innovation process organization of regional innovation ecosystem	number of years of initiative operating ("age" of the initiative) size of cluster initiative (number of participants) proportion of SMEs members in the initiative significance of innovation in the initiative's strategy proportion of member companies involved in innovation activities lead role of cluster managers in initiating innovation projects

Many barriers to the performance of cluster initiatives as open innovation intermediaries were identified by the interviewees, the most important being distrust between members. Experts estimate different sources of this barrier: relating it to the attitudes of individual companies and/or cultural determinants of the country. This barrier was perceived to be far more important than any other, including IPR protection and technological problems. Indications of distrust as the most important barrier implied the need to stimulate increased activity of cluster initiatives in the field of open innovation called for by experts. The most common potential drivers of open innovation performance in cluster initiatives that the experts indicated include access to best practices of open innovation projects within the same industry and public financial support for organizing open innovation activities.

DISCUSSION OF RESULTS

There was no doubt among experts interviewed in the study that a cluster initiative as a governing body of a cluster could become an intermediary of open innovation for its cluster members (Q1). Cluster initiatives seem to influence the emergence of open innovation activities by member firms through increased trust and reduced information asymmetries. (Nestle et al., 2019). It was to be expected, in light of the fact that some cluster initiatives in Poland are already actively supporting the innovation processes in their member companies. Innovation intermediaries appear to be developing new practices in environments where risk and uncertainty are high and where sophisticated management principles have to be developed (Agogue et al., 2017). Opening the processes of innovation in an environment of geographical proximity, trust, and effectively managing an organization could be, therefore, a relatively small step in advanced cluster initiatives. But not all initiatives in Poland are at the moment equipped with competencies needed for that kind of activity. A need to finance operations from their own very limited resources means that most of them, at present, limit their innovation activity (Bembenek, 2017).

Regarding the second research question (Q2), on the basis of the literature and experts' responses, this article identifies practices and proposed roles that cluster initiatives could take as intermediaries of open innovation. The identified practices range from simple communication of a potential innovation partner proposal to a broad, multithreaded strategic action aimed at expansion of the whole innovation ecosystem. The role of open innovation intermediaries seemingly extends from linking parties for collaboration, to setting up and

mediating relationships and bridging a wide array of knowledge, competency and capability gaps (Smedlund, 2006; Edler & Yeow, 2016).

This article proposes a number of roles for cluster initiatives as open innovation intermediaries. The roles were based on the range of practices proposed by the experts and categorized from the narrowest to the broadest view of the impact on the ecosystem and therefore value generated: from an Ecosystem Agent, through an Ecosystem Builder to an Ecosystem Shaper. Ecosystem Agents in this context are cluster initiatives that act as knowledge repositories that introduce new combinations of knowledge and also make knowledge-based contributions when providing solutions to their clients (Howells, 2006), or in this situation – cluster members. This article proposes the category of Ecosystem Builders to those cluster initiatives as, among the varied types of engagement by innovation intermediaries (Howells, 2006), their interaction in collaborative projects represents one of their more complex, enriched and involved roles as they (in addition to developing and supporting the partnership) engage in the co-development of innovative activity with collaborators, e.g. in an EU-funded international project or through creating a product platform. Ecosystem Shapers, in our study, are those cluster initiatives that, in addition to other roles, are central to creating and maintaining a successful innovation ecosystem (Sieg et al., 2010). Collaboration in an ecosystem is difficult when partners have diverse interests, goals, and motivations. One way of overcoming this is through shaping the interests of actors within an innovation system to increase the chances of reaching a shared understanding and mutuality between the participating actors, which is important for successful collaboration (Wallin and von Krogh, 2010; Tjong et al., 2015). Thus, innovation intermediaries, in collaboration with other actors in the innovation system, often engage in helping to shape the strategic policy direction, which results in convergence around the interests of actors within the region. Some researchers even argue that developing a consensus is one of intermediaries' key functions (Meyer et al., 2019).

Regarding the factors that might affect the successful adoption of a role of an intermediary of open innovation by clusters (Q3), during the study, a list of potential external and internal factors (in relation to a cluster initiative) was composed. The external factors included technological conditions, e.g. the type of industry. It is in line with previous studies indicating that open innovation practices occur more often in high-tech sectors such as the ICT industry (Christensen et al., 2005; Dittrich & Duysters, 2007), biotechnology (Fetterhoff &Voelkel, 2006), financial services (Fasnacht, 2009) and in large enterprises and multinational corporations (Chesbrough, 2006). Regional conditions also might be a factor affecting the process of open innovation. The cluster initiative itself has a limited influence on the composition of

the regional ecosystem but a greater one in developing stronger relations between ecosystem members. Lee et al. (2010) indicate that the key determinant of open innovation implementation is the existence of a network of links between institutions promoting cooperation and technology transfer. In Polish conditions, companies are very reluctant to cooperate with scientific and research institutions (Sopińska & Mierzejewska, 2017).

Internal factors, affecting the process of open innovation in clusters identified in the study, pointed at the maturity of cluster initiatives and the organizational activity of the initiatives. It is in line with the results of a benchmarking of cluster initiatives carried out in several European countries, which showed a strong correlation between the age and size of the cluster and the impact of cluster organization activities on the business and research and development activities of SMEs (Lammer-Gamp et al., 2011). The benchmarking study assumed, however, that the majority of cluster organizations' activities will be co-financed from public funds, like takes place in most European countries, and that as their maturity increases, clusters will increase their competence in cooperation coordination. Instability in the financing of cluster initiatives in a Polish context might affect the organization of their activities, the difficulties in undertaking long-term innovation activities, and balancing the divergent interests of different groups of stakeholders. With no or minimal external support, Polish cluster initiatives must decide on the scope of innovation services offered, taking into account their business model and financial stability.

CONCLUSIONS

The findings of the study provide an insight into the role of cluster initiatives as proxies – open innovation intermediaries – that might support open innovation within initiatives themselves as well as in broader innovation ecosystems. This article has argued that the concept of open innovation, as it was originally coined and as it has been applied by companies and institutions worldwide, has a fundamental regional dimension. Geographical proximity can represent a key competitive advantage and clusters can achieve such advantages by becoming intermediaries of open innovation, a paradigm that works particularly well thanks to the structure of clusters themselves. Eventually, geographical proximity also favors the development of trust, an intangible element that stimulates the generation of best practices and, even more importantly, encourages firms to diffuse their internal learning and research. Cluster initiatives not only have certain features of the knowledge base, such as universities, research institutes or a pool of highly qualified

employees but also provide the necessary elements to facilitate knowledge development, dissemination, and accumulation, such as various cooperation platforms, social networks, and active coordinator support. Indeed, cluster initiatives, enhancing, managing and mediating the process, might act as a central element in an open innovation ecosystem. Various ways of organizing open innovation practices can provide a source of knowledge for ecosystem members and bring companies closer in terms of potential partnership in new ventures (Radziwon et al., 2014; Chesbrough et al., 2014).

Evaluations of economic policy programs based on clusters indicate that "the success of cluster initiatives as drivers of innovation processes of companies is beyond dispute" (Kocker et al., 2017). This means that clusters contribute to accelerating innovation processes for the benefit of their stakeholders. However, the process of open innovation within cluster initiatives in Poland seems to be still at a relatively early stage of development. With the greater maturity of the cluster initiative and the increase in management experience, the cluster's potential for effective management of innovation processes in the interest of its members most probably will be growing.

Clusters can play a quasi-public role as an innovation intermediary and a central element of regional innovation ecosystems, but the need to finance activities from their own very limited resources means that they limit their innovation activities (Koszarek, 2014; Bembenek, 2017). Direct financial support for innovation activities in clusters is a standard in the majority of European countries (including other Eastern European countries, except Poland) and is recommended by the OECD as contributing to long-term economic growth. The results of research on the importance of public financial support for the innovation activity of Polish enterprises, including open innovation processes, carried out by Lewandowska (2017), show that an increase in public support for innovation activity is accompanied by an increased openness to cooperation.

Implication for research and practice

The present study contributes to the previous research on open innovation intermediaries and clusters. The findings contribute to a comprehensive understanding of the potential roles of open innovation intermediaries in regard to clusters in the context of transitioning economies. Furthermore, this study develops a framework to explore the processes through which open innovation intermediaries fill the aforementioned roles. In the context of transition economies, but also in general, SMEs often lack the innovation capabilities necessary to access and enter a business field featuring high turbulence and risk (Paliokaite, 2019). This study strongly suggests that cluster

initiatives as open innovation intermediaries can provide effective assistance to the innovation processes of SMEs. As a consequence, cluster initiatives can be more capable of serving as a crucial compensating mechanism for a regional innovation ecosystem system. From a practical point of view cluster managers might use the proposed framework to promote the evolvement of an open innovation-friendly culture in their participating companies. Clusters should also strive to not only manage and mediate but also to shape and create an innovation ecosystem, under which extensive cooperation, with business partners, non-profit organizations, support institutions from the region and the country, affects the consolidation of inputs and higher efficiency of actions taken. Lastly, this article calls for the need to reframe policy so that it is designed to stimulate companies to organize or actively participate in innovation ecosystems that integrate a diverse set of entities at various stages of the innovation process (West & Bogers, 2014).

Limitations and further research

This article conceptually links open innovation and clusters, proposes and categorizes the roles of cluster initiatives as open innovation intermediaries, as well as indicates potential factors that might affect the successful adoption of a role of an intermediary of open innovation by clusters. It has to be emphasized, however, that conclusions made on the basis of the literature review and an exploratory study, are to be verified in the following quantitative study. This article, empirically, is based on a small-scale, expert interviews qualitative study, which is appropriate only as an exploratory study. Future research is needed to statistically validate the finding in this study by collecting a large organization-level data set. This study was exploratory in nature as the first step in a three-part, nation-wide mixed methods project, which had been undertaken subsequently. Furthermore, the study was based in a Polish context. It is plausible to assume that factors affecting open innovation processes in cluster initiatives will vary from country to country (even region to region), reflecting each country's culture, individual systems, and institutions. Therefore, cooperation in comparative settings would clarify those factors that are likely to remain constant under different conditions, and those that would differ. Also, more work will be necessary to develop direct tools that practitioners can use to develop open innovation activity within clusters.

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Abstrakt

Otwarte innowacje to koncepcja, której cechy można postrzegać jako naturalnie łączące się z opartą na bliskości charakterystyką klastrów. Celem tego artykułu było zbadanie potencjalnej roli klastrów jako pośredników otwartych innowacji dla swoich członków. Przeprowadzono przegląd literatury i badanie eksploracyjne, w tym pogłębione wywiady z ekspertami w dziedzinach innowacji i klastrów w Polsce. W artykule dokonano połączenia koncepcji otwartych innowacji i klastrów, zaproponowano i skategoryzowano role klastrów jako pośredników otwartych innowacji, a także wskazano czynniki, które mogą mieć wpływ na pomyślne przyjęcie tej roli. Ponadto wykazano, że klastry mogą nie tylko zarządzać i pośredniczyć w kontaktach wewnątrz sieci członków, ale także kształtować i współtworzyć szerszy otwarty ekosystem innowacji. Wyniki badania przyczyniają się do kompleksowego zrozumienia potencjalnych ról pośredników otwartych innowacji w odniesieniu do klastrów w kontekście kraju w trakcie transformacji gospodarczej. Ponieważ klastry odgrywają rolę pośrednika otwartych innowacji, wsparcie publiczne tej roli może zwiększyć otwartość na współpracę nie tylko firm członkowskich, ale wszystkich uczestników regionalnego ekosystemu innowacji.

Słowa kluczowe: *klastry, inicjatywy klastrowe, otwarte innowacje, ekosystem innowacyjny, pośrednik innowacyjny, pośrednik otwartych innowacji, polityka innowacji*

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Innovative ecosystems behind regional smart specializations: The role of social, cognitive and geographical proximity

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Abstract

The article shows how regional smart specializations that are currently considered as the most essential tool of European innovation policy may be assessed if they form innovative ecosystems based on social, cognitive, and geographical proximity. The article presents the concepts of smart specializations and innovative ecosystems, as well as the concept of proximity and its aspects being of reference to smart specialization ideas. The concept of innovative ecosystems is presented from the perspective of its foundations and relations to other concepts and theories. Cooperation in the innovation process by varied actors is considered a significant feature of innovative ecosystems and the manifestation of social proximity. Related diversity of smart specialization areas indicates their cognitive proximity, and embeddedness in a particular administrative region shows their geographical proximity. The results of research carried out in the Subcarpathian region prove that firms in smart specializations are more Research & Development and innovation-intensive and more prone to cooperation than other companies, which determines their social proximity. The research also shows that smart specializations have positive effects on regional development, which indicates the efficiency of their innovative ecosystems. Related diversity of Subcarpathian Regional Smart Specializations (RSS) is also measured to show their cognitive proximity. Analysis of the locations of RSS companies indicates that they are characterized not only by regional but often even by local geographical proximity. The applied methods are desk research, web site queries, a literature review, statistical data analysis, as well as direct research based

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on a survey and econometric analysis of the results of the survey. The article responds to the lack of studies on smart specializations in the context of proximity.
Keywords: *regional smart specializations, innovative ecosystems, social proximity, cognitive proximity, geographical proximity, Subcarpathian voivodship*

INTRODUCTION

Regional smart specializations (RSS) in the EU have been indicated as stimulants of the innovative development of regions. They reflect areas of not necessarily the highest technological advancement but in which the region specializes and has a comparative advantage, and implements innovations based on research. Strategies for smart specializations assume the joint implementation of projects by enterprises and scientific entities, and thus the existence of cooperation of these sectors in the regions for the development of innovative solutions. This means that smart specializations should reflect innovative ecosystems characterized by links between enterprises and between sectors (like business-science links) in the research and innovation process. These ecosystems should have business, technological and knowledge layers – subsystems – and thus be capable of generating new value together, both inventing and commercializing it. At the same time, this interdependence in the innovation process determines the competitiveness of individual organizations within the ecosystems of smart specializations, that is, the appropriate cooperation and occurrence of particular types of partners will determine whether other members of the ecosystem can be effective, as in biological ecosystems. The reasons for the occurrence of innovative ecosystems arise from the features of modern economies, the complexity of technology and the turbulent environment to which organizations adapt by adopting flexible, agile, organizational forms. The complexity of technology and products/services, and at the same time, hyper-competition means that no organization is able to have all the resources needed in-house and often needs complementary products/services/materials that will condition its achievements. As a result, a well-functioning innovation ecosystem will determine the competitiveness of its members, and at the same time, translate into effects in the field of regional development based on innovative processes.

Accurately indicated regional smart specializations are based on actual innovative ecosystems characterized by social proximity reflected in interactions in the innovative process. They are also characterized by cognitive proximity through a common knowledge base due to the related diversity of their industries. Moreover, as regional smart specializations were indicated

by particular administrative regions at the second level of the Nomenclature of Territorial Units for Statistics (NUTS 2), they consist of entities located in the same geographical territory, which indicates geographical proximity. The article presents the concepts of smart specializations and innovative ecosystems, as well as the concept of proximity and its aspects being of reference to smart specialization ideas.

The hypothesis of the research for the article is that well indicated Regional Smart Specializations reflect efficient, innovative ecosystems based on social, cognitive, and geographical proximity. The purpose of the article is to develop a tool for the analysis of innovative ecosystem effectiveness in terms of these types of proximities and to test the tool in the Subcarpathian voivodship in Poland. The assumptions for the developed tool are as follows:

1) Cooperation in the innovation process and network structure may be perceived as the main common features and are the basis for the concepts of RSS and innovative ecosystems. These are also manifestations of social proximity.
2) Embeddedness of RSS in a given knowledge base indicates cognitive proximity. The characteristic of innovative ecosystems is the crucial role of a knowledge base, which constitutes part of the innovative potential determining the ability of a system to introduce new products based on mixing different but related competences to create new value. Cognitive proximity is reflected in the related diversity of innovative ecosystems of RSS areas.
3) Embeddedness of RSS in a specified territory indicates geographical proximity. Analysis of the location of RSS companies allows one to check if they are based not only on regional but also local geographical proximity, which might further stimulate more intense social interaction and proximity due to easier tacit knowledge flows.
4) Efficiency of innovative ecosystems based on social, cognitive and geographical proximity is visible in positive spill-overs of them in terms of quicker regional development.

The proposed tool may be used to check if the RSS areas were indicated in a proper way, that is, whether they form actual innovative ecosystems.

Over 400 articles related to smart specialization concept are in the Scopus database, but none of them have the keyword proximity. Only nine Scopus indexed articles also refer to the concept of innovative ecosystem and they stress the collaborative aspect of innovative ecosystems in terms of an open innovation model or collaboration crossing administrative boundaries (Carayannis, Meissner, & Edelkina, 2017; Woronowicz, Boronowsky, Wewezer, Mitasiunas, Seidel, & Cotera, 2017). A tool to analyze the cells of a business ecosystem is offered by Vlados and Chatzinikolaou (2019). In the article, the tool for assessing if regional smart specializations are based on actual

innovative ecosystems is proposed consisting of a theoretical approach, and methods and sources of data that may be used to check the presence of social, cognitive and geographical proximities as characteristics of innovative ecosystems of RSS. Smart specialization strategies enhance the effects of such proximity-based joint activities in the innovative ecosystems of RSS.

The subsequent parts of the article consist of a literature review presenting the concept of regional smart specializations, the concept of innovative ecosystem and its foundations, as well as the concept of proximity and its different types. A data and methods section presents the empirical strategy based on theory, as well as the sources of data and methods used for the development of the tool. The results section is divided into sub-sections reflecting social, cognitive, and spatial as well as geographical proximity. Conclusions complete the text.

LITERATURE REVIEW

Smart specializations are science-related areas of economies that have been selected by individual regions for the smart specialization strategies that form the 3rd generation of regional innovation strategies in the EU. These areas can receive regional support for research under the Structural Funds. Their selection results from the necessity to prioritize and concentrate resources on research in areas which, in a given region, can bring the best results in terms of the implementation of innovative and internationally competitive solutions, and which derive from the existing structure and development of regions. In addition, smart specialization strategies indicate areas that may be promising for regions in the future. These strategies are designed to support entrepreneurial discovery in regions, especially in phases, when it requires some protection through public support to bring about the desired return on private and public investment (OECD, 2013).

In addition, the strategy of smart specialization should lead to the technological modernization of an existing industry, including the development of specific applications of the main technology in a given sector as a traditional one. For example, the Finnish pulp and paper industry perceives nanotechnology as a source of valuable innovations. Smart specialization policies must be rooted in local conditions and guarantee access to external knowledge through strong and vital links with the supra-regional environment (Capello & Lenzi, 2013). Foray (2017) sets the following economic fundamentals of SS strategies: specialization in the area of R&D and innovation, transformative activities of existing sectors and creating new sectors, and an entrepreneurial discovery process.

According to McCann and Ortega-Argilés (2016), the basic argument of the smart specialization strategies is that policy resources must be spent on those activities, technologies or sectors where a region has the most realistic chances to develop internationally competitive products, based on many different local and inter-regional linkages and connections. This approach requires that many of these activities are already embedded in the region's existing industrial fabric and that as many local actors are engaged in the policy design and delivery process as possible. This involves an entrepreneurial ecosystems' type of approach in which the role of entrepreneurship in driving local innovation is seen as critical for enhancing regional competitiveness. This type of thinking implies that policies may target any of the technological, financial, institutional, or skill-related elements within the ecosystem, to enhance certain features of the local business system, to overcome constraints, or to bridge missing links. Modernizing traditional specialties through entrepreneurial discovery refers to the collective nature of the process of learning in territories through interpersonal interactions and achieving synergetic effects. This is characteristic of industrial districts/clusters/innovation environments, or cities where the learning process is rooted in a developed sector of small and medium-sized enterprises and in the local labor market (Wojnicka-Sycz, 2020). The rapidly changing conditions in which enterprises operate, and especially the critical importance of knowledge and innovation for the success of modern organizations, have created new organizational forms such as virtual and network organizations that create more or less dependent and formally related entities within their environment which are business or innovation ecosystems. This also reflects the growing importance of the systemic paradigm in science, technology, and the economy.

The concept of an innovative ecosystem reflects a shift towards a systemic paradigm from a mechanistic approach in the case of innovation processes in an organization that is increasingly interdependent with its environment. The systemic paradigm is based on the theory of systems, the essence of which is the holistic approach to reality. The concept of the open system of Ludwig von Bertalanffy (1968) is the basis of the theory of systems, and especially the systems' school in management theory. Von Bertalanffy's concept is based on the perception of living organisms as organized wholes with a dynamic character. This means that individual parts of the body can only be determined by knowing their place in the whole. At the same time, these organized entities are "open systems" because they collect and render the material substance into the environment (Hammond, 2010, p. 112).

The business ecosystem, on the other hand, is a term proposed by J.F. Moore, who said that a company could not be seen as a representative of one industry but as a part of a business ecosystem that crosses industry

boundaries. In the business ecosystem, the partners work together to develop competitive products and services and develop skills and innovations together, but they are also competitors. The business ecosystem includes the organization, its clients, competitors, market intermediaries, companies selling complementary goods, and suppliers, as well as regulators or media that may have a less direct, but significant, impact on the operations of an organization. The ecosystem works together, partly deliberately, organizes itself, and is characterized by decentralized decision making. According to Moore, the business ecosystem should replace the term industry, because currently, it is challenging to assign a given organization to a specific industry. Linking an ecosystem's actors means that they have an impact on each other. Organizations in the business ecosystem are trying to implement innovations and use the skills of other ecosystems' participants. At the same time, however, they function in a turbulent environment, so they constitute a dynamic structure (Moore, 2016).

Organizations nowadays increasingly function as entangled organizations that depend on their environment and perceive that business is not war, and its goal is to create value, which means a non-zero-sum game. Creating value is a common goal that connects organizations. In a modern economy, no organization is able to perform all activities on its own – the benefits of specialization encourage the outsourcing of all functions that do not belong to the core business. Cooperation is the main factor shaping the relationships between organizations, and the basis of economic life is symbiosis, not aggression. Companies want to focus on a narrow area of their key competences and key processes, so they try to pass on as many side activities as possible to external subcontractors. The more companies specialize, the more they become dependent on other companies and need formal mechanisms to harmonize their activities. Continued partnership will be fostered by the balance of anticipated benefits and the required work input (de Wit & Meyer, 2017).

Business ecosystems can contain key and niche organizations. The key organizations control the most critical organizational resources – distribution, technology, or brand, but the organization becomes more resilient when these resources and related organizations are more diversified. Therefore, key organizations should, instead of gaining more control in the ecosystem, try to have a greater share in distribution and joint value creation with partners, which will also increase their resilience. An example of building an efficient ecosystem in recent years with partners is, for example, Cisco, or the ecosystem of music publishing houses and others selling their songs through the iTunes platform created by Apple. Platforms are creating an entirely new blueprint for competition that puts ecosystems in head-to-head competition.

The utility of almost any platform is shaped more and more by the ecosystem that surrounds it. Take Apple's iOS platform that includes the iPhone, iPod, and iPad. Its value to its users comes largely from the 800,000 complementary apps over which Apple has little ownership. The emergence of such platform ecosystems is relocating the locus of innovation from the firm to a massive network of outside firms. The goal is to develop new capabilities and foster innovations unforeseeable by the platform's designers (Tiwana, 2013).

The concept of a business ecosystem is derived from the definition of a biological ecosystem, and thus, the system of organisms dealing with a given habitat, along with those aspects of the physical environment in which they interact. The ecosystem must adapt to the changing environment, so there must be a large variety of species so that the entire ecosystem survives in a changing situation (Peltoniemi & Vuori, 2016). Rothschild (1990) sees the economy as an ecosystem that continues and develops thanks to copying information and thus increasing the knowledge base, which speeds up the development. According to Rothschild, the main difference between natural and economic systems is a much faster process of changes in economic systems, while the basic mechanism is the same. The economic change is based on copying, exchange, and development of technological knowledge, just like genetic information in nature.

In terms of innovativeness, the concept of an innovative ecosystem exists. It consists of all partners of a company whose knowledge the company uses or in cooperation with which it develops innovations and conducts research and development (R&D). The term ecosystem is also related to the national systems of innovation concept (Lundvall, 1990). The main components of innovation ecosystems are other enterprises, but also the R&D sphere, universities, intermediary institutions, such as technology transfer centers or knowledge-based business services, as well as administration creating the right conditions for the development of innovation, or directly creating the demand for innovative products in public procurement. From the perspective of the quadruple helix or the demand-driven approach to innovation, apart from business, science and administration, users – society – are also an important subsystem of innovative systems. Recently, the environmental dimension has also been added to this model – a quintuple helix. Among the elements of such an ecosystem, there are direct interactions, like the joint implementation of all or some elements of the R&D and innovation process on a partnership basis or in the form of subcontracting, and also indirect interactions based on technology transfer or tacit knowledge flows through the mobility of personnel (Wojnicka-Sycz, Sycz, Walentynowicz, & Waśniewski, 2018; Teixeira & Lopes, 2012).

The idea of networks and interdependent ecosystems is also reflected in theories emphasizing the positive effects of agglomerations for local and regional development, such as the concept of Marshall's territorial production systems from 1899 or clusters based on Porter's diamond, for example, clusters of a given industry and related industries (suppliers and customers) and supporting institutions in a given area, as well as relevant resources – production factors. Nowadays, clusters are mainly perceived as innovative ecosystems, especially those that, in addition to companies, also include the knowledge subsystem like universities or research institutes. According to Andersen (2011), innovative ecosystems are successful agglomerations in geographical, economic, industrial or entrepreneurial terms, and therefore, particularly innovative regions/territories such as Silicon Valley, Bangalore, or successful ICT platforms like the iPhone or Android, as well as new industries such as calculations in the cloud.

Xua, Wub, Minshallc, and Zhoud (2018) believe that an innovation ecosystem consists of a knowledge ecosystem driven by research and development, and a business ecosystem driven by market forces. In addition, in the definition of an ecosystem, the knowledge created as a public good and technological knowledge covered by the protection of intellectual and partly private property should be distinguished. Thus, in the innovative ecosystem, they distinguish the business, technological and scientific layers. There are interactions between the business ecosystem and the knowledge ecosystem that may lead to their evolution, for example, through spillover effects from basic knowledge or value propositions for the knowledge sector from business partners. However, the knowledge and business subsystems differ in goals and organization, and hence their cooperation may be difficult. However, this cooperation may be facilitated by various instruments in the field of innovation or market policy, like pro-innovation institutions such as technology transfer centers, technology parks, or consulting companies.

It is thus possible to summarize the concept of an innovative ecosystem as deriving from:

1) In terms of theoretical foundations:
   a) systems theory – open systems theory, systems school in management, engineering – systems design;
   b) innovation theory – innovative systems based on interactions within a quadruple/quintuple helix: business, science, administration and society/environment, innovative networks, clusters – based on the benefits of agglomeration from clusters of a given industry and related industries together with scientific institutions supporting a given sector, open innovations based on cooperation of the company with the environment in implementing innovations, which allows the lowering of the costs of this process.

2) At the mezzo and macro level, the concept of an innovative ecosystem is related to the concept of a business ecosystem and the perception of the economy as having similar features to biological ecosystems. This also results in the increasingly frequent phenomenon of coopetition, which is the capitalism of allies instead of perceiving competition as a zero-sum game. Moreover, it means competition between ecosystems, not individual companies.
3) At the micro-level, the concept of an innovative ecosystem reflects a systemic approach to the organization as well as the concept of an entangled organization and networked and virtual organizations (Figure 1).

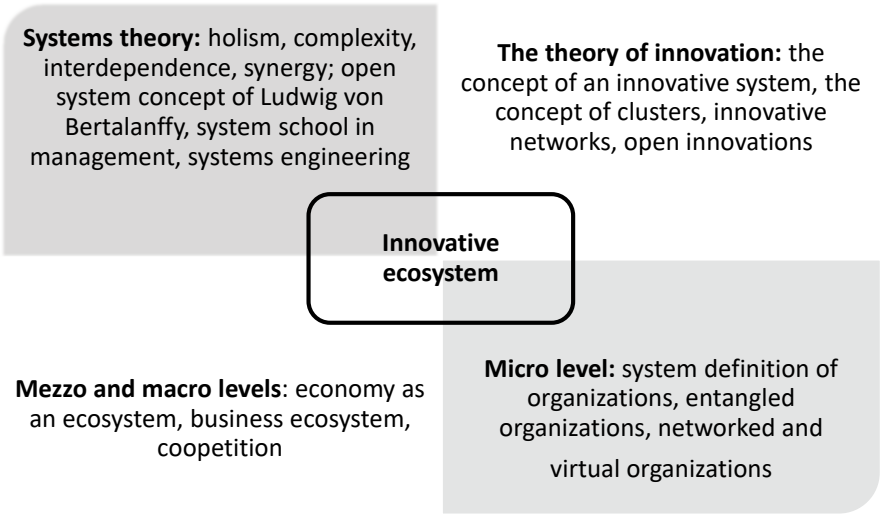

Figure 1. The foundations of the innovative ecosystem concept

Source: Wojnicka-Sycz & Sycz (2018).

Proximity, in the simplest terms, means similarity of the organization's attributes (Boschma & Frenken, 2009). More broadly, proximity refers to the similarity "of physical space, psychological and social relations as well as shared cultural values or similarity of institutional operating conditions" (Czakon, 2010). External proximity can be seen through the prism of belonging of market participants to the same circle of friends, community, family, professional group, organization, or institution (Torre & Rallet, 2005). Individual authors emphasize the multidimensionality of proximity by listing various components (Klimas, 2011 p. 16).

Social proximity refers to the issue of strength of interpersonal relationships, in particular to what extent people know each other and interact in a private or professional context (Huber, 2011). The traditional

belief is that strong relationships based on trust facilitate the exchange of knowledge (Gertler, 2004, p. 156). However, the existing literature on social proximity, sometimes also called relational proximity or personal proximity, is dominated by the slightly loose use of this idea (Amin & Cohendet, 2004).

Broadly understood cognitive proximity means similarity in the way people perceive, interpret, understand, and evaluate the world (Wuyts, Colomb, Dutta, & Nooteboom, 2005). Cognitive proximity is essential for mutual understanding and effective communication with each other. Existing empirical studies do not distinguish between dimensions of cognitive proximity, which seems important for understanding the complexity of the broad concept of cognitive proximity (Nooteboom, Van Haverbeke, Duysters, Gilsing, & Van Den Oord, 2007).

The similarity of knowledge bases, patents, and technologies used is perceived as a factor determining and accelerating the processes of knowledge generation and commercialization of innovation. The implementation of joint learning processes is effective because entities close to each other in cognitive terms tend to understand the same phenomenon or process (Lagendijk & Lorentzen, 2007). Common interests reduce the risk of opportunistic behavior and focus on combining complementary resources and technologies to eliminate information gaps and knowledge gaps (Klimas, 2011, p. 17).

Geographical proximity is the proximity based on the same physical space, which means that the agents are located not far from each other. This proximity depends on the type of geographical scale taken into account. In the case of regional smart specializations, what is essential is regional space, understood as being located in the same administrative region on the NUTS 2 administrative level and being covered by the same Regional Smart Specialization Strategy that is Regional Innovative Strategy of the 3rd generation. However, local geographical proximity is also important as the logic of smart specializations stresses concentration of resources on R&D and innovative activity, which may be amplified by local concentration of companies and institutions stimulating tacit knowledge flows during direct, often informal, meetings of employees of RSS agents.

Proximity helps explain such important processes as building a competitive advantage, increasing efficiency and effectiveness, making strategic choices, and organizational collaboration (Czakon, 2010). Economic geography literature and endogenic regional development theory find proximity and networking as determinant factors for explaining local and regional development (González-López, Dileo, & Losurdo 2014). Recently, most attention has been focused on linking proximity with innovation, acquisition, and diffusion of knowledge (Boschma, 2005), especially quiet and difficult to codify (Gertler, 2004). Moreover, some indicate that properly close inter-organizational interactions allow the realization of full and multidimensional learning (Crevoisier &

Jeannerat, 2009) and the use of the effect of knowledge diffusion. The closer the organizations are, the greater the likelihood of knowledge transfer in the inter-organizational network and the higher external effects of its functioning. Enterprises striving to optimize cooperation and maximize their results, strive to reduce the distance between them (Klimas, 2011, p.17). Obtaining the most favorable effects of proximity requires the appropriate configuration of several of its dimensions. Optimal configuration of proximity types refers to providing the right structure and level of proximity (Boschma, 2005). A proper structure of proximity shall consider interrelationships and couplings between dimensions and the effects that the organization plans to achieve through cooperation. The right level of proximity means a good balance between a lack of closeness and its completeness. Large proximity provides many positive effects, but on the other hand, too high a level can be harmful to the organization and cause counterproductive effects. Then occurs the so-called paradox of proximity (Boschma & Frenken, 2010), consisting in the fact that too close inter-organizational relationships can lead to inertia, loss of flexibility, bureaucracy and economic inefficiency, and what is important to limit access to innovation and new knowledge outside the network (Boschma, 2005). The proximity paradox reflects the parabolic nature of the relationship between proximity and the benefits of maintaining it (Czakon, 2010; Klimas, 2011, p. 17).

DATA AND METHODS

The literature analysis presented in the article showed that a systemic approach and networks of cooperation, as well as innovativeness, are crucial both for the concept of smart specializations and innovative ecosystems. The concept of innovative ecosystems is different from the original concept of national innovation systems, mainly in the stressing of the dynamic rather than institutional aspects of the system. It also makes it more difficult to indicate the borders of an ecosystem as they evolve similarly to natural, biological ecosystems. The linking mechanism of innovative ecosystems, as well as smart specializations, are interactions between agents, which often take the form of less or more formal cooperation complementing competition. Such competition of allies is characterized by the emergence of networked organizations with their breeding environment, occurrence of platform-type business ecosystems, as well as by the importance of knowledge exchange for learning and innovation processes in the era of complexity and knowledge-based economies.

These types of proximity: social, cognitive and spatial, which are characteristics of an innovative ecosystem and a regional smart specializations

concept, are interrelated and enhance their own importance reciprocally for the smooth and value-adding operation of RSS areas as innovative ecosystems. Cognitive proximity, in the form of a common knowledge base and complementary capabilities reflected in the related diversity of RSS areas and subareas, is important from the perspective of an innovation ecosystem concept as it means a mixture of different capabilities that are crucial for cooperation-based innovations and for the creation of new value in a systemic way. This also resembles the way of operation of platform-based ecosystems where, often spontaneously, varied companies produce applications that may be used with particular platform type software. The related diversity of RSS is measured in a regional context, so it refers to complementary capabilities present in a particular geographical space of location of RSS companies. Concentrations of RSS companies in local territories make tacit knowledge flows more probable and this is crucial for innovative ecosystems like, for example, clusters. Tacit knowledge flows, as well as more direct and formal types of cooperation, involve social interactions between people, which are based on or create social proximity. These types of proximity, based on social interactions, knowledge flows and formal cooperation agreements, make the diffusion of knowledge and innovation possible as well as the creation of new value in the form of innovations by companies cooperating with academia, administration, society, and the environment. This subsequently leads to the quicker development of a region thanks to the diffusion of growth from innovative ecosystems of regional smart specializations to the other regional industries (Figure 2). The above relations derived from theory are the basis for the empirical analysis in the article.

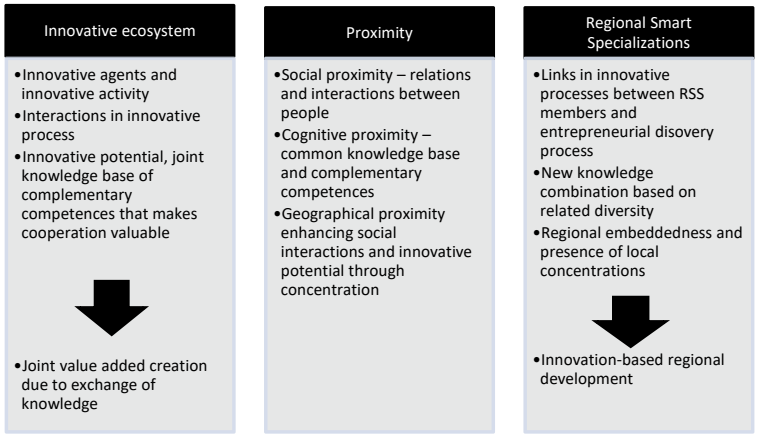

Figure 2. Innovative ecosystem's and RSS's concepts and related with them types of proximity

The analysis in the article is carried out for the Subcarpathian voivodship in Poland. The Subcarpathian region is located in south-eastern Poland, and it is one of the poorer regions at the NUTS 2 level of Poland and the European Union. GDP per capita in the Subcarpathian region in 2017 was 49% of the average for the EU-27 in PPS, while in relation to the average for Poland, it was 71%. The population of this region was 2.13 million people in 2018. The Subcarpathian Region is characterized by a high share of industry in the economy, as 39% of the added value was generated in industry and construction in 2016, compared to 35% on average in Poland. The Subcarpathian region is also characterized by a relatively high share of employment in agriculture, forestry, and fisheries – 11.6% (similar to the average for Poland), however, agriculture is not very productive, as this sector had only 1.5% share in the added value generated in the region in 2016. However, the region is the seat of the Aviation Valley industrial cluster, and many international companies are present here. As a result, the Subcarpathian region distinguishes itself in terms of the share of R&D expenditures of enterprises in GDP (BERD), which in 2017 amounted to 0.86% here compared to 0.67% of the total GDP in Poland. The total share of expenditure on R&D in the region's GDP in 2017 was 1.03%, and it was equal to the Polish average.[4]

In 2015, the value of exports from the region was 37% higher than the value of imports and in 2016 exports from the region grew by 10,6 % in comparison with 2015. Calculated for one exporting company, it amounted to PLN 14 million, which was the eighth-highest value in the country. From 2010, exports from the region increased by 89.4%, a figure higher than the average for the country, which amounted to 69.9% (Klimczak, Miller, Wojnicka-Sycz, Sycz, & Piróg, 2017). Therefore, the region is an example of a poorer EU region due to the large share of traditional industries such as agriculture and tourism, but also with strong innovative and exporting industrial companies, and the choice of priorities for smart specialization strategies reflects the duality of this region. The aviation and space industries, along with the automotive industry and industries related to them as well as smart specialization "Quality of Life" and the horizontal ICT specialization, were indicated as smart specializations here.

The industrial specializations and ICT were indicated as bundles of related industries: end-product producers, suppliers, complementary products and services as well as R&D for the RSS. However, the RSS "Quality of Life" is too diversified often in an unrelated way. In detail, the specialization "Quality of Life" includes the following activities: passive construction, systems for smart houses, energy-saving construction materials, biodegradable plastics, cognitive tourism, leisure tourism, ecotourism, agrotourism; qualified tourism like hiking, skiing,

4 Data of Eurostat and the Central Statistical Office (CSO).

biking, motor, canoeing, sailing; health tourism; business tourism; religious tourism, culinary tourism, wine tourism, renewable energy, organic food, care for the elderly, preventive medicine and natural medicine. The Quality of Life specialization is meant to reflect the endogenic potential of the region.[5]

The analysis in the article is based on several aspects. There is a literature review and a statistical data analysis based on the OECD Input-Output trade tables and the data of the Rzeszow Statistical Office. In addition, there is an analysis of data gathered from website queries on companies that represent areas of Subcarpathian smart specializations. Finally, there is an analysis of the results of the CAWI (Computer Assisted Web Interview) survey carried out on 200 innovative enterprises that embrace the subgroup of firms of smart specializations in the Subcarpathian region of Poland in 2017 (for a research project commissioned by the Subcarpathian Marshall Office (Klimczak et al., 2017)). The respondents were selected in a targeted sampling from the database of smart specialization firms created from website queries and the database of innovative enterprises of other industries identified in a representative survey of 600 enterprises in the region, as well as the databases of economic entities that received support for innovations. Websites for the queries were found by searching varied firms' databases through keywords connected with particular subdomains of RSS areas. Moreover, we investigated the websites of firms indicated on the websites of clusters and associations connected with RSS. The CAWI research was done into those firms of RSS that indicated on their websites some kind of innovative activity.[6] CAWI research was used for testing the hypothesis formulated for logistic regression and for determining the internal related diversity of RSS areas. In the CAWI research, the companies self-assessed varied aspects, which were reflected in questions about conducting activity in a particular subarea of smart specializations, conducting R&D activity, cooperation with universities or other scientific institutions, membership in clusters and declaring the year of their origin. Industrial smart specializations were specified on the basis of the indicated subareas of RSS falling into the Aviation and Automotive RSS.

The econometric method that was used for the analysis of the results of the survey was logistic regression. Logistic regression, also called a logit

5 Regional Innovation Strategy of Podkarpackie Voivodship 2014-2020.

6 In particular the following websites were investigated: ICT clusters - http://www.klasterict.org.pl/, http://www.klasterit.pl, Eastern Automotive Alliance. http://eaa-wsm.pl/, http://www.automotivesuppliers.pl, Aviation Valley: http://www.dolinalotnicza.pl/, Aviation Cluster http://www.klasterlotniczy.pl/, Ecological housing: http://www.pasywny-budynek.pl/, https://lipinscy.pl/województwie podkarpackie, Oenology: http://www.naszewinnice.pl/polskie-winnice/prezentacja-winnic/woj-województwie podkarpackie?start=20, http://województwie podkarpackiszlakwinnic.pl/winnice/, Preventive medicine: http://www.sanatoria.org/pl/wojewodztwa/województwie podkarpackie.html; Cluster of Plastics Producers http://www.poligen.pl/, Energy providers http://energia.rzeszow.pl/, Ecological Valley http://www.dolinaeko.pl/, Regional products-http://www.smaki.województwie podkarpackie.pl, http://www.baza-firm.com.pl (searching with keywords as: computers, databases, Internet, electronics, telecommunication services, automotive: production and accessories, motorcycles, engines, smart houses, real estate developers, wooden houses, renewable energy, wind farms, fotovoltaic, solar panels, water power plants, ecologic food, healthy food, natural medicine, care for the elderly, medical care), BISNODE database.

model, is used to model dichotomous outcome variables. In the logit model, the log odds of the outcome are modeled as a linear combination of the predictor variables. Logit regressions show the probability that an explained variable will be 1 or 0 with given parameters and values of explanatory variables. The logit models in the article take the form of:

$$P(Y_n = 1|X = \Lambda(X\beta) = \frac{\exp(X\beta)}{1 + \exp(X\beta)} \quad (1)$$

Where: $\Lambda(X\beta)$ is a logistic cumulative distribution function, Y_n are variables reflecting the R&D and innovation activity of firms or other explained variable, with n=1,…, N firms, X is a vector containing a set of determinants like belonging (or not) to smart specializations, and β is a vector of parameters.

The hypothesis checked in the article with the usage of logistic regression were if the fact of activity of the surveyed enterprises in the areas of smart specialization increased the probability of their higher propensity to cooperate and conduct R&D activity reflecting social proximity and innovative potential as the characteristics of an innovative ecosystem.

To compare the strength of related diversity, based on the spatial proximity of particular industries of regional smart specialization areas, the following index was constructed.

$$RDSS_i = \sum_{j=1}^{PIio_j} PIio_j \sum_{i=1,j=1}^{Iss,Iio} \left(\frac{SIio_j}{SIss_i} \right) \quad (2)$$

Where: $RDSS_i$ – related diversity of a particular industry of the particular regional smart specialization area,

$PIio_j$ – proportion of a particular important (over 1.5% share) suppliers' industry according to the OECD Input-Output tables in total expenditures of the particular industry of smart specializations, without supplies coming from the same industry,

$SIss_i$ – percentage share of a particular industry of regional smart specialization areas in the total average employment in the region,

$SIio_j$ – percentage share of a particular important suppliers' industry in the total average employment in the region.

In this index, the analysis of intra industrial suppliers was omitted, which is suppliers from the same industry as the RSS industry. This index shows how big the pool of complementary competences is, in terms of employed

people in a given region, in comparison with competences related directly with a particular RSS industry. Hence, it is a measure of the external-related diversity of RSS areas, reflecting their cognitive proximity in the value chain of the region of location.

Moreover, based on the CAWI results, contingency tables and a Chi-square Pearson test was calculated between varied subdomains of RSS areas represented by the firms that indicated more than one subdomain of RSS as their field of activity. The variables here were dichotomous – 0 if a firm does not act in a specific subdomain of RSS and 1 when it does act. This reflects the internal-related diversity and internal cognitive proximity of particular RSS areas. A location quotient was also calculated to find local concentrations of RSS companies in the Subcarpathian region, reflecting geographical proximity on which innovative ecosystems of RSS are based. It was calculated on data from the Register of National Economy REGON and on data on companies of RSS gathered from website queries. The used indexes were (3) and (4).

$$LQ_R = \frac{P_{ip}}{P_{iv}} \tag{3}$$

Where: P_{ip} – percentage share of registered entities of a given RSS industry in all registered entities in a county (poviat in Poland),
P_{iv} – percentage share of registered entities of a given RSS industry in all registered entities in a voivodship.

$$LQ_{WQ} = \frac{P_{piWQ}}{P_{piRv}} \tag{4}$$

Where: P_{piWQ} – percentage share of a given poviat (county) in companies of a given RSS industry identified from website queries of the Subcarpathian RSS firms,
P_{piRv} – percentage share of a given poviat (county) in all registered companies in the Subcarpathian voivodeship.

These indicators show the relative concentration of companies of a given RSS industry in a given county in relation to the voivodship average (3) or average share of a county in regional companies. It was assumed that if it was higher than 1.25 it meant a significant concentration of entities of a given RSS industry in a given county.

RESULTS

Social proximity of innovative ecosystems and Subcarpathian SS

Innovative networks and cooperation in the innovation process are the glue of an effective innovative ecosystem. According to the quintuple helix concept, these interactions embrace interactions between academia, business, administration, society, and the environment. Cooperation means social interactions during joint projects, working in teams, often virtual, meetings, or talks with the usage of electronic tools. They may be formal or informal. Social interactions may sometimes lead to an unintended spread of tacit knowledge during informal meetings, which is enhanced by geographical proximity. To enhance cooperation and knowledge flows, varied publicly co-financed initiatives are implemented that create platforms of dialog like clusters and specifically designed financial instruments, like the improved assessment of applications from consortia instead of just single organizations (see Svare & Gausdal, 2017). Smart specializations are also an example of such cooperation-based tools and tools enhancing cooperation and, especially, social interactions between academia, business, and administration. However, companies searching for new ideas will often use new, innovation management methods like demand-driven innovation and engage users in innovation processes. Cooperation with the environment may be enhanced by the necessity to be environment friendly in order to get public grants, which stimulates social interaction with people in firms/institutions who are specialists in environmental protection technologies.

The preparation of strategies for smart specializations in the Subcarpathian region was based on extensive direct research, as well as workshops/ meetings with stakeholders, so it embraced social interactions. The concept of RSS embraces not only innovative networks but also the entrepreneurial discovery process. Entrepreneurial people, who are well prepared to look for new niches, often do not have sufficient external connections to enable the commercialization of new ideas and seek sources of financing. The presence of specialized support systems for searching for new activities is important (OECD, 2013) and the implementation of smart specialization strategies offer support systems like bridging tools between entrepreneurs and sources of finance (grants, venture capital funds, business angels) which are a form of socially interactive, institutionalized platforms. In the Pomeranian region of Poland, a competition for the label of smart specialization was held during which consortiums of business and academia had to prove that they could introduce internationally competitive innovations based on regional research, which stimulated entrepreneurial discovery and social networks

(Wojnicka-Sycz, 2018). Smart specialization strategies hence offer tools that stimulate the efficiency of innovative ecosystems of the areas of regional smart specializations, based on innovative interactions and entrepreneurial discovery processes being the earlier phase of innovation processes. These interactions are based on the social interactions of people from RSS entities: firms, institutions, academia, but also society and the environment in which RSS operates, creating social proximity.

For Poland, it was noticed that innovative networks promote innovations in companies, which determine their higher profitability. On the other hand, companies' income is a component of GDP. A series of analyses using logit regression based on a study of approximately 2,500 enterprises and 58 scientific units in Poland in the period 2003-2017, as well as analyses based on statistical data, showed the significant importance of cooperation in the innovation process for innovation and efficiency at the micro and macro levels. Business surveys have shown that cooperation in the innovation process, and in particular the cooperation between enterprises and science, increases their innovativeness in terms of novelty on the market scale, as well as their profitability and international competitiveness. Voivodships and industries, where more enterprises cooperate with science in the innovation process, develop more successfully. Scientific projects implemented by scientific units in partnership with a larger number of enterprises, bring better results in terms of the development of innovative solutions and increases in the entity's revenue, than those where scientific units dominate (Wojnicka-Sycz & Sycz, 2018).

Clusters are cooperative associations of firms aiming at enhancing their cooperation especially in innovation process. In the case of the Subcarpathian region, they embrace enterprises of the major and related sectors, scientific units as well as bridging institutions like technology parks, technology transfer centers, and consulting firms. One of the members of the main cluster of the Subcarpathian region's Aviation Valley is also a regional development agency as a representative of public administration.

All RSS priority areas of the Subcarpathian region have their cluster organizations. Entities connected with the aviation and automotive industries (e.g., from the metal industry) mostly belong to the Aviation Valley association. The Eastern IT Cluster also operates in the region, which includes 81 enterprises, 3 foundations and associations, and 3 universities. In the automotive industry, the cooperation platform is the Eastern Automotive Alliance, which consists of 22 enterprises, regional development institutions, and the Rzeszow University of Technology. The region also has the Subcarpathian Cluster of Pure Energy, Cluster of Good Tastes (organic food), the Bieszczady Cross-Border Tourist Centre, and the Spa Cluster of the Pearls of Eastern Poland. Each of the specializations, therefore, has its own

cluster organization. The CAWI results also confirmed a high propensity of RSS firms belong to clusters. One of the reasons is the possibility of obtaining a favorable assessment of applications for co-financing from structural funds when the enterprise belongs to a cluster initiative. At the same time, these clusters often include entities from other regions of the country, as well as from abroad, together with universities as supporting institutions. Therefore, they constitute an important platform for cooperation in the innovative and supra-regional system.

Using the logit regression, based on data from the survey of 200 innovative companies, the dependencies between the affiliation of enterprises to smart specializations and their R&D activity and cooperative attitude were examined. The analyzed hypothesis was if the fact of activity of innovative firms in the areas of smart specializations increased the probability of firms conducting research and development, and the probability of cooperation in innovative ecosystem. Table 1 shows the structure of answers of 200 innovative firms from the sample in the case of variables taken into account in logit models.

Table 1. Structure of answers in CAWI of innovative firms (n=200)

	Number of firms	**Percentage of innovative firms (%)**
R&D activity	100	50
Cluster membership	82	41
Cooperation with science	61	30.5
Activity in the areas of smart specialization	137	68.5
Company set up before 2000	94	47
Activity in the areas of industrial smart specialization	69	34.5
Profit in the previous year	171	85.5
Planning of R&D results implementation in 2 years	54	27

Source: own elaboration on the basis of the CAWI research.

Based on this analysis, it can be concluded that:

- the company's affiliation to industrial smart specializations increased the chance of the companies conducting R&D activities; at the same time, for R&D activity, the cooperation of companies with scientific units proved significant;
- the activity of the surveyed enterprises in the areas of smart specializations increased the chance of the enterprise belonging to a cluster, as well as increased the chance of them planning the implementation of R&D results in the next two years (Table 2).

Table 2. Results of estimations with the usage of logistic regression (n=200)

Explanatory variables	R&D activity	Cluster membership	Planning of R&D results implementation in 2 years
Constant	-0.76***	-0.75**	-2.71***
Cooperation with science	2.06***		
Industrial smart specialization	0.57*		
Smart specialization		0.92***	0.78**
Set up before 2000		-0.58*	0.61*
Profit in the previous year			0.96*
R^2 McFadden's	0.15	0.04	0.05

Notes: * - significance on 0.1 level, *** - significance on 0.01 level.
Source: own elaboration based on CAWI.

Cognitive and spatial proximity of Subcarpathian SS

The related diversity, defined by Boschma and Iammarino (2009) as "sectors of industry that are similar in terms of common or complementary competences," is also mentioned as an important element of the smart specialization strategy. These may be end producers and their suppliers or industries based on a common knowledge base like engineering competences. Common or complementary competences mean a common knowledge base making possible a mutual understanding on which different new niche areas may be created, for example, based on innovations transforming traditional industries with the usage of new technologies like General Purpose Technologies and leading to the formation of a new related industry. To some extent, aviation may be considered an automotive industry of a newer generation. Hence, related diversity is based on the cognitive proximity of companies and, if firms and sub-industries in RSS areas can be defined as based on related diversity, they represent cognitive proximity. RSS areas in the Subcarpathian region were indicated as bundles of interrelated industries. The industrial RSS and ICT embrace end-product producers and their suppliers as well as research and development activity for these sectors. Moreover, broadly understood engineering competences are also the basis of both the Automotive and Aviation RSS. These competences have been developing in the region since the beginning of industrialization in the 19th century, with the oldest company in the automotive industry being founded in 1838. The construction of the Central Industrial District originates from the beginning of the 20th century and includes a heavy industry center built in

1936-1939 as one of the main Polish projects before World War II. However, the sub-disciplines of the "Quality of Life" RSS often seem to be unrelated, for example, passive houses and oenology.

The presence of a greater number of related industries has proven to have a positive impact on economic growth in Spain, the Netherlands, and Italy, although, at the same time, unrelated diversity in some cases has reduced economic growth (Boschma & Innamarino, 2009). Simonen, Svento, and Juutinen (2014) noted that in order to obtain strong growth, the regions should strive to have a highly diversified structure based on the same technology, i.e. smart specialization. Small regions may have problems with achieving such a structure. Highly diversified or specialized regions that were analyzed in Finland had lower growth rates than regions with 2–3 strong high-tech industries and a few smaller ones. Therefore, whilst smart specialization is important, it does not mean too narrow a specialization or too strong a diversification.

Pylak and Kogler (2019) did not notice the role of unrelated diversity in income growth, especially in less developed regions, although related diversity was important. Unrelated diversity is, however, more characteristic of more developed and wealthier regions, which are denser in terms of varied industrial activity. Less developed regions encounter severe obstacles to diversification beyond related industries due to weaker learning abilities.

Pylak and Wojnicka-Sycz (2014) propose that related diversity may be measured by the average share of industries related to a particular industry in terms of buyers and suppliers present in a particular region from the perspective of their share in employment. The related industries for a particular region are determined by Input-Output tables on a domestic level as industries that have a large share in terms of revenues as buyers or suppliers of a particular industry. If the share of employment of industries related to industries of smart specializations is high in a given region, then it could be posited that it is based on a related diversity, meaning the presence of a common knowledge base and complementary capabilities in geographical space – the region of their location. It means, hence, both cognitive and spatial proximity.

For the analysis of the related diversity of RSS areas, an account was taken of the following statistical industries as reflecting the industries of the RSS of the Subcarpathian region:

1) Aviation RSS – other transport equipment (in the Subcarpathian region, mostly aviation).
2) Automotive – motor vehicles, trailers, and semi-trailers.
3) ICT – computer, electronic and optical products, and Telecommunications and IT, and other information services.
4) "Quality of Life":

- Biodegradable plastics – Rubber and plastic products;
- Tourism – Accommodation and food services; Arts, entertainment, recreation, and other service activities;
- Preventive medicine and care for elderly – Human health and social work;
- Passive construction – Construction;
- Renewable energy – Electricity, gas, water supply, sewerage, waste, and remediation services.

Based on the latest Input-Output tables of the OECD for Poland, the most important suppliers of industries connected with the Subcarpathian RSS, in terms of expenditure in US dollars on inputs from a particular industry, were indicated. The most important suppliers were classed as industries with a share of over 1.5% of the total expenditure on inputs of the particular RSS industry, on average, in the years 2010-2015. Subsequently, the share of the most important suppliers in the average employment in the regional economy was analyzed from the Rzeszow Statistical Office data. A high share of vertically related industries in the regional economy suggests that complementary competences and a common knowledge base are present in the region for the bundle of industries of the Subcarpathian RSS areas. As tables 3 and 4 show, the most important suppliers of the RSS industries (to which circa 85% of expenditures on inputs from these industries go) have, on average, a 45% share in regional employment, which means their significant presence in the region. This ranges from 32.1% in the case of Accommodation and catering and 37.1% in the case of Computer, optical and precision products to 51% in the case of Arts, entertainment, recreation and other service activities, and 45% in the case of Construction and 45.9% in the case of Telecommunication.

The most important suppliers of almost all of the RSS industries are the Wholesale and retail trade and the same industry, which means intra-industrial trade. Other business sector services, Transportation, and storage are important suppliers of all of the analyzed core industries of RSS in the Subcarpathian region. This shows the fact that R&D for particular RSS was correctly included in the bundle of industries constituting the Subcarpathian RSS and Transportation, and storage are crucial to the value chain of each industry. In the case of the "Quality of life" RSS, Electricity and Agriculture are important suppliers for all of the five sub-industries of the RSS. In the case of Automotive, Aviation, and ICT in terms of computer production, the same important suppliers are Rubber and plastics products, Manufacture of basic metals and Fabricated metal products, except machinery and equipment. This reflects a similar complementary competences for these industries. In the case of generally understood industries connected with "Quality of Life" RSS some common complementary competences also exist. However, "Quality of

Life" RSS is not so easily defined by statistical industries and rather consists of varied niche areas that often do not seem to be connected with each other.

Those most connected to other RSS industries are Rubber and plastics products, Computer, electronic and optical products and Electricity, gas, water supply, sewerage, waste, and remediation. These are each important suppliers for six other out of ten industries recognized as related to RSS of the Subcarpathian region. Motor vehicles, trailers and semi-trailers, Telecommunications, IT and other information services, Human health and social work and Arts, entertainment, recreation, and other service activities are important suppliers, each of them, for four other industries of RSS of the Subcarpathian region. The least related to other RSS industries, in terms of serving as their important suppliers, are Other transport equipment and Construction (tables 3 and 4). However, this also shows a similar knowledge base for the Subcarpathian RSS areas and their sometimes complementary character.

Table 3. Important suppliers of industries of RSS Aviation, Automotive and ICT and their share in employment in the Subcarpathian region

Suppliers with a share of over 1.5% in total supplies according to I-O tables	**Aviation**	**Automotive**	**ICT**			**Share in employment in Subcarpathian region 2017**
	Other transport equipment	Motor vehicles. trailers, and semi-trailers	Computer. electronic, and optical products	Telecommunications	IT and other information services	
Chemicals and pharmaceutical products	x	1.65	1.67	x	x	1.44
Rubber and plastics products	2.47	5.58	4.96	x	x	3.76
Manufacture of basic metals	6.34	6.03	2.56	x	x	1.05
Fabricated metal products, except machinery and equipment	4.57	9.93	1.91	x	x	4.16
Computer, electronic and optical products	x	x	40.13	4.68	2.36	0.75
Electrical equipment	1.85	1.84	10.14	x	x	0.37
Machinery and equipment n.e.c.	3.35	4.28	1.92	x	x	1.68
Motor vehicles, trailers and semi-trailers	1.65	33.87	x	x	x	2.39
Other transport equipment	38.42	x	x	x	x	2.36

Suppliers with a share of over 1.5% in total supplies according to I-O tables	**Aviation**	**Automotive**	**ICT**			**Share in employment in Subcarpathian region 2017**
	Other transport equipment	Motor vehicles. trailers and semi-trailers	Computer. electronic and optical products	Telecommunications	IT and other information services	
Other manufacturing; repair and installation of machinery and equipment	2.90	x	x	x	x	1.07
Electricity, gas. water supply, sewerage. waste and remediation services	x	1.66	x	3.35	1.88	0.83
Construction	x	x	x	4.51	x	6.15
Wholesale and retail trade; repair of motor vehicles	12.68	15.65	15.89	10.48	10.11	15.02
Transportation and storage	2.26	2.40	2.94	3.00	2.22	3.66
Publishing, audiovisual and broadcasting activities	x	x	x	2.54	2.88	1.36
Telecommunications	x	x	x	14.53	4.29	
IT and other information services	x	x	x	9.55	33.75	
Financial and insurance activities	2.37	x	x	5.00	3.25	1.14
Real estate activities	x	x	x	3.50	2.76	1.18
Other business sector services	6.19	2.88	3.62	24.76	16.13	5.24
Human health and social work	x	x	x	2.20	6.94	9.28
Arts, entertainment, recreation and other service activities	x	x	x	1.68	1.75	1.28
Share of important suppliers in total expenditures (%)	85.05	85.76	85.74	89.79	88.32	86.93
Share of employment in industries strongly related to RSS industry (%)	41.90	39.60	37.13	45.90	39.70	64.17

Source: own calculations on the basis of OECD input-output tables and Rzeszow Statistical Office data.

Table 4. Important suppliers of industries of RSS "Quality of Life" and their share in employment in Subcarpathian region

Suppliers with a share of over 1.5% in total supplies according to I-O tables	**Quality of Life RSS**						**Share in employment in Subcarpathian region 2017**
	Rubber and plastic	Electricity. gas. water supply…	Construction	Accomodation and food services	Human health …	Arts. entertainment…	
Agriculture, forestry and fishing	1.68	18.53	2.33	4.06	2.92	6.53	1.22
Food products, beverages and tobacco	x	x	x	39.84	x	x	2.7
Textiles, wearing apparel, leather and related products	1.98	x	x	x	x	x	0.93
Wood and of products of wood and cork	x	x	2.51	x	x	x	1.64
Paper products and printing	1.82	x		x	x	3.85	0.27
Coke and refined petroleum products	2.58	3.00	2.93	x	x	1.66	lack of data
Chemicals and pharmaceutical products	20.33	x		x	4.98	2.18	1.44
Rubber and plastics products	22.33	x	6.66	x	x		3.76
Other non-metallic mineral products	2.32	x	8.33	x	x	1.66	1.9
Manufacture of basic metals	x	x	5.36	x	x	x	1.05
Fabricated metal products. except machinery and equipment	2.12	x	5.76	x	x	x	4.16
Electrical equipment	x	1.64	1.84	x	x	x	0.37
Other manufacturing; repair and installation of machinery and equipment	x	2.21	x	x	5.09	2.77	1.07
Electricity, gas, water supply, sewerage, waste and remediation services	4.59	15.48	1.69	3.64	9.49	5.73	0.83
Construction	1.67	16.11	31.98		3.24	4.70	6.15
Wholesale and retail trade; repair of motor vehicles	16.08	8.33	9.41	19.05	8.92	12.19	15.02
Transportation and storage	3.65	5.27	2.53	1.83	2.04	3.51	3.66
Accomodation and food services	x	x	x	x	2.53	x	1.49

Suppliers with a share of over 1.5% in total supplies according to I-O tables	**Quality of Life RSS**						**Share in employment in Subcarpathian region 2017**
	Rubber and plastic	Electricity. gas. water supply…	Construction	Accomodation and food services	Human health …	Arts. entertainment…	
Publishing, audiovisual and broadcasting activities	x	x	x	x		2.14	1.36
Telecommunications	x	x	x	x	1.85	3.00	
IT and other information services	x	x	x	x	x	2.27	
Financial and insurance activities	x	2.33	x	2.27	3.01	5.10	1.14
Real estate activities	x	x	x	4.91	4.96	4.00	1.18
Other business sector services	3.94	6.71	4.09	6.56	6.86	10.53	5.24
Human health and social work	x	2.51	x	x	28.36	4.31	9.28
Arts, entertainment, recreation and other service activities	x	x	x	1.67	3.45	8.69	1.28
Share of important suppliers in total expenditures (%)	85.07	82.13	85.42	83.83	87.69	84.80	84.82
Share of employment in industries strongly related to RSS industry (%)	44.58	43.98	45	32.27	41.06	51.04	67.14

Source: own calculations on the basis of OECD input-output tables and Rzeszow Statistical Office data.

The index of RDSS, calculated according to the formula presented in the Data and methods section, shows that the relative pool of complementary competences required by a particular RSS industry in the Subcarpathian region is the highest for Electricity, Telecommunication and IT as well as Accommodation and food services and Computer, electronic and optical products. It means that suppliers from other industries constitute a much larger share of the average employment in the regional economy than the given RSS industry (figure 3). Hence, cognitive spatial proximity may be most easily achieved in the case of these industries. Nonetheless, all of the analyzed industries are characterized by a much higher share in the regional average employment of the sum of their important suppliers than the share of each of these particular industries in the regional employment.

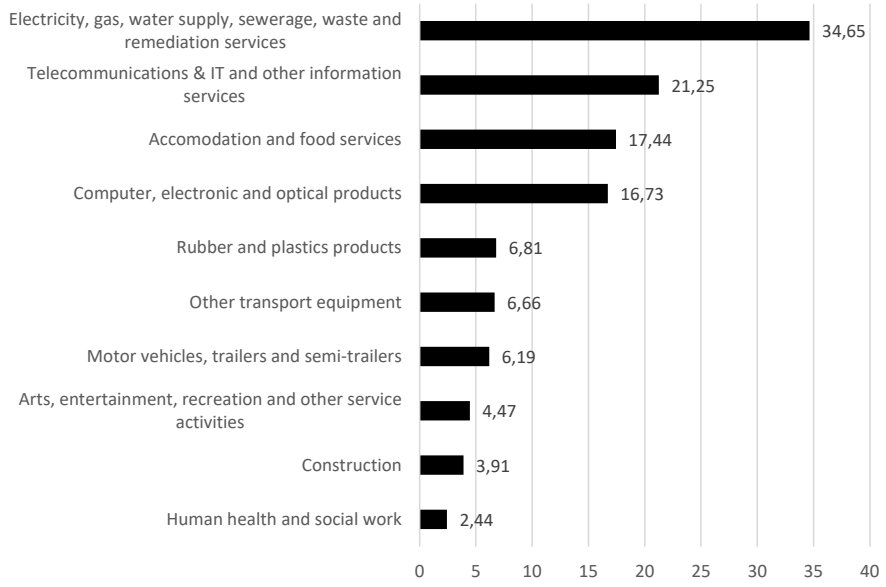

Figure 3. Index of external related diversity of smart specialization industries – cognitive spatial proximity index

Source: own elaboration based on OECD input-output tables and Rzeszow Statistical Office data.

The weakness of this way of calculating related diversity reflecting cognitive proximity is that it is based on general statistical industries and it is impossible to find out about specific sub-disciplines of particular RSS areas, like passive housing, or about the specific competences required for particular niche technologies of smart specializations. For this, direct research might be required, or a detailed analysis of, for example, patent information and data on registered companies on the level of, at least, classes of NACE (statistical classification of economic activities in the EU - Nomenclature statistique des Activités économiques dans la Communauté). Some examples of such analysis in the context of smart specializations or innovative ecosystems are Smoliński, Bondaruk, Pichlak, Trząski, and Uszok (2015) and Corradini and De Propris (2017).

In the CAWI sample, covered by the study of 200 innovative enterprises in the Subcarpathian region, there were 137 entities declaring affiliation to a smart specialization. Most of these entities were identified as active in the field of information technology – 53, automotive industry – 34, electronics – 29, aviation – 28, telecommunications – 25, production of sub-assemblies and materials for automotive industry – 25, passive construction

– 23, production of sub-assemblies and materials for aviation industry – 21, systems for smart homes – 20, energy-saving building materials – 15, renewable energy – 14, within recreational tourism – 13, cognitive tourism – 10, cosmonautics – 8, in the field of biodegradable plastics – 7, production of computers – 6, qualified tourism (e.g. hiking, skiing, cycling, motor, canoeing, sailing) – 6, preventive medicine (preventive: hygiene, dietetics, etc.) – 6. Five respondents indicated the activity in the field of business tourism and organic food. 4 companies described themselves as operating in the field of production of sub-assemblies for computers, ecotourism, agrotourism, and health tourism, and 3 indications concerned culinary tourism and care for the elderly. Two indications were associated with religious and wine tourism, and 1 company operates in the field of natural medicine.

At the same time, 55 out of 137 companies indicated more than one area of specialization, which proves that they are able to operate and function in various areas of smart specializations based on their skills, which means a related diversity of priority areas.

Table 5 shows the number of firms that are active in particular pairs of subdomains of RSS with grey highlighted the statistically significant Chi-square Pearson test calculated on answers of 76 companies covered by the CAWI survey that indicated more than one subarea of RSS as their field of activity. The analysis confirms mainly intra-specialization related diversity as aviation and cosmonautics and aviation-components for aviation, the automotive industry and components for this industry or information technology-electronics-telecommunication-computer production or competences of companies in the field of different types of tourism. However, some inter-specialization, across various RSS areas, related diversity also occurs: as computer components and components for automotive or automotive industry and biodegradable plastics or renewable energy and passive construction and systems for smart homes and electronics and telecommunication. Varied types of tourism are weakly related in terms of competences of RSS companies to passive houses and renewable energy from “Quality of Life” RSS. The latter is rather related to each other and the industrial RSS of the Subcarpathian region. Hence, it may be said that the scope of the “Quality of Life” RSS is too broad and, due to it not being based on related diversity, that it is cognitive proximity. Two distinct subgroups in terms of their knowledge base may be indicated in this RSS area – one based on renewable energy and connected issues as smart and passive houses and energy-saving building materials and, to some extent, biodegradable plastics – and the other subgroup being tourism and health.

Table 5. Number of firms active in particular pairs of the Subcarpathian RSS sub-areas (in grey, statistically significant Chi-square Pearson test at p=0.05)

	Informatics	Electronics	Telecommunication	Computer production	Components for aviation	Automotive industry	Components for automotive industry	Passive construction	Systems for smart homes	Energy-saving building materials	Biodegradable plastics	Cognitive Tourism	Recreational tourism	Ecotourism	Agritourism
Aviation	7	8	5		15	13									
Cosmonautics	3				3										
Informatics		19	17	5	4	5	4	3	12			3			
Electronics			14	3	6	6			9	3					
Telecom				4	4	4			7						
Computer components					3		3	2							
Components for aviation						12			3						
Automotive industry							20	5			3				
Components for automotive								5	5						
Passive construction									11						
Systems for smart homes										9					
Recreational tourism								3				6			
Ecotourism		3						2					2		
Agritourism		3											2	3	
Qualified tourism												4	5		
Health tourism												2	3		
Business tourism												3	3		
Culinary tourism													2		
Renewable energy	5	8	6					6	6					3	3
Eco food													2		

Source: own calculations on the basis of the CAWI research in SPSS.

Geographical proximity in local terms of the Subcarpathian RSS

Table 6 shows location quotients calculated according to the equations presented in the Data and methods section. The largest number of significant concentrations of entities related to smart specializations, four, are located in the Rzeszów poviat and the city of Rzeszów, three in the city

of Krosno and the Mielec poviat. In the Rzeszów poviat, there are significant concentrations of industrial entities of smart specializations, ICT, as well as other fields besides tourism from the RSS "Quality of life." There are concentrations of ICT entities and industrial smart specializations in Krosno. Rzeszów city is characterized by the concentration of ICT entities and other areas of RSS "Quality of Life" (except for tourism). In the Mielec poviat, there are concentrations of entities from industrial smart specializations and firms of manufacturing industries related to industrial smart specializations (plastic and metal products and metal production).

Table 6. Significant LQ of RSS companies in Subcarpathian poviats and subregions

Poviat	LQ Tourism (REGON)	LQ ICT (Web sites queries - WQ)	LQ Industrial RSS IS (WQ)	LQ Quality of Life RSS except Tourism (WQ)	LQ ICT (REGON)	LQ Industrial RSS (REGON)	LQ Industry connected with industrial RSS (REGON)
Krosno subregion							
bieszczadzki	2.3	x	x	x	x	x	x
jasielski	x	x	x	x	x	x	1.35
krośnieński	x	x	x	x	x	x	1.68
leski	3.65	x	x	x	x	x	x
Krosno	x	2.08	1.62	x	x	1.36	x
Przemysl subregion							
lubaczowski	x	x	x	1.34	x	x	x
przeworski	x	x	x	x	x	x	1.45
Rzeszow subregion							
łańcucki	x	x	x	1.38	x	x	x
Rzeszów	x	2.68	x	1.67	2.06	1.11	x
ropczycko-sędziszowski	x	x	2.04	x	x	x	x
rzeszowski	x	x	2.18	1.51	1.28	1.59	x
Tarnobrzeg subregion							
dębicki	x	x	1.25	x	x	x	1.63
mielecki	x	x	4.4	x	x	4.6	2.16
stalowowolski	x	1.31	x	x	x	x	x
tarnobrzeski	x	x	1.54	x	x	x	x

Source: own elaboration based on Klimczak et al. (2017).

The Sanocki poviat is characterized by the concentration of entities of tourism and industrial RSS (Aviation and Automotive), and the Dębicki poviat

by the concentration of industrial RSS and entities from manufacturing industries related to RSS. In other poviats there are individual concentrations of industries related to RSS:

- Bieszczady and Lesko poviats stand out in terms of tourism;
- Stalowa Wola distinguishes itself in terms of ICT;
- industrial RSS firms' concentrations are in Ropczycko-Sędziszowski and Tarnobrzeg poviats;
- in terms of other areas related to RSS "Quality of Life", apart from tourism, Lubaczów and Łańcut poviats stand out;
- concentrations of manufacturing industries related to RSS are in Jasielski and Krosno poviats.

Poviats for which there is no significant concentration of the RSS entities are: Brzozowski, Jarosławski, Kolbuszowski, Leżajski, Przemyśl, Tarnobrzeg, Niżański, Przemyśl, Przeworsk and Strzyżów (Klimczak et al., 2017).

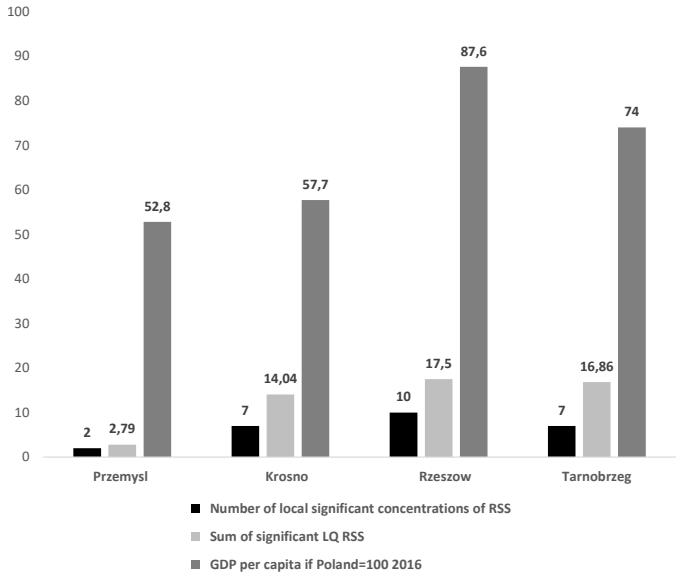

Figure 4. Local concentrations of RSS companies and GDP per capita in Subcarpathian subregions

Source: own elaboration based on Central Statistical Office data and Klimczak et al. (2017).

It means that RSS companies are, in fact, generally clustered in certain poviats in the region and not evenly spread in the whole region, so they are based on spatial proximity in local terms.

An analysis of the location of poviats in the subregions on a NUTS 3 level in the Subcarpathian region shows that the most developed subregions in terms

of GDP per capita are Rzeszow and Tarnobrzeg. They are also characterized by the highest concentrations of RSS companies in terms of the sum of total significant LQs. The least developed subregion, Przemyśl, is also very poor in local concentrations of RSS companies. It may be assumed that spatial proximity of local concentrations of RSS companies enhances their efficiency, which, however, is also conditioned by better overall local conditions for development of RSS enterprises (figure 4). The study by Klimczak et al. (2017) showed that the presence of entities associated with smart specializations in poviats, in particular the industrial RSS (Aviation and Automotive) and ICT, coincided with a higher income of the population, a greater number of job offers and lower unemployment rates in the poviats.

Ecosystems of smart specializations, therefore, generate a development effect for the areas of their location, and in the case of the labor market, also for the neighboring poviats because they affect the unemployment rate in them as well, which was proved in the analysis with the usage of spatial regressions. These effects are based on a higher than the regional average innovative activity of companies of Automotive, Aviation and ICT RSS, according to the Central Statistical Office data and the analysis of the information placed by firms on their websites (Klimczak et al., 2017).

CONCLUSIONS

The tool developed for finding out if RSS areas constitute innovative ecosystems based on social, cognitive and geographical proximity consists of a theoretical approach, methods, and sources of data. The theoretical approach shows three characteristics of innovative ecosystems of RSS that are in line with the concept of innovative ecosystem and definitions of 1) social, 2) cognitive and 3) geographical proximities. These are respectively: 1) links in innovative processes between RSS members as well as the entrepreneurial discovery process, 2) new knowledge combination based on related diversity and regional embeddedness and 3) the presence of local concentrations of RSS firms. The efficiency of innovative ecosystems of RSS shall stimulate innovations based on regional development.

The data used for the analysis of innovative ecosystems of RSS are those gathered in direct research into enterprises, OECD data from Input-output tables, statistical data as well as data collected in website queries and desk research. The used methods are varied and depend on the type of proximity. Social proximity may be assessed by a higher propensity of firms of RSS industries/activities than other regional enterprises to cooperate with other partners in an innovation process or to participate in clusters. It may be

measured with the help of micro econometric methods or by the presence of cluster structures in the areas of RSS. Cognitive proximity may be assessed by external and internal-related diversity of RSS areas. The external-related diversity index measures the presence of complementary competences required by RSS industries in the region of their location. Internal-related diversity will mean that firms of RSS may act in varied subdomains of RSS, which means the RSS areas are coherent in terms of a knowledge base. Geographical proximity may be measured by the presence of local, significant concentrations of companies of RSS in the region. Efficiency of RSS, as innovative ecosystems, may be determined by the analysis of the economic results of counties and the presence of RSS entities in them.

The analysis carried out in Poland proved that cooperation in an innovation process, especially with science, stimulates higher innovativeness and research and development (R&D) activity as well as higher competitiveness of enterprises and a better development of the territories of location of innovative companies. Moreover, the studied firms of smart specializations in the Subcarpathian region in Poland turned out to be more prone to cooperate as they more often than other surveyed firms belonged to clusters. Firms belonging to the Subcarpathian industrial smart specializations also were more prone to carry out R&D activity. It means that smart specializations may be perceived as innovative ecosystems based on networks and innovative activity, as R&D constitutes the first phase of most innovative projects. The analysis conducted in the article also proved that the innovative ecosystems of the Subcarpathian RSS, especially those of Aviation, Automotive and ICT, are based on social proximity reflected in the cooperation in an innovation process, especially in clusters. The Subcarpathian RSS are also based on cognitive proximity, reflected in the related diversity of RSS subareas and spatial proximity based on local concentrations of companies. All of the Subcarpathian RSS are characterized by geographical proximity. However, cognitive proximity is not present in the case of the "Quality of Life" RSS. This RSS embraces not innovative tourism, which is not related in cognitive terms to most of the other subareas of this RSS. Moreover, the location of a higher number of touristic companies in poviats in the Subcarpathian region coincided with lower incomes of people in these poviats (Klimczak et al., 2017). It means that Aviation, Automotive and ICT RSS may be perceived as innovative ecosystems based on social, cognitive and geographical proximity and stimulating the innovation-based development of the region. However, it is not the case for the "Quality of Life" RSS.

Further research could embrace a more detailed analysis of the paths of cooperation, the trajectory of those paths within RSS, how cooperation can build different types of proximity. It would help to find efficient ways

of cooperation leading to new value creation while considering the optimal level of proximity and cooperation that would give the highest value added from the perspective of the regional economy, perceived as a set of varied interconnected actors, not individualistic companies.

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Abstrakt

Artykuł pokazuje, w jaki sposób inteligentne specjalizacje regionalne, które są obecnie najważniejszym narzędziem europejskiej polityki innowacji, mogą być ocenione, czy stanowią innowacyjne ekosystemy oparte na bliskości społecznej, poznawczej i geograficznej. W artykule przedstawiono koncepcje inteligentnych specjalizacji i innowacyjnych ekosystemów, a także koncepcję bliskości i jej aspekty nawiązujące do idei inteligentnych specjalizacji. Koncepcja innowacyjnych ekosystemów jest prezentowana z perspektywy jej powstania i relacji do innych koncepcji i teorii. Współpraca różnych podmiotów w procesie innowacji jest uważana za główną cechę zarówno inteligentnych specjalizacji, jak i innowacyjnych ekosystemów oraz przejaw bliskości społecznej. Powiązana różnorodność obszarów inteligentnej specjalizacji wskazuje na ich bliskość poznawczą, a osadzenie w danym regionie administracyjnym odzwierciedla ich bliskość geograficzną. Wyniki badań przeprowadzonych w województwie podkarpackim pokazują, że firmy w inteligentnych specjalizacjach są bardziej zaangażowane w badania i rozwój oraz innowacje i bardziej podatne na współpracę niż inne firmy oraz że inteligentne specjalizacje mają pozytywny wpływ na rozwój regionalny, co świadczy o ich bliskości społecznej i wskazuje na wydajność ich innowacyjnych ekosystemów. Mierzona jest również powiązana różnorodność podkarpackich regionalnych inteligentnych specjalizacji (RSS), aby pokazać ich bliskość poznawczą. Analiza lokalizacji firm RSS pokazuje, że charakteryzują się one nie tylko regionalną, ale często także lokalną bliskością geograficzną. Zastosowane metody to badanie źródeł wtórnych, kwerenda internetowa, przegląd literatury, analiza danych statystycznych oraz bezpośrednie badania oparte na ankiecie i analiza ekonometryczna wyników ankiety. Artykuł odpowiada na brak badań inteligentnych specjalizacji w kontekście bliskości.

***Słowa kluczowe**: regionalne inteligentne specjalizacje, innowacyjne ekosystemy, bliskość społeczna, bliskość poznawcza, bliskość geograficzna.*

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Conflicts of interest

The authors declare no conflict of interest.

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The role proximity plays in university-driven social networks. The case of the US and EU life-science clusters

Małgorzata Runiewicz-Wardyn[1]

Abstract

Over the last decade, the research in the field of technology and innovation has progressed towards the development of the notion of an 'ecosystem' that lays within the idea that innovation and technological advances stem from collective research efforts and social interactions. The paper delivers new insights on successful university-based innovation ecosystems, by exploring the role of proximities in university-driven social networks. Two research problems are discussed: 1/ the structure and dynamics of university-driven social networks, and 2/ the role of proximities as pre-conditions for stronger social ties and more frequent interactions. The author applies a qualitative interview and direct observation methods on the example of several selected life-science university-based ecosystems in the EU and the US. The study identifies several fundamental relationships: (1) the presence of high physical, cognitive and organizational proximities within university-based ecosystems contributes to social networking and the interchange of knowledge; (2) cognitive and organizational proximities are the primary motives for social collaborations within university-based ecosystems; (3) physical proximity matters most when strong social networks already exist; (4) physical proximity allows ecosystem players to have more informal interactions; (5) cultural and social proximities increase more effective communication, trust and knowledge sharing; (6) social networking within university-based ecosystems may be partially engineered by the brokerage function of intermediary organizations and managers, aiming to narrow organizational, technological and cognitive proximities between ecosystem players. Bridging organizational, cognitive and social distances must be one of the regional innovation policies priorities. Further research must consider increasing technological convergence, shortening technological cycles and globalization processes within the life-science sector.

Keywords: *proximity, social networks, innovation ecosystem, life science, university*

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INTRODUCTION

The Triple Helix (TH) (university–industry–government interlinkages) approach to 'innovation systems' has been widely accepted, especially in the public sector. Recently, however, there has been an attempt to enrich this approach with the new concept of the Quadruple Helix (QH). This is grounded in the idea that innovation is the outcome of an interactive and trans-disciplinary process involving "all stakeholders as active players in jointly creating and experimenting in the new ways of doing things and creating new services and products" (European Commission, 2015). Notably, the QH approach builds on the emerging concept of an 'innovation ecosystem' and widens the TH concept with one more helix – society and societal perspective (McAdam & Debackere, 2018; Carayannis & Campbell, 2012). Consequently, in the QH interactions, knowledge transfer among innovation actors is additionally strengthened by social, trust-based relations among actors or so called "social proximity". The concept of an 'innovation ecosystem' refers to a network of interconnected organizations, connected to a focal firm or a platform, that incorporates both production and user side participants, and creates and appropriates new value through innovation (Autio & Thomas, 2014).

The interest in social networks within the aforementioned innovation ecosystems and their role in sharing knowledge and ideas, as well as stimulating inventions and innovations, have been progressively discussed. Several literature sources mention the concept of a 'university-based innovation ecosystem', which lies within the idea of the QH networks of innovation ecosystem. This refers to a university as an 'attractor' for developing and transferring innovative ideas via the social interactions between students, faculty, companies, intermediary agents, investors, and local authority representatives (Broekel & Boschma, 2016; Ponds, Oort, & Frenken, 2009; Audretsch & Feldman, 2004; Audretsch & Stephan, 1996; Adams, 2002; Anselin et al., 1997; Golejewska, 2018). These studies emphasize the importance of various types of "proximities" for the interactions and exchange of knowledge and innovations. The term proximity refers here to the degree to which one element is close to another. In this sense, proximity facilitates the interaction of actors with complementary pieces of knowledge, skills, and experiences. One popular type of proximity is the geographical dimension of proximity, such as the physical closeness of two or more actors. For example, studies by Fitjar et al. (2016) and Lorenzen (2007) show that geographical proximity between university ecosystem actors provides opportunities for frequent, interpersonal contacts, allowing the reduction of information asymmetries, whereas organizational and cultural proximities have an impact on the evolution of social interactions and social capital formation.

Unfortunately, other types of proximities, including cognitive, social and institutional proximities, have been largely neglected in the subject literature. Moreover, most of the existing subject literature on 'open innovation ecosystems' and QH linkages is grounded in the context of firms. Only a few studies consider social networks in the context of universities. In the recent studies by Schiumi and Carlucci (2018) and Fransman (2018), the authors emphasise the importance of universities (with their specialized knowledge, ideas, and skills) for companies' research and development, as well as the role of social interactions among the ecosystem players in facilitating knowledge flows. At the same, the authors do not provide more evidence on what factors influence such interaction.

After reviewing the existing state-of-the-art literature, the researcher seeks to fill the above mentioned literature gap by bringing new evidence to the role of physical, cognitive, cultural, institutional and technological proximities for university-driven social network formations. The paper aims at contributing to the emerging debate on the role of proximity (different types of proximities) in the research collaboration and social networking within university-based innovation ecosystems. More specifically, it aims to answer what role one or more dimensions of proximity play in strengthening QH interlinkages in the selected university-based ecosystems and, therefore, provide better conditions for the innovation process to take place. The concept of a 'university-based ecosystem' is defined as a complex set of relationships among actors from universities and research institutes, enterprises, and other institutions, that lead to the inter-exchange of technology and information, and stimulate innovations. In order to achieve the research aim, the author takes the example of three different life-science university ecosystems and discusses two major research problems: 1/ the structure of the analyzed university-driven social networks; 2/ the role of proximities – geographical, cognitive, technological, social, institutional and cultural – as pre-conditions for stronger interpersonal ties and more frequent interactions.

The following study provides new insights into the functioning of university-based ecosystems, and the role of social networks within the Triple (Quadruple) Helix model. The results of these insights enable the development of strategies and policy measures that further unlock the innovation potential in the universities and their local communities.

The paper is divided into seven sections. The introduction is followed by a presentation of the theoretical framework of the research study. The types of proximities, social networks ties, and their configurations are discussed here. Next, three sections discuss the technological convergence and research collaboration within the life-science sector as well as the role of university-based ecosystems in such collaboration. Finally, the fifth section

discusses the author`s qualitative research findings. The paper ends with the research conclusions and implication for the further studies.

LITERATURE REVIEW

The theoretical concept behind the university-driven social networks originates from the theory of the innovation ecosystem and the TH theory. QH is not a very well established and widely used concept in innovation research and in innovation policy. Three elements, which are important for the following research, are common to both analytical models (TH and QH). The first is the institutional element, covering actors from university, industry and government sectors. The second is the relational element, involving the relationships between all the mentioned actors, which include collaboration, moderation, leadership, substitution and networking. The third is the functional element, described as processes taking place in what Etzkowitz (2008) calls 'Knowledge, Innovation and Consensus Spaces".

Furthermore, over the last two decades a significant body of Triple (Quadruple) Helix theoretical and empirical research has been developed along two main complementary perspectives: a (neo)institutional one and a (neo)evolutionary one. The first one examines various Triple (Quadruple) Helix configurations and induces mechanisms in national and regional contexts (e.g. Etzkowitz, Mello & Almeida, 2005; Saad & Zawdie, 2011; González-López, 2014). The second one looks at university, industry and government as co-evolving sub-sets of social systems that interact through market selections, innovative dynamics, network controls, and communicate through specific codes (Etzkowitz & Leydesdorff, 1995).

The enhanced role of the university in the local innovation ecosystems arises from several specific developments in the subject literature. Firstly, the founder of the Triple Helix model, Etzkowitz (2003), has dedicated the university the 'third mission' – involvement in socio-economic development, next to the traditional academic missions of teaching and research. This, on the other hand, explains the stronger government interest in policies strengthening the links between universities, local community and the rest of society. Thus, universities and their social environments are the key players in the technological, social and economic development of regions. They serve as intermediaries between scientific knowledge and markets, and in such way promote the diffusion of innovations and foster competitiveness (see the works of Huggins et al., 2019; Johnston & Huggins, 2017; Kim, 2013; Hughes & Kitson, 2012; Garnsey & Heffernan, 2010; Chapple et al., 2005; Feldman, 1999; Kenney, 2000). What is more, universities, unlike industries, are

characterized by open knowledge creation and dissemination environments, whereas companies limit the access to their produced knowledge. As a result, universities and their ecosystems are considered a natural environment for local knowledge spillovers. The term 'ecosystem' alludes here to the biological sense of the ecosystem. One could find several different types of ecosystem in the subject literature: business ecosystem, innovation ecosystem, technology ecosystem, entrepreneurial ecosystem, etc. The heterogeneity of participants of the ecosystem models is of particular importance and difficulty when considering ecosystem boundaries. Indeed, ecosystems are dynamic communities who share complementary technologies and skills. The content of the social ties (both formal and informal) between actors within the ecosystems is different depending on the types of actors involved and the exchange of information and knowledge between them. As already stated before, this paper studies what role proximity has on social networks formation within university-based innovation ecosystems. Proximity does not create innovation, but only serves as an enabling factor for it to happen. As stated by Boschma (2005), there are several types of proximities facilitating these social ties and interactions, as well as an exchange of knowledge and information within an ecosystem, such as a geographical, cognitive and technological, social, cultural, organizational, and institutional one. The following section discusses each type of proximity in more details.

Geographical proximity

The geographical proximity appears as a distinctive element that leads to a clustering effect, especially useful for the transfer of tacit knowledge (Audretsch & Stephan, 1996). The increasing role of geographical proximity in shaping economic and social interactions (labor mobility, inter-firm linkages, etc.), knowledge spillovers, and innovative propensity, has triggered the "new" economic geography literature. As Glaeser et al. (1992, p. 1126) observe, "intellectual breakthroughs must cross hallways and streets more easily than oceans and continents". Thus, knowledge spreads more rapidly in agglomerated urban areas and in close proximity to major universities. The role of university collaboration networks in geographically mediated knowledge spillovers has been emphasized and evidenced by a number of studies conducted by Anselin et al. (1997), Bania et al. (1993), Baptista (2001), Adams (2002), Trajtenberg et al. (1997), and Ponds, Oort, and Frenken (2009). Interactive, huge, and diverse social capital makes large agglomeration regions with proximity to academic institutions ideal locations for social networking events and knowledge exchange.

Cognitive and technological proximities

A relatively small number of researchers have investigated the role of cognitive proximities and technological relatedness in the knowledge spillovers. Some names include the works of Petruzzelli (2011), Nooteboom (2000), Nahapiet and Ghoshal (1998), Brockhoff and Teichert (1995). In their findings, cognitive proximity is manifested by the homogeneity of competencies, capabilities and skills as well as the homogeneity of knowledge bases (Nooteboom, 2000, p. 3-11). The first level of homogeneity refers to cognitive similarity between individuals: communication codes, written specific technical language, common professional or scientific backgrounds. Whereas the second level of homogeneity refers to the cognitive similarity between independent organizations (in their knowledge bases, capabilities, competences, and experiences). Having an overlapping knowledge base and a shared technical vocabulary enhances the actors' ability to communicate and exchange information (Nahapiet & Ghoshal, 1998). The existence of a shared language and codes leads to the creation of social capital – as Adler and Kwon (2000) put it, "social capital is unlikely to arise among people who do not understand each other" (p. 99). In relation to partners' technological relatedness, Petruzzelli (2011) suggests that in order to increase innovative performance, a certain threshold of similar technological competencies between partners is required. However, too much similarity may in turn have a detrimental effect on the actors' innovative performance since the development of valuable innovations may require dissimilar but also complementary sources of knowledge.

Social proximity

This concept of "social proximity" originates from the literature on embeddedness. It claims that economic behaviour is heavily embedded in social relations, in which behavioural factors such as trust, openness, professionalism, complementarity and transparency are of key importance. The trustful relations among actors, driven by friendships or common experiences, encourage further development of new networks and the exchange of tacit-knowledge between related actors (Maskell & Mallberg, 1999; Ziemiański, 2018). Based on her study results, Feldman (1999) argues that decisions of the faculty members to start a company are socially conditioned, e.g. "efforts by pioneering faculty members to start a company lead other faculty members to found companies as well". It is in fact defined in terms of "socially embedded relations between agents at the micro-level" (Boschma, 2005). Therefore, common friendships and experiences among actors guarantee trust-based relations among actors and thus it strengthens

social proximity. These trust-based relationships also help build an open attitude of "communicative rationality" (Lundvall, 1993), rather than a purely market-oriented narrow communication.

Cultural proximity

Norms are unwritten social and cultural rules for how people should behave in various social relations and contexts. Research show that shared norms and beliefs in networks and social relations play an important role in the creation of social capital (Adler & Kwon, 2000). Furthermore, Nahapiet and Ghoshal (1998) state that norms represent a degree of consensus in a social system and that 'norms of cooperation' may influence the creation of social capital. These norms have influence on people's attitudes and motivations towards social interactions and social exchange, which, on the other hand, affect the social capital embedded within a network. Culture affects how people perceive and interpret their environment. The latter implies that individuals sharing a common language and culture are more likely to perceive the social interactions and exchanges in similar ways. For example, a culture of shared trust and similar habits can make knowledge transfer easier and people more willing to exchange information.

Institutional proximity

Institutional proximity refers to the interaction among actors from various institutions within the Triple Helix spheres. Much of the Triple (Quadruple) Helix literature focuses on the institutional spheres of university, industry and government in a holistic way, without going deeper to the specific actors within each sphere, their institutional identities, objectives and social interaction dynamics. As Jensen and Tragardh (2004) put it, cooperation within the Triple (Quadruple) Helix model is complex, dynamic and ambiguous, thus the institutional architecture of particular Triple (Quadruple) Helix relationship models may differ by sector, e.g. in the case of aerospace the government would occupy a larger role than in life sciences. Furthermore, geographical proximity can facilitate collaboration between the institutions, however, social interactions and trust can smoothen and make these interactions successful.

Organizational proximity

The literature on the organizational dimension of proximity identifies two levels of its analysis: the inter-organizational and the intra-organizational (Antonelli, 2000). The latter division results from the fact that knowledge

spills over from one to another organization, but also among different units within the same organization. People are simultaneously proximate to everyone else in their organization, as they move about the organization. The latter facilitates interaction both intentional and accidental. The inter-organizational proximity can be further distinguished from the low (loosely coupled) networks and weak ties between autonomous organization, to the highly networked, such as ownership and wholly-owned subsidiaries. In terms of the intra-organizational level, strong ties among different units define high organizational proximity, whereas weak ties correspond to a low proximity. Yet, in order to understand further the role of organizational proximity, different dimensions of organizational distance must be considered, each of which affect communication, friendships and social networking (Monge et al., 1985).

Social network ties and configurations

Granovetter (1973) distinguishes between strong and weak ties and states that the strength of a social tie is defined by a combination of the time invested, the emotional intensity, the intimacy or mutual confiding between the actors. In other words, ties with a higher degree of emotional involvement, are more important in the discovery of a business opportunity and weak ties become more important when exploiting these opportunities. Furthermore, Coleman (1988) argues that networks with a closed structure are better at facilitating social capital, as demonstrated in Figure 1 (a), than social networks characterized by an open structure, which is illustrated by Figure 1 (b).

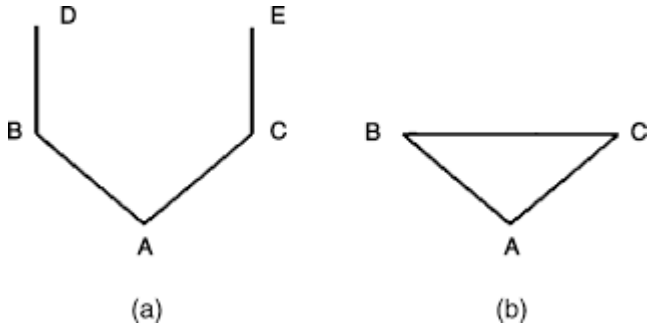

Figure 1. Social network without and with "closure"
Source: Coleman (1988).

Burt (1992), who introduced the concept of structural hole in networks, argues, on the contrary, that low density and connectivity are the most beneficial features of a social network. Structural holes mean that an individual has persons in his or her network that do not know each other and is defined as "a relationship of non-redundancy between two contacts", which is illustrated by the hole between contacts in a network that do not have any relationship to each other. In this way, that person is more likely to have access to so-called non-redundant information, i.e. information that is fresher and unique. Furthermore, Coleman (1988) argues that most social capital networks with closure create larger social capital while Burt (1992), on the other hand, argues that structural holes, i.e. without closure are the most beneficial network configuration in this study. In the start-up phase, an entrepreneur might need both of these models of networks. First, a closed network could provide trust and emotional support, which might be very important when deciding whether to exploit a research or business idea. Second, structural holes might be important in order to create a competitive new venture.

University-driven social networks

In university-based ecosystems, a network of formal relationships among organizations and their actors merges with the personal network(s) that every individual has in the ecosystem. Feldman (1999) in her studies demonstrates that, for example, the decisions of "academics to start a business were socially conditioned". This suggests that physical proximity might not be enough to create the 'contagion effect' for the local university-based ecosystem players and the occasions for learning and knowledge exchange seem to be facilitated by a high level of embeddedness of their social relations with other actors. This is in contrary to Boschma (2005), who has evidenced that social networks are location specific, suggesting that knowledge spillovers are geographically localized as well. Furthermore, the seminal study by Powell et al. (1996) on social network structures and innovation in the life-science sector found that the nature of previous ties was an indicator of positional strength in these networks. Similarly, Burt (1992) argues that structural holes in the form of the connection gaps within networks are a matter of the relations existing between actors, rather than the 'physical' attributes of actors. Notwithstanding, studies by Gordon and McCann (2000), point out the risk of "too much social proximity", which means that people only relate to those with whom they are socially proximate. Nonetheless, a university-based ecosystem can provide opportunities and mechanisms that help contrast this possibility. Unfortunately, there are few studies that have applied the social network concept in an empirical manner with regard to examining links

between universities, industry, local authorities and other related institutions within the local life-science ecosystem (Vonortas, 2009; Tortoriello, 2015; Kim et al., 2018). The following paper is one of the few attempts to contribute to the above-mentioned discussion on the role of physical, social and other types of proximities in the formation of university-driven social networks.

Technological convergence and collaboration within the life-science sector

Based on the theory of the innovation life cycle, the process of technological change in the life-science industry represents technological evolutions in the biopharmaceutical industry, as a whole. The life-science industry, including biotechnology, is a relatively young branch of bioscience, developed by the biopharmaceutical industry in the late 2000s. The innovation process shows that there is not one S-curve but a succession of S-curves from organic chemistry/pharmacology to biochemistry and molecular biology (Figure 2). It can be seen that the waves of molecular biology overlap the waves of biochemistry and are about to leap upwards. Currently, scientists and researchers are attempting to exploit basic molecular research to identify new drugs, the production of which is based on recent advances in genomics technology. Scientific breakthroughs such as genetic engineering, the ability to create monoclonal antibodies, and the mapping of the human genome have opened up new areas of research, and the pace of discovery in basic biomedical science has accelerated dramatically over the past few decades. These scientific trends, along with the dynamic growth of biopharmaceutical industry, require a convergent and a multi-disciplinary approach (applying a mix of knowledge from the biological sciences, chemical engineering, bioprocess engineering, information technology, and biorobotics) to produce new technological discoveries. The latter, on the other hand, brings the actors of the university ecosystems closer.

Furthermore, increasing competition drives the specialization and increases the role of business alliances and partnerships in research and innovation. The research results provided by Evald et al. (2006) emphasize the importance of strong social ties at the start-up phase of life-science sector companies as well as bridging the gap between biological and chemical sciences (Figure 2), which further accelerate the dynamics in life science. Furthermore, close collaboration is also important in the development of genomics technologies that requires massive amounts of information to be collected and analyzed, whereas the characterization of genes requires a means to manage, store and process enormous databases of biological information (bioinformatics).

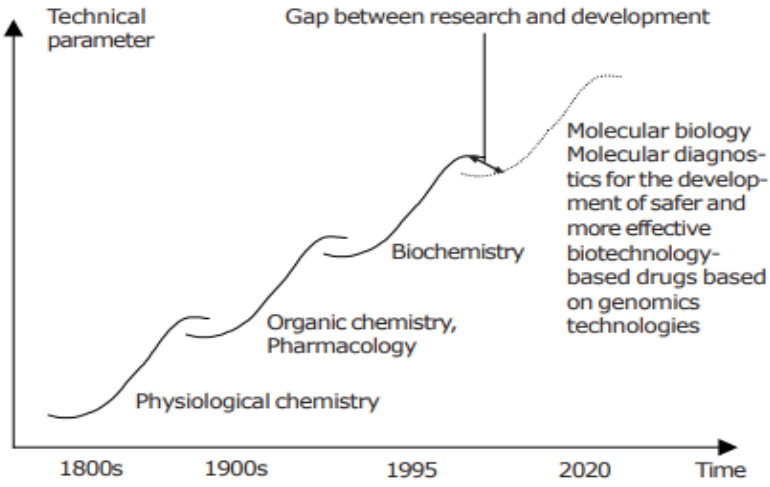

Figure 2. Technological change and technological convergence in the life-science industry

Source: own elaboration based on Utterback&Abernathy (1975), and Fisher&Pry (1971).

In sum, the technological convergence in life science, including the increasing role of bioinformatics, signifies the importance of the close integration of research efforts and social collaboration among the Triple Helix actors (pharmaceutical firms, intermediary institutions, hospitals, various university departments, etc.) of university-based ecosystems.

RESEARCH METHODS

In order to understand the role of proximity in university-driven social networks the author applied both quantitative and qualitative research methods. The qualitative research and the direct observations in the selected life-science university-based ecosystems in the European Union (EU) and the United States (US) were conducted in Copenhagen (Denmark), Lund (Sweden), Cambridge (UK) and the Bay Area (Palo Alto, San Jose, Fremont) (US) in July and August 2018. The 'interview' technique was applied in order to collect in-depth content. The broad goal of the interviews was to gain knowledge and insights on how a university-based ecosystem fosters research collaboration and innovations, as well as to determine the role proximity plays in social-driven networks formation within university-based innovation ecosystems. To proceed with this assignment, the researcher, firstly, identified a relevant common base to analyze and compare among the three life-science cluster

ecosystems and, secondly, discussed the role of different types of proximities in the social-related activities of ecosystems` actors. This method allowed a better understanding of the complex nature of university-based innovation ecosystems and the process of social networking within it. The questionnaire contained mixed questions (open and closed) and was composed of four parts: (1) the mission, structure and types of social networks; (2) the methods of networking and intensity of interactions; (3) the role of different types of proximities in social networking; (4) the impact of social networks on R&D collaboration and innovative performance.

The author conducted 47 interviews with the Heads and Deans of departments, the Technology Transfer Offices (TTO), related educational institutions and companies in the following life-science cluster ecosystems: Bay Area (Stanford University, Stanford Medical School and smaller local colleges: Ohlone College and Solano College), Medicon Valley (Copenhagen University, Lund University), Cambridge (Cambridge University, Cambridge Medical School, Trinity College). The number of interviews and average time per interview in each life-science cluster ecosystem is indicated in Table 1.

Table 1. Number of interviews and average time per interview

UE*	Bay Area	Medicon Valley	Cambridge
Number of interviewees	22	12	13
Total time of interviews	10 hours 33 minutes	5 hours 30 minutes	6 hours
Average time of interviews	32 minutes	44 minutes	35 minutes

Note: *UE university-based ecosystem.
*UE university-based ecosystem.

The list of all interviewed organizations is enclosed at the end of the paper. In order to analyze the evidence gathered, a multistep thematic content approach was applied. The researcher transcribed the interviews to gain preliminary results, and then looked for common and different patterns for all the analyzed ecosystems. Once common themes began to emerge, the researcher cross-referenced them with the existing literature.

EMPIRICAL ANALYSIS

The drivers, structure and role of proximities in university-driven social networks depends on the stage of maturity, degree of internationalization and research excellence of the particular university ecosystem. All analyzed university ecosystems – Cambridge in the UK, Bay Area in the US, and Medicon Valley in the EU – have their own internal technological and social dynamics. Considering the intensity and scale of technology transfer activities (patents, start-ups, collaboration agreements and innovation-technology disclosers), two major types of clusters emerge – the world-class cluster and a mature cluster (Christensen et al., 2012). According to the European Cluster Observatory 2016 and the latest ranking by the Genetic Engineering & Biotechnology News (GEN), Medicon Valley is 9th and 10th in the list of top biopharmaceutical clusters in the EU. This is surpassed by the Golden Triangle of Cambridge–Oxford–London, which (along with the US Bay Area life-science cluster) is now considered as a world-class leading biotechnology and life-science cluster. Table 2 presents a comparison of the three university-based innovation ecosystems considering their major universities rank, research excellence, human capital, internationalization and overall academic reputation.

The UK-based, Cambridge University ecosystem is one of the oldest and most successful ecosystems in the world, focused around one of the top academic and research institutions in the life-science sector. As after QS 2018 World University Ranking in Life Sciences, Cambridge University stays high in the expert opinions regarding teaching and research quality, number of citations per faculty and employer reputation (Table 2). It has a high market share of key innovations, top worldwide scientists, including Nobel Prize winners.

Similarly, the Bay Area life-science ecosystem has evolved around world-class universities, such as Stanford University and University of California in Berkeley, which offer high-skilled talents and a very entrepreneurial and innovative culture. Stanford University has high teaching and research quality, which is also depicted in a high perception of students of teaching quality, high teacher/student ratios and valuable education for the worldwide employment market. Both Cambridge and Stanford Universities rank high in terms of attracting faculty and students from across the world, providing a multinational and diverse environment, facilitating exchange of best practices and beliefs. In fact, since the creation of Stanford University and other local universities in the Bay Area, the cluster has taken the lead in the establishment of university–industry collaborations, resulting in cutting-edge developments and inventions with a markedly practical application, which in turn, attracts more talent, firms, and investments (Table 2).

Table 2. Levels of maturity, internationalization and excellence in Cambridge, Bay Area and Medicon Valley life-science ecosystems

Major universities	Cambridge University	Stanford University	Copenhagen University	Lund University
	World-class clusters		Mature clusters	
Overall Score (average 2018/2019)	95.6	98.6	63.5	62.1
Academic Reputation	100	100	67.2	67.2
International Students	97.7	70.5	28.0	71.8
Market Share of Key Innovations	significant	significant	growing	growing
Citations per Faculty	77.2	99	28.8	51.2
Employer Reputation	100	100	47.0	52.6
Human capital	worldwide scientists, (Nobel Prize winners)	worldwide scientists, (Nobel Prize winners)	attracting and retaining international talent	attracting and retaining international talent
Faculty Student	100	100	99.9	57.4
International Faculty	99.4	99.8	91.6	89.6
Hosting world events (conferences, workshops, etc.)	major world event location	major world and regional	regional and national reputation is strong	regional and national reputation is strong

Source: own elaboration based on World University Rankings 2019 by life sciences, www.timeshighereducation.com/...university-rankings/

At the same time, Medicon Valley with its two major universities, Lund University and University of Copenhagen, and over 15 smaller life-science institutions – is a relatively younger ecosystem, which nevertheless has a stable generation of spin-offs and startups. The cluster is especially active in the research and studying of the fields of diabetes and neuroscientific research. Both universities are actively involved in attracting international faculty and students, with Lund University being more popular and thus more advanced in these efforts. In comparison to Cambridge University and Stanford University, Copenhagen and Lund universities have much lower feedback from employers mentioning university education as a driver of competence and innovativeness among graduates (Employer Reputation). Moreover, the two leading Medicon Valley universities stand lower in terms of the total number of citations received by all papers produced across a five-year period by their faculty members (Citations per Faculty), and, consequently, a smaller share of key innovations globally. Finally, Cambridge and Stanford Universities are

more often hosting worldwide events (conferences, workshops, etc.), whereas Medicon Valley has a strong regional and national reputation for such events.

Considering the importance of universities in spatial, social, cultural and technologically mediated knowledge spillovers, this section discusses the interview survey findings on the role university-based innovation ecosystems play in the dissemination of scientific and technological knowledge via formal and informal social networks. Moreover, in university-based innovation ecosystems, formal relationships among organizations and their actors merge with personal networks. As Krugman (1991) points outs "knowledge flows are invisible". Thus, identification of the boundaries of knowledge flows within a particular personal network seems to be even more challenging. Therefore, the true value added of the following study resides in tracking the role of interactions at the human level not only at the organizational one.

The section below contains a summary of the most important questionnaire findings on the role each type of proximities played in each ecosystem (some original statements of the respondents are written in a cursive format). The significance of each type of proximities for social-driven networking activities as a percentage share of the total responses is presented in Table 3.

Geographical proximity

"Close physical (walking) distance to both academic spin-offs and mature companies operating within the analyzed life-science" university-based innovation ecosystems, was mentioned as a very important driver of potential innovations by all the interviewed respondents (regardless of their work position). This is especially advantageous in terms of the "access to the latest knowledge spillovers via job mobility and organization of different academic, scientific events and research collaboration". More importantly, the role of physical interactions was placed above ICT and social media technologies of communications. Furthermore, Stanford University ecosystem representatives (university faculty and business managers) considered physical proximity as equally important for both formal and informal social networks. In this context, the interviewees from the Stanford and Cambridge University ecosystems emphasized the importance of "social infrastructure – sport centers, clubs, bars and coffees – that create opportunities for informal interactions". "Having a brief chat over a cup of tea or coffee" was an especially popular attitude for the respondents of the Cambridge University ecosystem. This is in contrast to the Copenhagen and Lund Universities life-science cluster representatives, who found "geographical proximity being less significant for the informal interactions". The latter confirms that

geographical proximity alone is not sufficient to explain the process of how innovations happen within the ecosystems.

Table 3. Significance of each type of proximities for social-driven networking activities (in %)

Type of proximities		Cambridge	Bay Area	Medicon Valley
Geographical	yes	100	100	80
	no	-	-	20
Social	yes	60	100	68
	no	5	-	-
Organizational	yes	85	92	80
	no	-	-	-
Cognitive/ Technological	yes	96	75	82
	no	-	-	-
Institutional	yes	65	70	62
	no	-	-	-
Cultural	yes	32	46	65
	no	-	-	-

Source: own elaboration ("yes"-significant; "no"-not significant).

Social proximity

In terms of social proximity, the business-related respondents in the Bay Area pointed out that "social networking starts in the search of ideas but intensifies when selling technology or upgrading R&D ideas" (closer to the maturity stage of their technologies). Yet, since the early or so called "idea search" stage is very often filled with certain precautions, they had also demonstrated the preoccupation to "do not say too much". In terms of academia, Cambridge University faculty emphasized the importance of "social relations and networking skills", however they also pointed out the potential problem of "putting too big a pressure on scientists to attend social events, as well as bridging and bonding efforts". As it was put by one faculty member "this may infringe the privacy and risk of someone scooping one`s ideas". In a similar way, digital forms of social networking, "can facilitate communication but can limit one`s privacy as it leaves traces".

Moreover, all the respondents acknowledged the common behavioral components such as "trust, professionalism and openness as key for the social networks creation and connections to relevant stakeholders". However, the Bay Area representatives were driven by a greater level of trust and openness. The latter was more often strengthened via non-physical networks, such as

virtual platforms, e.g. alumni social media: Facebook, LinkedIn, e.g. faculty members often had their class Facebook group.

Organizational proximity

The primary motives for partners to start talking about research or academic collaborations were found in their cognitive and organizational proximities. Several respondents in the Bay Area mentioned social networking events in the field of life science, organized by their own company or intermediaries, as "strengthening their intra- and inter-organizational networks and thus organizational proximity". They also admitted that "informal social networking events stimulated inter-organizational knowledge sharing as well as improved their competences, capabilities and resources". Organizational proximity further strengthened the social networks between the Bay Area university department representatives. The latter occurred via naturally emerging formal and non-formal problem groups. Solano and Ohlone Colleges had platform groups focusing on education and career support for teachers in the field of STEM (science, technology, engineering and mathematics). The platform group takes their private initiatives to "meet informally at an academic researcher`s home in order to further exchange ideas and experiences in training teachers".

Furthermore, job mobility was mentioned as an "important process of bridging and networking between the various organizations". Researchers in the Bay Area mentioned that staying with one organization for around 4–5 years was an optimal period for successful career and professional network development. This contrasted with the respondents from the Cambridge and Medicon Valley ecosystems, who demonstrated poor job mobility and preferred long-term or undefined work contracts. Some incentives for job mobility were mentioned by the Medicon Valley respondents. The latter is also because the Danish part of the Medicon Valley has relatively higher wages and greater job opportunities than the Swedish part. Furthermore, the respondents from the Medicon Valley emphasized that there is "no need for constant geographical and social proximities in order to build organizational proximity, but rather an active participation in the organized meetings and short visits".

Cognitive and technological proximities

As the survey outcome shows, distance in terms of a knowledge base is both an enabler and an obstacle for the knowledge and innovative networking activities among the mentioned respondents. All the business respondents emphasized "the important role of local universities and R&D centers as

an incredible opportunity for knowledge spillovers and innovative activity" and that staying within "close proximity to the best universities in the world enabled them to acquire a high competence when dealing with the latest technologies". In this sense, limited competence and poor absorptive capacities of other non-local actors made the successful research interaction harder. This was especially emphasized by both faculty and business respondents from the two European life-science clusters. These respondents found technological proximities to be a "major challenge when expanding innovation-driven social networks with partners from Poland or Hungary". To some (limited) extent the gap created by cognitive and technological distances was bridged by intermediaries (e.g. individual faculty members, TTOs), institutional and cultural proximities.

In general, the respondents agreed with the importance of diversity, heterogeneity, and complementarity in enriching the capabilities and knowledge of actors involved in the innovation processes. Yet, Cambridge and Medicon Valley faculty and business respondents pointed out that "advancing from the same well established knowledge base and knowledge networks creates more opportunities", whereas Bay Area respondents emphasized the "importance of staying open and showing up at different regional and international life-science events is equally important – one never knows where the idea may come from".

Institutional proximity

In the view of 2/3 of respondents in the selected sample "the ongoing technological convergence, enforces close collaboration between representatives of diverse knowledge bases within their local university-based innovation ecosystems". The respondents from Medicon Valley and Bay Area universities admitted that "being institutionally proximate facilitates knowledge transfer and research collaboration". They also pointed out the "important role of TTOs and other intermediary-networking agents and institutions facilitating social networking and collaboration between various actors within their ecosystems". Moreover, once an established network of formal relationships among Triple Helix organizations merges with the informal social networks, the institutional proximity becomes less important. Thus, the respondents agreed that "intermediaries and institutional proximities play an essential role in narrowing social distances". Institutional proximity doesn`t seem to affect knowledge transfer much in the other two university-based innovation ecosystems.

In terms of student–teacher relationship, the Bay Area university-based ecosystem has also a more open and direct attitude in comparison to the other university-based innovation ecosystems. To support this argument, one of the respondents provided an example of "a group of European visiting students at Stanford, who were considering asking a faculty member to organize a meeting with Nobel Prize winners, being afraid that the winners may not respond to their direct request. To their surprise the Nobel Prize winners not only answered but also showed their interest to come and meet them". Another example is the establishment of the Stanford Entrepreneurship Network (SEN) – a working group of faculty and student organizations – offering opportunities to gain entrepreneurial knowledge/ experience via advice, mentoring, and networking opportunities.

Cultural proximity

With regards to cultural proximity, nearly 1/2 of all the respondents emphasized that "shared cultural, religious and linguistic backgrounds are very appreciated but not a precondition for successful social ties and more frequent interactions". However, almost everybody in the three analyzed university-based innovation ecosystems mentioned "openness (in sharing ideas and meeting people) as essential for strong and long-lasting social networks". Moreover, in the view of the interviewed scientists, managers and administrators, such behavioral components as "trust, openness, professionalism and complementarity become key drivers behind the social relationships and knowledge flows within the analyzed ecosystems".

Furthermore, the respondents from the Bay Area mentioned that "cultural proximity, resulting in the same cultural norms, habits and values, enables one to build trust and thus a willingness to exchange information". For example, in the Bay Area, respondents with Polish, Chinese or Hindi cultural roots were involved also in their national-based networks within the American Polish, Chinese, and Hindi migrant communities. In their opinion, their "cultural backgrounds enabled them to establish and facilitate professional scientific and social relationships within their groups (e.g. The Polish Club of Engineers, The US–Poland Science and Technology Symposium, The US–Poland Innovation HUB, etc.). In the case of the Hindi community, the "social networks lead to more intense outsourcing linkages with their peer researchers" in India. Few respondents mentioned any cultural differences as a barrier for building social networks. As one of the respondents remarked, "it takes more effort to reach a bond or open up Chinese researchers having strong cultural backgrounds". On the other hand, the following the

statement was made by another respondent, "the culture of collaboration and openness is secured if there is an alignment of interests". One of the ways to develop openness, collaboration and entrepreneurship among the researchers is to take students summer jobs in different fast food restaurants such as McDonalds, which, as emphasized by one the respondents in the Bay Area, "strengthens their social networking, problem solving and team work skills". In terms of social multimedia, the respondents agreed that it "may ease these interactions". Yet, further research is needed to identify whether cultural values take any precedence over personal characteristics and motives in determining behaviour in the virtual world.

DISCUSSION

The research survey conducted with the representatives of the three university-based innovation ecosystems – Cambridge (UK), Medicon Valley (EU) and Bay Area (US) ecosystems – allowed the identification of differences and similarities in which different proximities effect their social networks structure.

The Cambridge University ecosystem is rooted in a mature, world-class cluster in life sciences. It featured by more closed social networks with hierarchical structures. Moreover, the intensity of networks somewhat circulates around more powerful or higher status individuals – Deans and Heads of Departments – interconnecting the other actors in the ecosystem as well as holding control over the information that originates from other networking groups. This way, the closed hierarchical network structure (in the spirit of Coleman, 1988) provides the ecosystem actors with greater trust, which might be very important when deciding whether to exploit a research/business idea or not.

Interactions with individuals, which do not originate from a local ecosystem, tend to occur at larger distances. In terms of future social networks, the respondents in the Cambridge ecosystem emphasized the need to further exploit the diversity within the local vertical networks rather than horizontal ones (between other university-based innovation ecosystems). Here, the research study results pointed to the importance of physical, social, and organizational proximities when accessing the complementary knowledge base, feedback and support from the other faculty members within the Cambridge ecosystem.

Medicon Valley is considered to be one of the strongest, mature life-science clusters in Europe. Its development and co-operation in life sciences was given a major boost in 2000, thanks to the European Development Fund,

with the opening of the Öresund Bridge, joining Denmark and Sweden's life-science clusters together into one dense, innovative cluster.

This provides benefits both from a learning perspective and an exploitation of innovation perspective. In the last decade, many new partnerships have been formed by a mix of Danish–Swedish, public–private, academic–industry representatives, as both countries share quite similar cultures and institutions. Nevertheless, the existing differences in culture and language between Denmark and Sweden, affects their differences in social set-ups. The relationships between the researchers and colleagues at the cross-border firm and university levels are based on educational and professional backgrounds rather than personal friendships and territorially contained trust and understanding. As in the view of Granovetter (1973), one could say that social networks in the Medicon Valley are characterized by weaker ties but a greater openness as in the sense of Coleman (1988). For this life-science ecosystem, physical proximity remains a necessary condition for the social proximity to evolve and sustain.

Finally, the high physical, technological, organizational and cultural (in its entrepreneurial spirit) proximities between the life-science ecosystem actors in the Bay Area intensifies their social relations and the interchange of ideas. The Bay Area life-science ecosystem is characterized by a diverse and open culture, in which personal contacts have great value. This creates a model rooted in the open innovation paradigm, collaborative workspaces and horizontal structures. It recombines features of both social network models – a closed one (Coleman, 1988) and a network one rich in structural holes (Burt, 1992). In this way, the life-science ecosystem in the Bay Area is similar to the IT sector in Silicon Valley (even though the locations of both clusters do not entirely overlap, with first being located more in San Francisco and the East Bay, and second in Santa Clara and Sunnyvale). Furthermore, as the study shows, the social networks within the Bay Area actors are characterized by strong social ties and are expanded via both vertical and horizontal integration within the life-science cluster. The latter promotes further firms` specialization in life science while enriching it with new emerging research and commercialization opportunities.

CONCLUSION

Despite different origins and founding models of the three analyzed university-based innovation ecosystems, the study reveals that they display similar patterns of inter- relationships between different types of proximities and social network configurations that sustain regional innovation activity.

All of the levels of proximities have an important role to play in university-based innovation ecosystems. They moderate the nature and dynamics of interactions among ecosystem actors, both via formal and informal relationships. Geographical proximity (the physical distance among actors) allows ecosystem players to have interactions that are more informal and serves as a pre-condition to strengthen social ties. On the other hand, the geographic proximity can really matter when strong social networks already exist. Subsequently, physical proximity enhances and strengthens personal relationships within the existing networks.

Furthermore, the primary motives for partners to start collaborations are to be found in their cognitive and organizational proximities. Thus, in order to strengthen social network ties within the life-science university-based innovation ecosystems, organizational, technological and cognitive proximities within each ecosystem actor must be strengthened. The latter has important policy implications in which governments and local intermediary institutions can promote initiatives narrowing these proximities. The overall research findings showed that the communication dimension of proximity (even though it hasn`t been considered as a separate type of proximity in the survey) is very important. In fact, analyzing the opinions of respondents, it is noticeable that communication and 'social proximity' is mutually reinforcing. Communication, through its wide array of workshops and events, enables socialization, whereas higher social proximity induces communication that is more frequent and the development of closer relationships.

The study identifies several fundamental relationships that determine the role of proximity within the university-driven social networks in the life-science ecosystems: (1) the presence of high physical, technological/ cognitive and organizational proximities within university-based ecosystems contribute to social networking and the interchange of knowledge and ideas; (2) cognitive and organizational proximities are the primary motives for social collaborations within university-based ecosystems; (3) physical proximity matters most when strong social networks already exist; (4) physical proximity allows ecosystem players to have interactions that are more informal; (5) cultural and social proximities (a common language, friendships and entrepreneurial spirit) increase more effective communication, trust and knowledge sharing; (6) social networking within university-based innovation ecosystems may be partially engineered by the brokerage function of intermediary organizations and managers, aiming to narrow organizational, technological and cognitive proximities between ecosystem players.

Although the results of the study are somewhat consistent with the findings of other researchers, Boschma's (2005) studies on social networks in a location specific context, as well as Porter's role of clusters in the localized

knowledge spillovers, have a largely exploratory nature. Future studies would need to adjust the current research findings with the life-science industry`s technological dynamics. This is because the life-science industry goes through technological maturity in some fields and considerable growth in the others. Industries at different phases of their life cycle need different externalities to generate innovations. Therefore, it is important to carry out further tests on the role of different types of proximities in the case of the selected life-science industries specified environments. Apart from the types of proximities analyzed in the study, other factors may affect social ties within the life-science ecosystem, such as local actors absorptive and knowledge transfer capacities, which, on the other hand, may be determined by their talents and previous innovations.

The lack of in-depth consideration of the communication dimension of proximity is considered an important limitation of this study. Future research on the role of proximity within university-based innovation ecosystems must be enriched with communication aspects, which would enable the identification of what types, channels and formats of communication are most effective in bringing different ecosystem actors together and facilitating knowledge transfer between them.

Last, but not least, the increasing technological convergence and overall globalization of the life-science sector, challenges the ways in which the life-science university-based innovation ecosystems operate. Cross-region collaborations and international partnerships became of the key drivers of the life-science university-based innovation ecosystems growth. Further research on the role of proximity in moderating the nature and dynamics of interactions within the life-science university-based innovation ecosystems must consider increasing technological convergence and the overall globalization process within the life-science sector.

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Abstrakt

W ciągu ostatniej dekady badania w dziedzinie technologii i innowacji posunęły się w kierunku rozwoju pojęcia „ekosystemu" innowacji. Takie podejście stało się szczególnie przydatne w zrozumieniu dynamiki związanej ze złożonym procesem inwencji i jego przełożeniem na innowację, która dalej rozprzestrzenia się w społeczeństwie. Koncepcja ekosystemu innowacji opiera się na założeniu, że innowacje i postęp technologiczny nie wynikają z wynalazczych wysiłków jednej osoby, lecz raczej ze wspólnych wysiłków badawczych i interakcji społecznych. Artykuł stanowi wkład w powstającą debatę na temat ekosystemów innowacji poprzez dostarczanie nowych informacji i wiedzy na temat struktury powiązań społecznych w uniwersyteckich ekosystemach innowacji. W szczególności celem artykułu jest zbadanie roli różnych typów bliskości w budowaniu więzi społecznych w uniwersyteckich ekosystemach innowacji na przykładzie sektora nauk przyrodniczych i biotechnologii. Omawiane są dwa główne problemy badawcze: 1) struktura i rodzaj sieci społecznych w otoczeniu wybranych uniwersytów oraz 2) rola bliskości - geograficznej, społecznej, poznawczej, technologicznej, instytucjonalnej i kulturowej - jako czynnika silniejszych więzi społecznych i częstszych interakcji. Autorka stosuje wywiad jakościowy i metody obserwacji bezpośredniej, które pozwalają lepiej zrozumieć złożoną naturę tworzenia się powiązań społecznych w ramach ekosystemu uniwersyteckiego nauk przyrodniczych. Badanie obejmuje kilka wybranych ekosystemów uniwersyteckich nauk przyrodniczych w Unii Europejskiej i Stanach Zjednoczonych. Wyniki wywiadów, analiza dostępnej literatury przedmiotu oraz innych zebranych dowodów empirycznych, umożliwiają opracowanie odpowiednich wniosków oraz implikacji dla polityki i dalszych badań.

Słowa kluczowe: *bliskość, więzi społeczne, ekosystem innowacji, nauki przyrodnicze, uniwersytet*

Biographical note

Prof. Małgorzata Runiewicz-Wardyn graduated from Masters and doctoral studies at Warsaw School of Economics. Since 2004, she has been a research worker and lecturer at the Kozminski University in Warsaw (lectured subjects: Microeconomics, Macroeconomics, International Competitiveness, International Economics, Technology Dynamics and Innovation Policies, Business Economics). Her main scientific and research interests include the factors and measures of international competitiveness of countries and regions; knowledge-based economy; innovation systems; industry clusters; regional innovation policies. She was a Postdoctoral Fellow at Harvard and Berkeley Universities. She is the author of eight monographs and over 40 other scientific publications; coordinator and co-author of six European Commission research projects on e-economy, e-Learning and knowledge economy.

Conflicts of interest

The author declares no conflict of interest.

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