

Relationships Between Geographical and Virtual Proximity in Cluster Organisations

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Anna Lis

Gdansk University of Technology, Faculty of Management and Economics,
ul. Narutowicza 11/12, 80-233 Gdańsk; e-mail anna.lis@pg.edu.pl;
ORCID: 0000-0002-1527-7796

Adrian Lis

Collegium Civitas, plac Defilad 1, XII piętro, 00-901 Warszawa; e-mail: adrian.lis@civitas.edu.pl;
ORCID 0000-0003-4801-704X

Abstract

The purpose of the paper is to explore the relationships between geographical and virtual proximity in cluster organisations (COs). The authors report the findings from a qualitative study conducted in four COs in Poland. The basic technique for collecting and analysing data was an in-depth individual interview and qualitative content analysis. The research has shown that the relationships between geographical and virtual proximity depend on the cooperation level and the role of the CO. The findings presents a broader view on cluster cooperation as a phenomenon based on geographical proximity which facilitates personal interactions, but needs to be supported by various ICT tools.

Keywords

cluster, cluster organisation, proximity, geographical proximity, virtual proximity, cooperation

Relacje między bliskością geograficzną i wirtualną w organizacjach klastrowych

Streszczenie

Celem artykułu jest zbadanie relacji między bliskością geograficzną i wirtualną w organizacjach klastrowych. Autorzy przedstawiają wyniki badań jakościowych przeprowadzonych w czterech organizacjach klastrowych działających w Polsce. Podstawowymi technikami zbierania i analizowania danych był pogłębiony wywiad indywidualny oraz jakościowa analiza treści. Badania pokazały, że relacje między bliskością geograficzną i wirtualną zależą od poziomu zaawansowania współpracy i roli organizacji klastrowej. Badania prezentują szersze spojrzenie na współpracę klastrową jako zjawisko bazujące na bliskości geograficznej, ułatwiającej osobiste interakcje, wspierane przez różne narzędzia ICT.

Słowa kluczowe

klastrer, organizacja klastrowa, bliskość, bliskość geograficzna, bliskość wirtualna, współpraca

1. Introduction

For years, there has been a discussion in the literature about the role of common location for the development of cooperation among business entities. On the one hand, the role of geographical proximity in the development of interactions among enterprises is emphasised, the more so as geographical proximity can – based on the overlap mechanism – support the development of other, non-spatial dimensions of proximity. This applies especially to social (e.g. Malmberg and Maskell 2006; Hansen 2015) and cognitive proximity (Boschma 2005; Guerini et al. 2013; Paci /et al. 2014). There is ample evidence that geographical proximity supports the establishment and development of relationships based on trust, especially on individual level (social proximity), and also promotes

collective learning and the flow of tacit knowledge (cognitive proximity) which is difficult to transfer over greater distances. On the other hand, more and more authors begin to de-emphasise the role of geographical proximity, all the more so since geographical proximity can be partially or even completely replaced by other dimensions of proximity based on the substitution mechanism. In the era of ICT technologies, this dimension of proximity is becoming increasingly marginalised, while communicative proximity (with particular emphasis on virtual and temporary geographical proximity), which can bring cooperating entities similar benefits as geographical proximity, is gaining importance.

However, there is no convincing evidence of “distance death” in the literature. Representatives of the trend emphasising the importance of geographical proximity for the development of cooperation point out that, despite the ubiquitous globalisation processes, most contacts still involve direct interactions between entities in geographical proximity (Weterings 2006; Boschma and Wal 2007; Suire and Vicente 2009; Hoekman et al. 2010; Boschma et al. 2014). Equally importantly, despite the fact that new communication technologies enable and facilitate building and developing contacts “at a distance”, they have not managed to eliminate (at least so far) the need to strengthen and consolidate relationships through face-to-face meetings, at least temporarily placing two or more entities in geographical proximity (Rallet and Torre 1999). Also, the sharing of tacit knowledge (difficult to achieve based on virtual proximity) can take place thanks to geographical proximity, i.e. during periodic face-to-face meetings of people involved in specific activities.

Due to the lack of clear findings regarding the role of geographical proximity in the development of inter-organisational cooperation, there is still a cognitive gap in this area. This problem is all the more important due to changes in companies caused by the SARS-CoV-2 pandemic. In the current pandemic conditions, the marginalisation of geographical proximity in favour of virtual proximity and the increasing use of ICT is clearly visible.

Taking the above into account, the purpose of this paper is to explore the relationships between geographical and communicative proximity occurring in the form of virtual proximity based on the use of ICTs. These relationships are discussed in terms of three mechanisms of interaction between geographical and communicative proximity, described in the literature: complementarity, substitution and overlap. These three types of relationships are explored in the study within a framework provided by the previously developed original concept of the trajectory of development of cooperative relationships in cluster organisations (COs), which distinguishes four levels of cluster cooperation advancement, as well as three main roles and 12 specific roles cluster organisations can fulfill (Lis 2018; Lis and Lis 2021). The adopted optics of qualitative research (relatively rare in research on geographical proximity) allowed for an in-depth exploration of the analysed area, which in turn translated into a better understanding of the phenomenon of cluster cooperation, especially in the context of selected dimensions of proximity.

The research goes beyond the state-of-the-art knowledge in relation to the concept of industrial clusters and the concept of proximity by exposing a broader view on cluster cooperation based on a common location and network of direct personal contacts, but increasingly supported by a variety of ICT tools. The conducted study indicates that geographical proximity still remains a factor of much greater importance than virtual proximity for fulfilling the roles COs play, and thus for the development of cooperation relationships in the COs. It is worth adding here that the authors were interested in all relatively permanent acts of cooperation taking place among cluster entities (from simple information exchange to advanced business cooperation).

Additionally, the paper focuses on COs, i.e. entities which in the literature are often referred to as bottom-up clusters or cluster initiatives (Sölvell et al. 2003; Lindqvist et al. 2013). Despite the popularity of COs (especially in the EU countries), this is a mostly unexplored area. The vast majority of papers in the literature refer to clusters in geographical or economic terms, and only a few of them address clusters as organisations, presenting experiences especially from countries from Central and Eastern Europe (CEE) (e.g. Pavelkova et al. 2015; Balog 2016; Lis 2019; 2019; Žižka et al. 2018). However, this type of formalised clusters is worth exploring as it is particularly well suited to analysing the relationships occurring between geographical and virtual proximity and the impact of these two types of proximity on the development of inter-organisational cooperation.



The discourse is organised in the following manner. The first section presents a literature review on the role of proximity in the development of cooperation in industrial clusters, with particular emphasis on geographical and communicative proximity, taking into account virtual proximity. The second section provides a detailed methodology description, while the third reports the empirical results. Finally, discussion and conclusions are provided in the final sections.

2. Literature review

Cluster is a concept introduced into the literature by Porter (1998; 2008), although this is not the only concept emphasising the importance of a shared location for the development of cooperation networks. There are many other older and contemporary theories on the links between economic entities operating in geographical proximity and the consequences of these links for economic growth and development (such as industrial district, innovative milieu, regional innovation system or innovation ecosystem). All these theories emphasise the significance of trust as an important determinant of cooperation, and geographical proximity, facilitating the development of relationships.

However, geographical proximity is only one of the dimensions of proximity described in the current literature. Proximity is a complex and multidimensional concept (Boschma 2004; 2005; Jakobsen and Steinmo 2016; Torre 2014). In this paper, the concept of proximity should be understood as the similarity of a specific set of features that two or more organisations have in a specific context (e.g. organisational, cognitive, social, etc.).

The term “proximity” is merely a commonly used term that refers to a set of specific aspects; however, the list of these aspects is not complete or unambiguous. As reported by Klimas (2011), more than 30 different dimensions of proximity can be found to be discussed in the literature. Researchers most often refer to the five dimensions of proximity proposed by Boschma: geographical, cognitive, social, organisational and institutional proximity (Boschma 2004; 2005; Boschma and Frenken 2010; Boschma et al. 2014; Balland et al. 2015).

Nevertheless, a systematic review of the literature shows that geographical proximity is the most frequently studied dimension of proximity; it is also the most difficult to modify, the most basic and the earliest-noticed dimension. It is worth adding that the domination of research on geographical proximity results, *inter alia*, from the fact that research in this area is conducted mainly within economic geography. In turn, in the case of management sciences, cognitive proximity and social proximity arouse much more interest.

The term “geographical proximity” should be understood as the relation of a given entity being located in a specific point of physical space within a small distance (physical or temporal) to other entities significant from a given point of view (Boschma et al., 2014; Boschma 2005; Torre and Rallet 2005; Gilly and Torre 2000). As far as geographical proximity is concerned, relatively to specific assumptions, the physical, spatial, locational, co-locational or functional proximity could be referenced (Klimas 2020). The concept of a cluster strongly reflects the important consequences sharing one place in the physical space has for business entities embedded in a specific area. The topic of geographical proximity is already emphasised in the definition of a cluster – a cluster is defined as a geographical concentration of entities (Porter 1998; 2008). The small distance between the enterprises (but also other common location factors: a cultural community, a common language and a common system of values) fosters informal relationships. In turn, numerous and repeated interactions between cluster partners can turn into lasting, trust-based business relationships. Strongly localised processes create and maintain the competitive advantage of a region and entities operating in this region.

Geographical proximity is also indicated as the source of the privileged position of local enterprises in accessing, creating and disseminating knowledge (Jaffe et al. 1993; Audretsch and Feldman 2004). This issue was also discussed by Boschma who noted that enterprises located near sources of knowledge benefit more than those more distant. The more of these potential sources of knowledge in a given area, the greater the benefits local entities would expect (Boschma 2005). In turn, the shorter the distance between the partners, the lower the cost of sharing knowledge and information, and the more efficient the communication between individual entities (Doloreux 2002). Besides, strengthening the trust between partners of a particular cooperative relationship requires



frequent interactions, and this condition is much easier to meet in a situation of physical proximity. Such interactions located in one area may be additionally reinforced by being anchored in a uniform system of socio-cultural values and norms, known to all participants in the cooperative relationship (Simmie 2003).

An analysis of the most recent literature devoted to geographical proximity indicates, however, that although in most cases of contemporary research and analysis the coexistence of entities in one area was at least one of the factors positively influencing the development of cooperation, geographical proximity was rarely a sufficient condition for the establishment of effective cooperative relationships. For a positive effect of co-localisation, a simultaneous co-occurrence of other factors was necessary, including proximity in dimensions other than just geographical (i.a. Geerts et al. 2018; Davids and Frenken 2018; Boschma et al. 2017; Crescenzi et al. 2017; Drejer and Østergaard 2017; Korbi and Chouki 2017; Mascia et al. 2017; Kuttim 2016). Also the research conducted by Lis (2018) shows that “proximity”, i.e. the factor that has proved to be a noticeable one in the development of cooperation in COs, should not be considered only in its geographical dimension.

This reinforces the argument about the multidimensional nature of proximity and at the same time about the interdependence of all dimensions (Boschma 2005; D'Este et al. 2013) within their mutual interaction (Letaifa and Rabeau 2013). A review of the literature shows that geographical proximity can stimulate other dimensions of proximity, and is often replaced by them (Boschma 2005). According to Cooke (2006), the most important feature of geographical proximity is that it is a means to achieve many, if not all, other types of proximity. Therefore, the process of constructing and strengthening social, organisational, cognitive and institutional proximity that can arise between entities will be significantly complemented by those entities remaining in a spatially close relationship (Boschma 2005). Geographical proximity, although it is not a prerequisite for the establishment of cooperative relationships among economic entities, may support the creation of such relationships in other aspects of proximity – the effect of physical “neighbourhood” will always contribute to the formation of a specific “overlay” between the spatial dimension of proximity and its other dimensions (Malmberg and Maskell 2006). This particular link between geographical proximity and its non-spatial dimensions is very important for the reflections on the role of geographical proximity in the functioning of enterprises.

Hansen distinguished two mechanisms (Hansen 2015) that govern the relationships between the physical dimension of proximity and its other dimensions. The first is substitution (where one dimension substitutes another or others), when non-spatial forms of proximity can replace spatial proximity without losing the quality of an existing cooperative relationship or without reducing the chances of developing relationships that are in the process of forming. Strong links based on the substitution mechanism occur especially between geographical and social proximity. Social proximity established among partners can act as a neutraliser for the negative factor of physical distance (Guerini et al. 2013). The second mechanism is the overlap mechanism (where one dimension facilitates another or others), when geographical proximity facilitates the emergence and development of non-spatial forms of proximity. The third mechanism, which was not identified by Hansen but occurs even more often than the two mechanisms he lists, is complementarity. It consists in complementing geographical proximity with other dimensions of proximity that occur regardless of geographical proximity, or result from it, based on the overlap mechanism.

There are also approaches to geographical proximity that relegate it into the background or almost completely deprive it of importance in the process of creating and developing inter-organisational cooperation. More recently, there have been studies indicating that a small physical distance between entities may not affect their cooperation (Fontes and Sousa 2016; Guan and Yan 2016; Scherrer and Deflorin 2017; Ayoubi et al. 2017) or may even inhibit it (Fitjar 2016). The merit of this argument is growing stronger especially in the context of the development of ICT technologies, which partially remove the physical distance barrier.

This point of view reflects the shift of the focus of research interest towards communicative proximity, a concept that does not even appear amongst the identified types of proximity by Boschma, but is increasingly emphasised in the literature, due to the perceived relationship between proximity and inter-organisational communication (Romijn and Albu 2002; Torre 2014, Klimas 2020). Communicative proximity encompasses three main components of communication. The first



component – relational proximity referring to both indirect and direct communication (Eklinder-Frick et al. 2011) – relates to inter-organisational (organisation-organisation) relationships dedicated to meeting business targets, compliance with procedures and executing operations fundamental for those collaboration-oriented interactions. It is important to emphasise that the strength of inter-organisational contacts does not include informal and interpersonal contacts classified as social proximity (Eklinder-Frick et al. 2011). The second component includes virtual proximity (electronic proximity) consisting in indirect communication at distance facilitated by ICT (Zeller 2004). Virtual proximity is determined by the frequency and intensity of communication, the involvement of communicating parties as well as Internet access (Klimas 2020). The third component is temporary geographical proximity consisting in direct, face-to-face but time-bound contact (Torre 2008; 2014; Boschma et al. 2014; Knobens and Oerlemans 2006).

The need to acknowledge the communicative dimension of proximity stems also from the fact that it could be perceived as complementary to, substitutional for (Morgan 2004) or moderating (D'Este et al. 2013) geographical proximity (Klimas 2020). This applies especially to virtual proximity, which is becoming equivalent to or even more significant than geographical proximity due to the growing mobility, development of ICT technologies, accelerating Internet speed and other effects of the global digital revolution.

3. Research methods

The paper reports the results of an explorative, qualitative study aimed at analysing the relationships between geographical and virtual proximity, which can be understood as one form of communicative proximity. This is a part of a larger research project whose goal was to identify the levels of advancement in the cooperation among enterprises in selected COs in Poland (Lis 2018). The questions the current study attempted to answer were as follows:

- What is the significance of geographical proximity (based on face-to-face contacts) and virtual proximity (based on the use of ICTs) in fulfilling the roles by COs?
- What are the relationships between geographical and virtual proximity in fulfilling the COs' roles? Which mechanisms (i.e. complementarity, substitution and overlap) govern these relationships?

In our study, we were based on the abduction approach (Peirce 1931–1958), which refers to the study of facts and the development of theories which explain these facts (Cunningham 1998), but these explanations are only hypothetical. We discovered the relationships between geographical and virtual proximity as a result of the analysis and interpretation of the collected data, and we used abduction to create the best explanations for our observations. The research process began with empirical research, which allowed first to identify the relevant categories, and then the relationships between them. Finally, our discoveries prompted us to conduct the literature review to use state-of-the-art knowledge as a theoretical background for our findings.

The research was carried out in the first half of 2016 in four purposefully selected cluster organisations in Poland. In the selection of Cos, the extreme cases logic was used to ensure maximum variability and diversity within the research field. The basic factors for the selection of COs for the study were location and industry, size of the CO and its organisational maturity (duration, scope of activity, etc.). Some of these factors were the differentiating criteria (e.g. sector, size), the remainder were the criteria based on similarity (such as location, duration, scope of activity). With the economic sector as the main differentiating criterion, the research was conducted in two COs representing the ICT industry (the Mazovia Cluster ICT, Interizon: the Pomeranian Region ICT Cluster) and two from the metal industry (Metal Cluster of the Lubuskie Province, Metal Working Eastern Cluster). In addition to the economic sector, another important differentiating criterion was the size of the organisation – the studied ICT clusters were much larger (with 200 and 130 members, respectively), while the metal clusters should be assessed as medium-sized (35 and 78 members). All four COs were established at a similar time (in the 2007–2009 periods) and have a regional range.



Table 1. The axial coding

No.	Category	Peculiarities
1	Levels of cooperation	Level I "Integration at the unit level" Level II "Allocation and integration at the process level" Level III "Impact on the environment" Level IV "Creation and integration at the organisational level"
2	General roles	Direct resource supplier (DRS) Broker (BR) Integrator (INT)
3	Specific roles	I.1. Informer I.2. Information exchange platform I.3. Social integrator II.1. Donor II.2. Resource exchange platform II.3. Process integrator III.1. Information tube III.2. Connector with the environment III.3. Lobbyist-visionary IV.1. Mentor IV.2. Common resource creation platform IV.3. Organisation integrator
4	Benefits	Access to information Access to knowledge Networking Development of relationship Increase the quality / reduce costs Impact on the external environment Development of cooperation
5	Dimensions of proximity	Geographical proximity Virtual proximity
6	Mechanisms	Complementarity Substitution Overlap

Source: own elaboration.

The basic techniques of data collection were in-depth individual interviews and document analyses (cluster documents and web resources), which ensured methodological and data triangulations (Maxwell 2005). In total, 35 interviews were conducted (17 in the ICT COs and 18 in the metal COs) with the cluster coordinators and members. The sample was composed of the company owners or top managers as well as individuals chosen to represent the organisation in the CO. The interview questions were divided into the following sections: forms of cooperation in the COs, involvement of the coordinator and members in the COs, creating opportunities and achieving benefits in the COs, and flows of knowledge and information in the COs. The selection of the above thematic blocks resulted from the objectives set out within the larger study.

The data analysis and interpretation were based on content analysis and coding. We used qualitative content analysis (Hsieh and Shannon 2005; Glaser and Strauss 1999) as the main procedure to analyse the interviews. As far as the coding schemes are concerned, each statement was assessed with reference to previously identified themes to arrive at inductively delimited codes from the collected data (Glaser and Strauss 1999). The analysis included three steps, i.e. open, axial and selective coding. At the open coding stage some common themes emerging from the interviews in each CO were identified (for instance, these were: "broker", "access to information", etc.). In the second stage – axial coding – we classified each theme with respect to the six distinguished categories and their characteristics: levels of cooperation, general roles, specific roles, benefits, dimension of proximity and mechanisms (Tab. 1). At the final, selective coding stage, the categories and their characteristics were horizontally grouped to define the mechanisms that occur between geographical and virtual proximity, with reference to the obtained benefits and roles (specific and general) fulfilled by COs at each of the four distinguished levels of cooperation (Tab. 2).

Table 2. The selective coding

Cat. 1. Levels of cooperation	Cat. 2. General roles	Cat. 3. Specific roles	Cat. 4. Benefits	Cat. 5. Dimensions of proximity	Cat. 6. Mechanisms
Level I "Integration at the unit level"	Direct resource supplier (DRS)	I.1. Informer	Access to information	Geographical Virtual	Complementarity Substitution
	Broker (BR)	I.2. Information exchange platform	Access to information Networking	Geographical Virtual	Complementarity Substitution
	Integrator (INT)	I.3. Social integrator	Access to information Development of relationship	Geographical Virtual	
Level II "Allocation and integration at the process level"	Direct resource supplier (DRS)	II.1. Donor	Access to information	Geographical Virtual	Complementarity Substitution
	Broker (BR)	II.2. Resource exchange platform	Access to knowledge Networking	Geographical Virtual	Complementarity Substitution
	Integrator (INT)	II.3. Process integrator	Increase the quality / reduce costs	Geographical Virtual	Complementarity Substitution
Level III "Impact on the environment"	Direct resource supplier (DRS)	III.1. Information tube	Access to information	Geographical Virtual	Complementarity Substitution
	Broker (BR)	III.2. Connector with the environment	Access to knowledge Networking	Geographical Virtual	Complementarity Substitution
	Integrator (INT)	III.3. Lobbyist-visionary	Impact on the external environment	Geographical Virtual	Complementarity
Level IV "Creation and integration at the organisational level"	Direct resource supplier (DRS)	IV.1. Mentor	Access to knowledge	Geographical Virtual	Complementarity
	Broker (BR)	IV.2. Common resource creation platform	Access to knowledge Networking	Geographical Virtual	Complementarity
	Integrator (INT)	IV.3. Organisation integrator	Development of cooperation	Geographical Virtual	Complementarity

Source: own elaboration.

4. Results

4.1. The roles of cluster organisations at different levels of cooperation

Previous research (Lis 2018; Lis and Lis 2021) established that cooperation in COs takes different forms, which can form a hierarchical system consisting of four levels of cooperation (Tab. 2, cat. 1). The defined levels of cooperation determine the trajectory of the development of cooperative relationships in COs. These levels, identified with regard to the main objectives indicating the key type of activity in COs, were subsequently ranked according to the cooperation markers that reflected the approach of cluster entities to the activities, goals and interests set within a cluster (individual approach – collective approach). At level I, the main objective is to create a base network of relationships among cluster partners. At level II, two objectives are defined: facilitating the access to the increased pool of resources and improving the quality of products and services or reducing costs. At level III, the primary objective is to achieve an impact on the external

environment of the CO, while level IV cooperation aims to create shared added value by pooling resources of the cluster members. As research shows, regardless of the differences between the four levels of cluster cooperation, at each of these levels COs may play three main roles: a Direct Resource Supplier, a Broker and an Integrator. Despite the fact that COs play those roles at all levels of cooperation, each role is affected by the specific nature of a particular level. This interaction of role and level allowed to distinguish 12 specific roles – three on each level of cooperation (Tab. 2, cat. 1-3).

The first two identified roles (DRS and BR) fit within the resource theory approach – they relate to supplementing own resources with resources at the disposal of other cluster entities. Thus they are focused either on ensuring access to a certain set of resources in the CO (DRS) or on facilitating resource exchanges and creating a platform for such exchanges co-managed by constituent entities of the cluster organisation (BR). Entities associated in COs can gain access to a wide range of resources: financial, human, material, information, knowledge, etc. However, as virtual proximity and its relationship with geographical proximity are the main areas of interest in this study, the focus of the inquiry has been shifted towards resources specific to virtual proximity – information and knowledge.

As previous research indicates, the pool of resources obtained in COs depends on both the level of cooperation and the role played by the given CO at this level. At each level of cluster cooperation there are relational resources that determine the development of cooperative relationships among the members. With the transition to higher levels of cooperation, the availability of this type of resources may increase (which means strengthening the relationships among selected cluster partners), facilitating access to other types of resources. In addition to relational resources, cluster members receive access to information, except that at each level of cooperation the pool of information is different. At level I, cluster entities gain access to general information, first of all about other members, and secondly – about the immediate environment of the CO (I.1 & I.2). At level II, information is more detailed – suitably selected and personalised, and therefore better suited to the profile and needs of the cluster entities (II.1 & II.2). At level III, the cluster members have priority in obtaining significant information about the socio-economic environment (III.1. & III.2), while at level IV they also gain access to confidential information (IV.1 & IV.2). At this highest level of cooperation, new knowledge is also generated between the cooperating entities, through the cooperation relationships. However, it is reserved only for a limited group of trusted partners.

The third of the identified roles of COs (INT) refers to various dimensions of integration occurring among cluster entities. Integration within COs can be considered as a complex process, which consists – in the first place – of social integration (I.3), i.e. integration at the individual level, including persons representing enterprises associated in the CO. This type of integration leads to the development of relationships within a given CO and is typical of level I. Integration at higher levels of cooperation in COs is the result of social integration, and its specific characteristics result from the level of advancement of partner cooperation. At level II, integration of selected processes in cluster enterprises takes place (II.3), which may lead to an improvement in the quality of their products (or services) or a reduction in the costs of their business activity. In a broader perspective, process integration is to facilitate undertaking the most advanced forms of cluster cooperation (at level IV). The integration occurring at the last two levels of cluster cooperation aims to unite entrepreneurs around common goals (level III and IV) or common interests (level IV). At level III, there is broadly understood industry integration (III.3); common goals are primarily the result of industry affiliation and colocation (e.g. functioning in the same industry, in the same region). At level IV, there is gradual organisational integration among selected cluster enterprises (IV.3), which begins to combine common interest. This type of integration occurs as a result of cooperation in the implementation of joint projects, development of joint products (or services) or launching joint economic activity.



4.2. The importance of geographical and virtual proximity in fulfilling the roles by cluster organisations

Direct Resource Supplier

The research findings demonstrate that the COs operated in the role of Informer (level I) in both the physical and virtual proximity of the cluster members (Tab. 3). The main activities of the COs in this role included the acquisition and distribution of information relevant to the cluster members. The information was primarily of a general nature and was provided both in person, during meetings, and via electronic media (websites, mailings). In the role of Donor (level II), the COs still provided information using both face-to-face contacts and ICT, but it was now information carefully selected by the coordinators or other persons delegated to do so as part of COs (in terms of the criterion of greatest suitability for cluster entities) – in the electronic version it most often took the form of a newsletter for members. Being an Information Tube (level III) meant the distribution of information from the outside to the inside of the CO, as well as the dissemination of information on the CO's activities outside the CO. This was done both in person and via ICT – such as rapid publication of relevant information on the Internet via Twitter. The last role – Mentor (level IV) – was associated with knowledge rather than information. In the context of face-to-face meetings, it meant the opportunity for transferring both codified and non-codified (tacit) knowledge. On the other hand, virtual proximity created through the use of ICT enabled mainly (if not only) transfer of codified knowledge.

Table 3. Geographical and virtual proximity in the COs acting as a Direct Resource Supplier

Specific roles	Benefits	Selected quotations	
		Geographical proximity	Virtual proximity
I.1.	<ul style="list-style-type: none"> • Access to information 	<ul style="list-style-type: none"> • “Despite the fact that the information is on our website, it is better to get information directly.” (A5) 	<ul style="list-style-type: none"> • “Mailings usually concern one issue, for example today it will be sent regarding a project that can be joined.” (D2)
II.1.		<ul style="list-style-type: none"> • “The information I share in the cluster is filtered by me [as a coordinator]. I want less information, but more valuable, because [otherwise] it will become spam.” (D2) 	<ul style="list-style-type: none"> • “In general, I don't like having a cluttered mailbox, but I think that a newsletter is a sensible solution in a cluster. [...] The newsletter contains selected information, the life of the cluster looking a little back and a little forward.” (D6)
III.1.		<ul style="list-style-type: none"> • “If I get an invitation to a meeting from any institutions, I don't go there, because this knowledge will be unstructured. I get a lot of knowledge from the cluster coordinator who analyses and knows which projects are worth participating in.” (D5) 	<ul style="list-style-type: none"> • “We've had a Twitter account for about two months, it's cool because we send various information immediately, for example about our meeting at the ministry.” (D2)
IV.1.	<ul style="list-style-type: none"> • Access to knowledge 	<ul style="list-style-type: none"> • “Codified knowledge ‘for everyone’ is in practice ‘for no one’ [...] And the worst thing we can do is put everything in one place and say: you have everything there. No one will enter such an encyclopaedia of knowledge. You need a man who will adapt it.” (D3) 	<ul style="list-style-type: none"> • “If we would like to collect and codify knowledge from various thematic areas, this would be knowledge at the Internet level.” (D8)

Source: own elaboration.

Broker

Considering the functioning of the surveyed COs in the role of Broker slightly changes the perspective – the COs are now observed not as information and knowledge providers but as intermediaries, facilitating access to various types of resources for their members.



The research findings show that the COs in the role of Information Exchange Platform (level I) were focused on creating for their members cooperation conditions in which the exchange and flow of information was as fast and simple as possible (Tab. 4). The activities of COs in the role of Resource Exchange Platform (level II) included being a platform, but not only for sharing of general information by cluster members, but primarily for sharing specific information that was of particular importance to them. As the study demonstrates, valuable activity in this area was the creation of an information database on the cluster members, with ICT playing an important role in this process. The collection of data on the cluster companies had to take place in the form of in-person meetings, because only in face-to-face relationships it was possible to flexibly take into account additional factors (whose significance was revealed during meetings). The role of Connector with the environment (level III) emphasises the visibility of the COs "outside" and their relationships with the environment. In the case of the surveyed COs, being a Broker in the specific role of the Connector with the environment manifested itself primarily in creating conditions conducive to establishing new, and developing the existing relationships with entities outside the COs. To achieve this goal, both geographical proximity (cluster members' meetings with representatives of institutions and organisations outside the COs) and virtual proximity (mailings tailored to the specific industry, properly developed COs' websites, etc.) were used. In the role of Common Resource Creation Platform (level IV), the tasks related to knowledge sharing among the cluster members and networking for the purpose of acquiring valuable members for teams (task and project) created within the COs came to the fore. Stimulating face-to-face contact was an important element of the activities undertaken

Table 4. Geographical and virtual proximity in the COs acting as a Broker

Specific roles	Benefits	Selected quotations	
		Geographical proximity	Virtual proximity
I.2.	<ul style="list-style-type: none"> • Access to information • Networking 	<ul style="list-style-type: none"> • "Direct contacts cannot be replaced. The written word does not convey the intention of the interlocutor and it is difficult to ask for details that can be a sensitive element of the contract. If you tell me that you deal with employee outsourcing and I grow strawberries, maybe I can find you an employee. It is difficult to convey otherwise." (C5) 	<ul style="list-style-type: none"> • "We had an interactive meeting room once a month, such a virtual room that gathers people with whom we want to talk, allows us to exchange information. I was waiting for these meetings, it is a substitute for face to face contact." (C5)
II.2.		<ul style="list-style-type: none"> • "We even wanted to make a database of companies [...] about what equipment the company has, what its capacity is. But the companies did not want to share it [...] It is easier for them to share it in person." (A5) 	<ul style="list-style-type: none"> • "I convinced the coordinator to make such a knowledge base [...] To describe companies well, that if I search for a specific tag, then companies that know something in a given area will be shown." (C2)
III.2.		<ul style="list-style-type: none"> • "The deputy minister comes to the cluster and says what the competitions will look like in six months. This is important information for them." (D1) 	<ul style="list-style-type: none"> • "The cluster is such an information tube. If some government agencies were to send some information to all of us, it would not go in the same way as a personalised, intelligent email." (C5)
IV.2.	<ul style="list-style-type: none"> • Access to knowledge • Networking 	<ul style="list-style-type: none"> • "In the Internet age, if I'm looking for a partner for a project, I shouldn't have any problems with that. Only that companies do not know what to write on websites, so that it is clear. [...] I am a bit of a translator. I have several meetings a week and I always remember important issues. And then when I get an important project, I have several potential entities that may be interested in it." (C2) 	<ul style="list-style-type: none"> • "There is less ICT in our ICT cluster than you might think. I am very sceptical about ideas such as the portal for technological knowledge exchange. Informal exchanges of knowledge are crucial, not formal." (D1)

Source: own elaboration.

by the studied COs playing this role. The previously established personal relationships between individual members played an important role here, while the role of ICT was very limited.

Integrator

As our findings show, when examined in the Integrator roles, the COs showed noticeable differences in the importance of proximity dimensions depending on the cooperation level reached by the cluster. Probably the most noticeable difference in comparison with the perspectives discussed earlier (DRS and Br) is the extremely strong link between the role of Integrator on the first level of cooperation (Social Integrator) and geographical proximity (Tab. 5).

Table 5. Geographical and virtual proximity in the COs acting as an Integrator

Specific roles	Benefits	Selected quotations	
		Geographical proximity	Virtual proximity
I.3.	<ul style="list-style-type: none"> • Access to information • Development of relationship 	<ul style="list-style-type: none"> • "Information ... I think it's not in the newsletter. I think it is passed on in informal conversations. You can meet and talk on various topics, and after repeated meetings to share knowledge on various topics – certainly the cluster helps in this." (D7) 	<ul style="list-style-type: none"> • "IT tools do not completely replace face-to-face contact, because business is made up of people, not some records with data." (A7)
II.3.	<ul style="list-style-type: none"> • Increase the quality / reduce costs 	<ul style="list-style-type: none"> • "We wanted to create conditions in the cluster for creating and testing prototypes. Companies would use prototypes for their own purposes. The basic barrier would probably be location." (A7) 	<ul style="list-style-type: none"> • "In a cluster, it would be easier to adopt certain standards and implement them for similar companies [...] This can also be done remotely using the Internet." (B4)
III.3.	<ul style="list-style-type: none"> • Impact on the external environment 	<ul style="list-style-type: none"> • "Companies meet and try to stimulate regional policy in the context of, for example, supporting the space sector." (D1) 	<ul style="list-style-type: none"> • "We have fought for the metal industry's inclusion in smart specialisation. [...] Without our meetings in the cluster, I think that this would not have been possible." (B2)
IV.3.	<ul style="list-style-type: none"> • Development of cooperation 	<ul style="list-style-type: none"> • "From the cluster's point of view, it's important that you can do something in one place, even software products. A lot of scripting teams work together in the same place, because sometimes one word can inspire." (C3) 	<ul style="list-style-type: none"> • "The tool is able to help in the design of technology, but you need someone who will develop relationships in the team." (A7)

Source: own elaboration.

The role of Social Integrator requires the COs playing this role to undertake highly specific actions. Social integration, i.e. the development of multilateral personal relationships connecting individual cluster members, took place in conditions of geographical proximity, i.e. physical co-existence. The results show that there was no possibility of engaging ICT in the process of social integration. The research findings demonstrate that virtual proximity played a greater role when COs acted as Process Integrators (level II). The main goal of COs in this role was to improve the quality of offered products (or services) or to reduce the costs of functioning as a result of cluster cooperation. It was possible to use ICT to support improving the quality (in the form of creating shared standards of operation), while cost-oriented activities had to be largely carried out in person (e.g. negotiations with suppliers, service providers, etc.). Being a Lobbyist-visionary (level III), and thus exerting influence on the external environment, required the COs to operate primarily via face-to-face communications. Virtual proximity played a secondary role here. It was similar in the case of the role of Organisation Integrator (level IV) – as our results show; it was not possible to carry out this type of integration "at a distance". However, it should be emphasised that this type

of integration was the most difficult and rarely implemented by the studied COs, even in the conditions of geographical proximity of the cluster partners. It required developed personal relationships (based on previous cooperation and trust built in this way), exchange of tacit knowledge (without the use of any medium) and being in the same place. Virtual proximity turned out to be of a minor importance also in this case.

4.3. Relationships between geographical and virtual proximity in fulfilling the roles by cluster organisations

Direct Resource Supplier

Considering the relations between geographical and virtual proximity in the role of the DRS, it can be seen that in the case of Informer and Donor roles, virtual proximity can perform both the function of complementarity and substitution with respect to geographical proximity (Tab. 6).

The complementarity mechanism consisted in supplementing the information obtained in COs in the form of face-to-face contacts with the information published or sent by COs using ICT. The study also revealed a substitution mechanism, where no additional context was needed for the proper understanding of messages consistent with the role of Informer and Donor – the content of the message was enough. An important feature of ICT mediated activities carried out by COs in the first two identified roles was the time-independence of the published message (it appears immediately after publication and remains available until further notice).

COs acting as an Information Tube involved a narrower use of virtual proximity. While virtual proximity could complement the activities undertaken personally by cluster members (facilitating agreeing the meeting dates or setting their details), their complete effective replacement was simply impossible. This was even more evident in the role of Mentor – transmission of codified knowledge only (which the use of ICT enabled) was severely limiting, as for effective and full transfer of knowledge its additional non-codified, informal context (tacit knowledge) must be taken into account, and this is, according to the interviewed COs, possible only through face-to-face contacts. However, no overlap mechanism was observed in any of the four roles assigned to DRS between the two analysed types of proximity: geographical and virtual.

Table 6. Relationships between geographical and virtual proximity in the COs acting as a Direct Resource Supplier

Specific roles	Benefits	Mechanisms		
		Complementarity	Substitution	Overlap
I.1.	<ul style="list-style-type: none"> • Access to information: – Flow and selection of general information 	<ul style="list-style-type: none"> • Flow of general information • Removing time restrictions • Removing distance restrictions 	<ul style="list-style-type: none"> • Flow of general information 	–
II.1.				
III.1.				
IV.1.	<ul style="list-style-type: none"> • Access to knowledge: – Knowledge flow and codification 	<ul style="list-style-type: none"> • Removing time restrictions • Transfer of codified knowledge 	–	

Source: own elaboration.

Broker

The research findings demonstrate that the issues of complementarity and substitutions of geographical proximity by virtual proximity in the context of cluster activities in the Broker's role are quite similar to the role of DRS. Similarly to the previously described role, no overlap mechanism was found here, either.

As the study revealed, for Information Exchange Platform and Resource Exchange Platform roles, virtual proximity acted both as an element complementing relationships based on geographical proximity, where COs acted as a platform for the exchange of general and detailed information



(complementarity), and to a limited extent replacing it (some substitution) (Tab. 7). The substitutability referred only to some specific types of activities undertaken by the members of the studied COs, primarily meetings that could be carried out easier and faster by means of ICT (when relevant key participants were not available in person). It is therefore not an unconditional replacement, but, in principle, a “temporary” replacement. In no case, however, did virtual proximity completely replace geographical proximity. Both the simple sharing of information about resources and the priority in accessing such information favoured relationships formed and maintained face-to-face.

Table 7. Relations between geographical and virtual proximity in the COs acting as a Broker

Specific roles	Benefits	Mechanisms		
		Complementarity	Substitution	Overlap
I.2.	<ul style="list-style-type: none"> • Access to information: <ul style="list-style-type: none"> – Exchange of information (detailed) – Priority in accessing relevant information 	<ul style="list-style-type: none"> • Flow of short and simple messages • Presentation of the business profile of cluster companies 	<ul style="list-style-type: none"> • Removing distance restrictions (for certain activities) 	–
II.2.	<ul style="list-style-type: none"> • Networking: <ul style="list-style-type: none"> – Contact interactivity – Cooperation animation, motivation – Lifting the barrier of distrust 	<ul style="list-style-type: none"> • Removing distance restrictions 		
III.2.				
IV.2.	<ul style="list-style-type: none"> • Access to knowledge: <ul style="list-style-type: none"> – Exchange of knowledge • Networking: <ul style="list-style-type: none"> – Creating teams (task and project) 	<ul style="list-style-type: none"> • If (and only if) trust has already developed among cluster partners • If (and only if) temporary geographical proximity is maintained 	–	

Source: own elaboration.

The functioning of the COs in the role of Connector with the environment meant focusing on networking and shaping cooperation with entities outside the COs. In these activities, ICT played supporting (complementary) roles, while it was impossible for virtual proximity to replace geographical proximity. The last of the identified Broker roles – Common Resource Creation Platform – was not only the most difficult to achieve by the surveyed COs and their members, but also the most demanding in terms of in-person contact. The study has shown that, in this role, geographical proximity could not be replaced with virtual proximity (no substitution mechanism existed). However, it was possible for a mechanism of complementarity to occur, but this depended on the existence of previously developed personal relationships between the cluster partners, based on established trust.

Integrator

Following the path of Integration strongly influenced the importance and the function of virtual proximity in the surveyed COs. Virtual proximity was typically only marginally useful on this path, which was reflected in a significantly lower use of ICT in joint activities undertaken by the members of the studied COs (Tab. 8).

This particularly applied to the mechanism of substituting virtual proximity for geographical proximity, as in most of the identified Integrator roles (with the exception of Process Integrator) virtual proximity could not be regarded as a substitute for geographical proximity and face-to-face relationships. In addition, where COs acted as a Social Integrator, virtual proximity could not be used even to complement face-to-face communication. Sharing of relevant information, overcoming anonymity and establishing and developing relationships required the parties to establish and maintain face-to-face communication.

In the other three Integrator roles, COs made some, if limited, use of virtual proximity (in the context of complementarity mechanism). In the role of Process Integrator – virtual proximity supported tasks that do not require partner collocation (marketing, quality, sales, etc.); in the role of Lobbyist-visionary, it facilitated communicating selected plans and activities of the COs and their

members to the general public, and, in the role of Organisation Integrator, virtual proximity complemented activities supporting project teams and cooperation within the value chain (subject to the cluster members establishing at least a temporary geographical proximity). It is worth noting that no overlap mechanism was observed in the Integration path (just as in the previous two roles).

Table 8. Relationships between geographical and virtual proximity in the COs acting as an Integrator

Specific roles	Benefits	Mechanisms		
		Complementarity	Substitution	Overlap
I.3.	<ul style="list-style-type: none"> • Access to information: <ul style="list-style-type: none"> – Exchange of information (informal, confidential) • Development of relationship: <ul style="list-style-type: none"> – Making contacts – Breaking the barrier of distrust 	–	–	–
II.3.	<ul style="list-style-type: none"> • Increase the quality / reduce costs 	<ul style="list-style-type: none"> • Implementation of processes that do not require partner colocation (quality, marketing, group purchases, etc.) 		
III.3.	<ul style="list-style-type: none"> • Impact on the external environment 	<ul style="list-style-type: none"> • Achieving common goals 	–	
IV.3.	<ul style="list-style-type: none"> • Access to knowledge: <ul style="list-style-type: none"> – Exchange of knowledge • Development of relationships: <ul style="list-style-type: none"> – Trust development and verification • Development of cooperation <ul style="list-style-type: none"> – Cooperation in task and project groups – Cooperation in the value chain 	<ul style="list-style-type: none"> • Achieving common interests • Provided that trust develops among cluster partners • Provided temporary geographical proximity is established 	–	

Source: own elaboration.

5. Discussion

Our research shows that sharing the same location seems to be a prerequisite for cooperation at each of the four identified levels of intra-cluster cooperation and in relation to each of the 12 roles assumed by COs. In order to effectively meet the objectives set for COs, it is necessary to transform the impersonal relationships between relatively anonymous “generic” cluster members and develop personal relationships based on trust, as well as to continuously verify the level of this trust by assessing the attitudes of the cluster partners. These require face-to-face communications, which affects the development of social proximity. This determines the extent to which virtual proximity is used as a replacement or supplement for physically staying in the same location (geographical proximity). In the DRS and BR roles, virtual proximity is complementary to geographical proximity – it is a tool enabling the development of relationships initiated during face-to-face meetings of people involved in the activities of a given CO (Tab. 9).

Virtual proximity contributes to improving virtual processes (primarily because virtual acts are instantaneous and to some extent distance-independent) and creating and maintaining the public image of both the CO and its members (via websites and social media). The substitutability of geographical proximity by virtual proximity can be observed in the DRS and BR paths, but not at the highest level of cluster cooperation (level IV) in the two roles identified at that level: IV.1 and IV.2. The specificity of both of the abovementioned roles requires the physical presence of partners so that the activities envisaged under these roles can be carried out effectively. These are based primarily on personal relationships (built on trust), reducing the risks inherent in cooperation and enabling the flow of tacit knowledge.

We observed an even more limited use of virtual proximity to support activities anchored in geographical proximity when we analysed the Integrator role. Cluster organisations acting as an INT at various levels of their functioning cannot treat virtual proximity as a replacement for geographical proximity (except for one role, II.3). Integration was clearly associated with the presence of the cluster members in the same or very close locations. The hardware infrastructure and software that

Table 9. Relations between geographical and virtual proximity in the cluster organisations

Levels of cooperation	Roles		Mechanisms		
	General	Specific	Complementarity	Substitution	Overlap
I	DRS	I.1.	+	+	–
	BR	I.2.	+	+	–
	INT	I.3.	–	–	–
II	DRS	II.1.	+	+	–
	BR	II.2.	+	+	–
	INT	II.3.	+	+	–
III	DRS	III.1.	+	+	–
	BR	III.2.	+	+	–
	INT	III.3.	+	–	–
IV	DRS	IV.1.	+	–	–
	BR	IV.2.	+	–	–
	INT	IV.3.	+	–	–

Source: own elaboration.

together make up the ICT tools used in COs turned out to be only an add-on that facilitates the process of integration of individual aspects of the cluster entities' operations – thus, they performed, at most, a complementary function in relation to geographical proximity. Their use, however, was strongly contingent on whether it was possible to develop relationships based on trust among the cluster entities (for this, prior in-person contact and sharing of positive experiences by persons involved in cluster activities were necessary).

At the end of the discussion, it is worth emphasising that our interest in virtual proximity found quite unexpected consequences in the form of addressing the currently most popular topic – the coexistence and cooperation of various entities (both individual and collective) in the conditions of limited possibility of using direct contacts (due to the SARS-CoV-2 pandemic). The publications cited in the literature part, although considering the role of geographical proximity and other types of proximity (as a supplement to or replacement of geographical proximity), for obvious reasons (no epidemics with global consequences such as the SARS-CoV-2 epidemic) did not take into account the importance of virtual proximity as currently one of the key dimensions of proximity. Therefore, the results of the research discussed in this paper, quite unexpectedly, gain significance in comparison with previous publications on the concept of proximity and its dimensions.

6. Conclusions

6.1. Contribution and practical implications

The findings add to the state-of-the-art knowledge related both to the concept of industrial clusters and the concept of proximity by presenting a new light on cluster cooperation as a phenomenon based in geographical proximity which facilitates personal interactions, but supported by virtual proximity and various ICT tools. Additionally, the study extended the reach of prior research as it has focused on clusters considered in organisational terms (COs, so far rarely a subject of research) and their role in achieving higher levels of cooperation and associated benefits for cluster entities.

Our study supports the notion, derived from the theoretical underpinnings, that geographical proximity is still important for the development of inter-organisational cooperation. In the light of our results, the “death of distance” announcement, repeated since the mid-1990s, seems to be very premature and much exaggerated. Despite the growing number of publications proposing arguments in favour of a marginalised role of geographical proximity in the process of establishing and strengthening cooperative relationships, this dimension of proximity should still be recognised as

a key one for stimulating and coordinating cooperation within COs. The fact that people and their aggregates (e.g. enterprises) exist, physically occupying a specific place in geographical space, is the obvious argument supporting this thesis. The need to pay continuous attention to the location and the closer and further geographical environment is one of the consequences of this physical and localised existence. A completely new perspective for research on geographical and virtual proximity is opening up in the era of the SARS-CoV-2 pandemic and the associated, forced and widespread online work. However, a longer period of time is needed to carry out in-depth analyses in this regard.

The empirical findings also offer some practical implications for COs' coordinators. The obtained results suggest that the knowledge about the links between geographical and virtual proximity and their influence on cluster cooperation can help COs achieve higher levels of development and fulfil their assigned roles at each level. This, in turn, may increase the pool of benefits that COs can offer their members.

6.2. Limitations and further research

The study has two main limitations. The first limitation is the relatively small sample that does not meet the criteria of representativeness, which limits the possibility of generalising the conclusions. Nevertheless, the assumptions made at the sampling stage (the logic of selecting the sample according to the extreme-cases rule in order to ensure maximum variability and diversity) allow for putting forward the thesis about a wider universality of the discovered patterns. The second limitation is subjectivity inherent to any study conducted in the field of social sciences, especially qualitative research. The qualitative interviews enabled the respondents to express their opinions freely, thus creating a broad field for mutual subjectivity. However, it was limited due to the methodological regime applied. Moreover, a specific limitation of the described study was also the time when it was conducted (just before the outbreak of the COVID-19 pandemic). Re-conducting this study in the near future could shed new light on the issue of virtual proximity and its role in the development of cluster cooperation.

Based on the study results, a conceptual model taking into account the analysed relationships between geographical and virtual proximity should be developed for further investigation to verify its conceptual validity. As our study has implemented the abductive approach, which is logical but conjectural (Peirce 1931–1958), the only possibility of confirming the model inferred from our data is to validate it in subsequent empirical studies. Quantitative research on a large sample covering COs operating in various sectors of the economy would enable testing the patterns observed in the current study. The analysis of data collected in this way should include structural equation modelling, which allows for determining the directions of the analysed relationships.

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