Empirical Paper

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Local context of local government participation in the innovation networks: Evidence from Poland

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Abstract: Innovation networks help to create innovation ecosystems by strengthen interactions between government, academia, business, and special institutions. The purpose of the article is to identify the relationship between the local context, i.e., the conditions and environment in which the Local Government Unit operates and their participation in the innovation networks. The analysis is based on a survey of 184 local government authorities in Poland, Local Administrative Unit level 2. The present study examines the hypothesis that the more supportive the local context is in the Polish municipalities and cities on district rights, the greater the engagement of local government authorities in local or regional innovation networks. The supportive local context was defined by a set of institutional, economic, geographical, demographic, cultural, political, managerial, and administrative factors. The research findings indicate that the key factors that influence the engagement of local government in local or regional innovation networks are institutional factors.

Keywords: entrepreneurial and innovation ecosystem, innovation networks, local context, local government, Poland
JEL Classification: E02, H70, O30, O52

1 Introduction

Innovations[1] are of crucial importance because they are the driving force of economic development [Schumpeter, 1943] and are particularly important in the present turbulent times of the COVID-19 pandemic. However, over time, there has been a change in attitude toward innovation, and nowadays many scholars acknowledge the importance of an established innovation ecosystem as a crucial factor for successful value creation through innovation [Su et al., 2018]. An innovation ecosystem[2] may transform knowledge into additional value, and create synergy effects or power collaboration and co-creation [Durst and Poutanen, 2013]. An innovation ecosystem may consist of a network of central, regional, or local government authorities, financial institutions, customers, intermediaries, universities, suppliers, and/or competitors [Su et al., 2018]. The creation of innovation ecosystems can be facilitated by innovation networks established between at least three independent organizations connected by a set of long-term

1 See Godlewska (2021), Granieri and Renda (2012), or Edquist (2005) for a discussion on the definition of innovation.
2 See Gobble (2014), Su et al. (2018), or de Vasconcelos Gomes et al. (2018) for a discussion on the definition and key importance of innovation ecosystem.

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cooperation ties seeking innovation [Batterink et al., 2010, de Vasconcelos Gomes et al., 2018]. Innovation networks are locally rooted thanks to knowledge spillover and social embeddedness [Jaffe et al., 1993]; thus, the local context is growing significantly in importance [Martin and Rypestøl, 2018], in particular in times of the COVID-19 pandemic, which has affected global value chains and reinforced local cooperation. Local government units (LGUs) enter innovation networks to exchange ideas on local innovation and/or to foster local innovation initiatives.

Innovation networks may help to expand innovation capacity [Rampersad et al., 2010] or accelerate the creation of value through innovation [Barsh et al., 2008] at the local level. Moreover, Kim and Yoon [2015], based on a survey of 1,576 employees in the Seoul Metropolitan Government, argue that LGU participation in innovation networks may enhance local creativity and foster a local culture of innovation. However, LGUs differ not only due to factors such as geographical location, territorial size, population density, history, culture, local economy, natural resources, etc. [Koellinger and Thurik, 2012] but also due to a self-enforcement mechanism [Godlewska and Morawska, 2020] or good governance [Rodríguez-Pose and Garcilazo, 2015]. Having in mind all the advantages linked to participation of LGUs in innovation networks, we examined why only a few LGUs participate in such networks, and whether local context matters for the participation of LGUs in innovation networks.

The local contexts of innovative behaviors of entrepreneurs are well-recognized, but the determinants of LGU participation in innovation networks have not been thoroughly investigated by scholars. Although studies of innovative activities of LGUs do exist, there have been many calls for further studies to explore why LGUs engage in local value creation or participation in local innovation networks [Damanpour and Schneider, 2009; Gonzalez et al., 2013; Skog, 2016].

Previous research focused on: (i) regional innovation networks [Cooke, 1996; Pekkarinen and Harmaakorpi, 2006; Schoonmaker and Carayannis, 2010]; (ii) learning region in the context of institutions, innovation, and regional renewal [Morgan, 1997]; (iii) LGU manager characteristics in the context of the adoption of innovation [Damanpour and Schneider, 2009]; or (iv) typology or strategic profile of innovative activities of LGUs [Gonzalez et al., 2013].

This study responds to these calls by addressing a problematic local context understood by authors as the following set of factors measured at LGUs' level: (i) institutional; (ii) economic; (iii) geographical; (iv) cultural; (v) demographic; (vi) administrative; (vii) political; and (viii) managerial. The selection of factors was formulated based on a literature review [North, 1990; Hodgson, 2006; Damanpour and Schneider, 2009; Reginato et al., 2011; Gonzalez et al., 2013; Rodríguez-Pose and Garcilazo, 2015; Ketterer and Rodríguez-Pose, 2016; Capello and Perucca, 2018]. Therefore, the purpose of the present research was to ascertain whether local context matters for LGUs' participation in innovation networks.

The empirical analysis is based on data collected through an electronic survey sent in April 2020 to all the Polish LGUs (all the municipalities and cities on district rights). The local context analysis was based on data published by Statistics Poland in the Local Data Bank for 2019. The logistic regression analysis was performed to predict a binary outcome such as LGUs' participation in innovation networks. A logistic regression model predicts the LGUs' participation in innovation networks (dependent variable) by analyzing the relationship with the set of defined local factors (independent variables) such as: previous cooperation with special local institutions (SLI), the number of business environment institutions (BEI) located in a given LGU, the level of economic development, debt per capita, population, type of LGU, and gender, age, and education level of the LGU manager as well as his or her political independence.

This paper is organized as follows. The first section presents the findings of a literature review of local context factors, the second section describes the research approach, and the third section discusses the results. The summary highlights the most important conclusions of the study.

2 Local determinants of LGUs' participation in innovation networks

According to the new growth theory, new economic geography, the new economics of innovation, the concept of an innovation ecosystem, or new institutional economics, innovations are key factors in each

national economy [Acs and Varga, 2002]. Institutional theory may give an insight into the innovative activities of LGUs. Rodrik et al. [2004] highlight that the quality of institutions such as LGUs matters more than development factors, such as geography or trade, for determining national or regional growth. This may be the case also for successful value creation through innovation or innovation networks. Freeman [1994] has noted that the innovativeness of regions is determined by several institutions and organizations, which, together with enterprises, form a relatively separate territorial system, the essence of which is interactive network connections.

An entrepreneurial or innovation ecosystem may be established at national [Wessner, 2005, Godlewska, 2021], regional [Cooke, 1996; Pekkarinen and Harmaakorpi, 2006; Schoonmaker and Carayannis, 2010], or local [Derlukiewicz et al., 2021, Pilewicz et al., 2021] levels. The significance of the local context factor for successful value creation through innovation or innovation networks has been repeatedly highlighted in literature. What is missing, however, is a discussion of which local context factors influence the LGUs' participation in innovation networks. As there is neither a list of innovation networks nor data on participation in innovation networks, authors made an attempt to investigate the scale of such initiatives in Poland. Therefore, a bottom-up approach was needed, which indicated that a local-level analysis would be appropriate. Brenner and Broekel [2011] argue that regional or local level of empirical investigation is justified if the innovation network has a strong regional or local dimension or there are no firm-level data.

Entrepreneurship or innovation literature highlights that context[3]is usually taken for granted by scholars [Johns, 2006]. However, there is no consensus on what constitutes context in terms of entrepreneurship and innovation [Zahra et al., 2014]. Moreover, scholars argue that there is a need for additional studies of the context of entrepreneurship or innovation ecosystems [Zahra and Wright, 2012, Derlukiewicz et al., 2021]. This context is a crucial topic for entrepreneurship and innovation researchers, as it may help them to understand how different contexts may enhance or hamper entrepreneurial and innovation processes or affect outcomes at national, regional, or local levels [Zahra, 2007; Hindle, 2010; Welter, 2011; Zahra and Wright, 2012; Müller and Korsgaard 2018]. Context may be an asset or a liability [Welter, 2011]. Context matters [Welter, 2011] because it regulates the outcomes of the entrepreneurial and innovation ecosystems [Acs et al., 2014]. Contexts such as temporal, industry, spatial, institutional, economic, social, and organizational or ownership and governance contexts [Hindle, 2010; Welter, 2011; Zahra et al., 2014; Müller and Korsgaard, 2018] may frame and shape the entrepreneurial or innovative activities of local government. The contextual approach may investigate why not all local government authorities participate in innovation networks [Godlewska et al., 2022].

2.1 Institutional factors

According to Kishna et al. [2017], innovation emerges from the interaction between actors in an institutional context. Moreover, institutions determine the learning capacity of a region [Morgan, 1997] and consequently its ability to innovate. North [1990] highlights that institutions that support value creation through innovation or innovation networks at a local level may be divided into formal institutions such as formal rules and norms and informal institutions such as innovative culture or values, such as trust, reciprocity, cooperation, and positive attitude toward risk. North [1990, p. 477] understood institutions as "the rules of the game in a society." Meanwhile, Hodgson [2006] argues that institutions are socially embedded in a local context. Amin [1999] emphasizes that any economy includes formal institutions such as rules, laws, and organization, as well as informal institutions such as individual habits, customs, or social norms and values. This is why we may treat organizations as "a special kind of institution, with additional features" [Hodgson, 2006, p. 8]. These SLI such as technology, science parks, R&D institutes, technology transfer centers, incubators, business angles, etc. provide various forms of support for innovators and innovation networks. SLI have key importance for supporting entrepreneurship (entrepreneurial) and innovation ecosystems [Derlukiewicz et al., 2021]. That is why the present authors chose SLI as a crucial example of the institutional factor.

3 See Johns (2006), Zahra (2007) or Müller and Korsgaard (2018) for a discussion on the definition of context.

Gebauer et al. [2005] highlight, based on research in German cities, that LGUs co-exist in the local context with different types of institutions. The question arises whether previous cooperation with such SLI may influence the LGUs' participation in the innovation networks. Zeng et al. [2010] argue that previous cooperation between LGUs and SLI such as science parks has key importance for supporting value creation through innovation or innovation networks at a local level. Moreover, Ketterer and Rodríguez-Pose [2016] underline that institutions such as the rule of law, the prevalent level of corruption, government effectiveness, or the strength of democracy and rule of electoral institutions at local and regional levels in Europe were more relevant than geographical indicators for economic growth in European regions in the period 1995–2009. In addition, institutional factors such as place-based habits, conventions, and routines [Morgan, 1997], cooperation with SLI, and local law or rules may determine the LGUs' participation in innovation networks. That is why the previous LGUs' cooperation with SLI, or the number of the BEI on LGUs' territory, may enhance the LGUs' participation in the innovation networks due to the knowledge of local innovation needs possessed by these institutions.

2.2 Geographical factors

Economically developed regions have well-developed interactive networks, the existence of which is one of the main reasons for their stable and long-term development. Less developed regions also have networks, but these are different, in that they are usually vertical and asymmetric, with local institutions strongly subordinated to the state hierarchy. On the other hand, horizontal networks, which are most effective and function the best, are found in more developed regions [Lundvall, 1995]. In addition, there are relationships between a region's innovation capability and its network location [Han et al., 2020].

In the concept of regional experimentalism, the government, companies, and intermediaries work in repetitive interactions to define development support services by setting goals, and monitoring results in a way that promotes learning [Sabel, 1995]. Sabel [1995] argues that public institutions such as LGUs in less-favored regions do not have the capacity to engage in interactive service delivery. Therefore, location in a specific region may influence the LGUs' participation in an innovation network. This may be a factor determining the innovation of companies and public institutions or governments in particular countries, where regional differences are significant. Poland is a country with a relatively high level of regional heterogeneity. That is why, when a given LGU is situated in a particular Polish voivodeship, this fact may enhance that LGUs' participation in the innovation networks in accordance with the level of economic development characterizing that specific region.[4]

2.3 Economic factors

The LGUs' participation in innovation networks may depend on economic factors. In principle, the higher the income, the greater the expenditure on investments in networking infrastructure (for example, investments in information technology, IT infrastructure) and on education. According to a study carried out among LGUs in one Polish region, insufficient funds make it necessary to focus on the basic needs of residents in the first place, and innovative activity is not such a need. As a consequence, although local authorities recognized the need for pro-innovative activities, they say that these are rarely undertaken [Mackiewicz and Dąbrowska, 2012].

LGUs bear expenditures like investments in the infrastructure, healthcare, or education system to support local development processes. However, many rural municipalities, after improving their attractiveness in terms of offering a lucrative place to live and invest in, suffered in the following years from excessive indebtedness that threatened their operation and local development [Kozera et al., 2020]. In addition, higher debt ratios of LGUs is a factor limiting their expenditures [Lora and Olivera, 2006].

4 The authors have studied the division of regions – neither based on any geospatial system of classification, such as west/east, north/south, or east/west/south borders, nor based on geolocation-associated factors, such as location at the seaside, etc. – but by way of deliberately maintaining an exclusive focus on the administrative division of regions, to see if these divisions influence the LGUs' participation in innovation networks. Further investigation is needed to ascertain the influence of geographic location of regions.

The number of enterprises reflects the economic potential of a given location. A study by Lopez et al. [2021] shows that innovative performance of regions is related to the number of SMEs with product or process innovations. Thus, LGUs often undertake activities aimed at attracting investments and creating new companies in a given municipality. They use various instruments to this end, such as preparing investment sites and investing in human capital.

The actions of LGUs influence the environment for enterprises that constitute the tax base. However, some LGUs do not succeed in starting this process. Such a case is similar to the "regional innovation paradox" described by Oughton et al. [2002].

That is why the high level of LGUs' debt per capita or the high level of previous LGUs' expenditures (in total) may hamper the LGUs' participation in the innovation networks due to lack of possibility of obtaining new funds for social innovation or investments in local innovation. However, the high level of LGUs' income per capita or the high number of enterprises active or newly registered on LGUs' territory may enhance the LGUs' participation in the innovation networks, because the relationship between institutions and entrepreneurship is complex and bidirectional [Elert and Henrekson, 2017; Godlewska, 2019]. Institutions may affect the nature of entrepreneurship or innovation, their location, and even the outcome.

2.4 Demographic factors

Demographic factors have long been analyzed in the context of development processes. In the models of endogenous technological change, population is a variable impacting technological change [Grossman and Helpman, 1991]. The empirical research provides evidence that demographic factors are positively related to economic growth [Munir and Shahid, 2020]. J. R. Hicks even believed that the increase in welfare is proportional to the increase in population (up to a certain limit)[5]. The number and density of the population, in particular a population with tertiary education, is important for the innovative performance of regions [Lopez et al., 2021]. The working population provides (through taxes) funds for LGUs, which allows them to carry out innovative activities. On the other hand, the post-working-age population forces the development of social innovations, in which local government authorities also often participate.

Demographic factors are crucial for social capital and institutional capacity. The development paradigm based on the network relationships is related to the enormous importance of social capital for regional development. This capital was defined by Putnam [1993] as trust, norms, and networks, which enable the improvement of the efficiency of society by facilitating coordinated action. Social capital and trust help to achieve competitiveness due to lower transaction costs (in an environment of mutual trust, it is not necessary to supervise compliance with contracts).

Local population density is vital to the production, diffusion, and deployment of new knowledge, both tacit and formalized. Demography is considered one of the sources of opportunities for innovation [Drucker, 2015].

Since Kremer developed a model [1993] explaining why a larger population leads to faster technological progress, several papers continued exploring the importance of demographic factors for competitive advantages and innovation [Dakhli and De Clercq, 2004; Hedge and Shapira, 2007; Zerenler et al., 2008], but the empirical evidence is still insufficient [Mariz-Pérez et al., 2012]. That is why population density per 1 km^2 or number of inhabitants (NIN) of LGU may enhance the LGUs' participation in innovation networks in accordance with the need for local social innovation to support development of local social capital.

2.5 Cultural factors

Culture is necessary for initiating the innovation process, as Shane proved [1993] based on research on national rates of innovation in 33 countries in 1975 and 1980. It may also be important for the LGUs' participation in innovation networks. Moreover, Herbig and Dunphy [1998] highlight the huge impact of

5 See J. R. Hicks on the Economics of Population, Population and Development Review, Vol. 25, No. 2, 1999, pp. 345–53. JSTOR, http://www.jstor.org/stable/172429.

culture on innovation capacity, which supports the flow of new ideas and innovation. Based on tracing the prosperity of nations between 1820 and 1960, Phelps [2013] also underlines the significant role of culture for innovation or innovation networks ecosystems.

Culture can also be associated with features of society such as tolerance, openness, or trust. The importance of these components of culture was emphasized by Putnam [1993], and Florida [2003], who looked at the creative class. Florida [2003] focused on the role of cities that give access to infrastructure, skills, learning opportunities, the possibility of establishing contacts, etc. An important feature is the creative atmosphere created when a city offers many opportunities to participate in artistic and sports events and those combining various areas of social life. The city is perceived then as the center of events – a place to be, to experience new things, meet interesting people, and draw inspiration.

Based on the concepts of Florida's creative class, Krauskopf et al. [2010] underline that the development of cultural infrastructure such as theater, museums, cinema, or opera influences the economic well-being of a region. In addition, Strauf and Scherer [2010] underline that cultural infrastructure has positive effects on innovation ability of citizens, the regional or local added value, the image of a region or LGUs, networks and competencies within territorial units, and the identity of a region or LGUs. Owing to these beneficious effects that the cultural infrastructure characterizing an LGU is able to exert on the aforementioned factors, the concerned LGU is able to significantly, positively improve its innovation ability; and such a development might in turn enhance such LGUs' participation in the innovation networks.

2.6 Administrative factors

The role of the local and regional authorities is to create a climate conducive to innovation, entrepreneurship, and cooperation networks between SLI, a role that could be assumed by regional development agencies, chambers of commerce, and even large, leading local companies. However, none of these institutions have the political and moral legitimacy of democratically elected local government authorities [Morgan and Nauwelaers, 1999].

LGUs in Poland are not obliged by law to support value creation through innovation or innovation networks at a local level under the Polish Act of 8 March 1990 on Local Self-Government or the European Charter of Local Self-Government 1985. Despite this, some LGUs in Poland or in Spain do support these at a local level [Gonzalez et al., 2013]. However, Laukkanen and Niittykangas [2003] argue that Finnish rural municipalities with "difficult surroundings" wait passively for entrepreneurs or innovation to emerge. Similarly, LGUs in rural municipalities may not engage in participation in the innovation networks. That is why the type of LGU may enhance the LGUs' participation in the innovation networks due to higher ability of urban municipalities or cities on district rights to engage in local innovation processes.

2.7 Managerial factors

LGU managers who act on behalf of municipalities may be, for example, (i) a municipal council (or city council) that adopts, changes, or drafts its own resolutions; (ii) a local mayor (city mayor) who draws up draft resolutions; or (iii) public managers, for example department heads of a municipal (or city) office who are assigned to prepare these draft resolutions by the mayor [Godlewska and Pilewicz, 2020]. In Poland, mayors alone, or public managers who act on their behalf, may undertake entrepreneurial or innovative activities on behalf of their LGUs [Skica et al., 2013]. In addition, based on US local government studies, Mitchell [2018] argues that public managers are more active than elected officials such as mayors. However, in this article, the authors focus on managerial indicators of local mayors (or city mayors).

Damanpour and Schneider [2009] argue that the innovative activities of LGUs may be influenced by their managers' demographic and personal characteristics such as age, tenure, education, or gender. Nevertheless, research findings on a manager's gender or tenure on innovative activities of LGUs are mixed. However, the education level or age of LGU managers (local or city mayors) may enhance the LGUs' participation in the innovation networks as younger and better educated mayors may have higher level of personal innovative spirit.

2.8 Political factors

Rapoport et al. [2019] claim that leaders, especially those in LGUs, are increasingly embedded in a wider system of politics beyond government. This is consistent with the regime theory highlighting the networked relationships of governance, sometimes informal, which LGU leaders develop with businesses and other stakeholders [DiGaetano and Klemanski, 1999].

There is little evidence on the specific influence of the political environment and political support on the innovative activities of local leaders. Some scholars claim that innovation is encouraged by the cooperative nature of LGU managers [Moon and deLeon, 2001]. Damanpour and Schneider [2009] investigated the effect of political orientation (conservative vs. liberal) of LGU leaders on innovation adopted in public administration. They suggest that elected LGU leaders or the local electorate, rather than their political orientation, may affect the innovative activities of LGUs, as manifested by participation in innovation networks.

It can be assumed that the innovative activity of LGUs is influenced by the political support for the local manager. Innovation always involves some risk, while managers in the public sector are often risk-averse, mostly due to the responsibility for public funds and accountability required by citizens [Windrum, 2008]. Therefore, if a leader has strong support, it should be relatively easy to implement new ideas. That is why the political independence of LGU managers (ILM) may hamper the LGUs' participation in the innovation networks as LGUs managers who are independent and do not belong to any political party may be more risk-averse and have lower level of personal innovative spirit or less freedom to express it.

The conclusions of the literature review presented above allow us to hypothesize that the factors listed in Sections 2.1–2.8 may influence the decisions of LGUs on participation in innovation networks. In the following part of the article, we present results confirming which of these factors are significant in Polish conditions.

3 Methods

The theory of innovation networks or concept of innovation ecosystem highlights the key importance of local context [Damanpour and Schneider, 2009; Gonzalez et al., 2013; Skog, 2016] and LGUs to the study of the innovation ecosystem at a local level [Gorzelany-Dziadkowiec et al., 2019]. For this reason, in response to calls for research [Mazzucato, 2016] that aims to enhance theories of local context and innovation networks by focusing on the local determinants of LGUs' participation in the innovation networks and to better understand the state of play or investigate research gaps, the authors chose a six-stage approach (Figure 1).

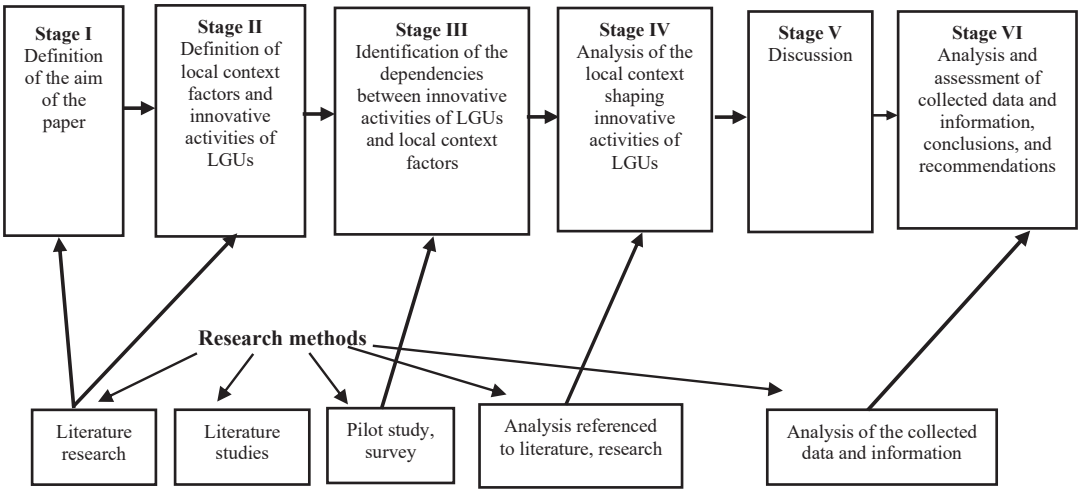


Figure 1. Stages of the study process.
Source: The authors' own compilation based on Gorzelany-Dziadkowiec et al. [2019]. LGUs, local government units.

Despite the widely held belief that local context matters when it comes to innovation networks, no studies have provided evidence of whether local context matters for LGUs' participation in the innovation networks. Addressing this perceived gap in the literature was, accordingly, the main objective of this study.

Therefore, in this paper, based on the most recent studies by Ketterer and Rodríguez-Pose [2016], Drucker [2015], Phelps [2013], Gonzalez et al. [2013], Zeng et al. [2010], Damanpour and Schneirder [2009], Laukkanen and Niittykangas [2003], Oughton et al. [2002], Sabel [1995], and Lundvall [1995], the following hypothesis was introduced:

H1: *The following set of factors, namely: (i) institutional (cooperation between LGUs and special local institutions or tiers of business environment institutions active on LGU territory); (ii) geographical (the seat of an LGU in a particular region, i.e., one of 16 voivodeships); (iii) economic (the tier of entrepreneurs active in the LGU territory or tier of total income, expenditure, or debt per capita); (iv) demographic (the number of inhabitants or local population density); (v) cultural (the amount of cultural infrastructure); (vi) administrative (the type of LGU); (vii) managerial (age, gender, or education of LGU mayors); and (viii) political (political support for the local mayor/city mayor), influence the LGUs' participation in the innovation networks.*

Aars and Fimreite [2005] or Gebauer et al. [2005] highlight that LGUs are members of innovation networks in Norway or Germany. In Poland, there is no available data on LGU participation in the innovation networks. This knowledge is important, as LGUs are a key element of an innovation or entrepreneurial ecosystem. That is why the authors have chosen Polish LGUs for empirical investigation.

Empirical research into Polish LGUs based on the Brenner and Broekel [2011] methodological approach for spatial units was carried out from April 6, 2020, to April 30, 2020. Data were acquired using an electronic survey in Polish (an English translation of the survey is provided in Appendix 1), which was sent to $n = 2{,}477$ LGUs, i.e., all rural, rural-urban, and urban municipalities and cities on district rights, Local Administrative Unit (LAU) level 2. The electronic survey questionnaire (Appendix 1) was based on a literature review and tested during the pilot study. Finally, the response rate from Polish LGUs was $n = 184$ complete records, i.e., 7.2% of the population (requiring $n = \text{min. } 182$). The sample had a 7% maximum error (2SE) and a 5% materiality level. The research sample was not fully representative of all LGUs, because rural municipalities and urban-rural municipalities were under-represented by 3%, in contrast to urban municipalities and cities on district rights, which were over-represented by 3% in the sample compared to the population.

The dependent variable was LGUs' participation in the innovation networks of all kinds. The variable (MIN) has a value of "0" if LGUs do not participate in the innovation networks, and "1" if they do.

The list of independent variables would be as follows (Table 1): (i) cooperation with SLI; (ii) BEI per 10,000 entities of the national economy (ENE); (iii) newly registered entities (NRE) per 10,000 working-age population; (iv) ENE in total; (v) debt per capita (DEB); (vi) total income per capita (TIP); (vii) total expenditure per capita (TEP); (viii) number of cultural infrastructure (NCI); (ix) population density per 1 km^2 (PDE); (x) number of inhabitants (NIN); (xi) age of LGU manager (ALM); (xii) gender of LGU manager (GLM); (xiii) education of LGU manager (ELM); (xiv) political ILM; and (xv) type of local government (TLG), or voivodeship (VOI). The independent variables were chosen from among the following: (i) the Local Data Bank of Statistics Poland for 2019 [https://bdl.stat.gov.pl/bdl/metadane] (for the variables ENE, NRE, BEI, DEB, TIP, TEP, NCI, PDE, and NIN); (ii) a survey (for the variables SLI, ALM, GLM, TLG, and VOI); and (iii) the National Electoral Commission for local elections in 2018 [https://pkw.gov.pl/wybory-i-referenda/wybory-samorzadowe-i-referenda-lokalne/wybory-samorzadowe-w-2018ampnbspr] (for the variable ILM).

Statistical analyses were conducted using the (1 New Orchard Road Armonk, New York 10504-1722 United States) IBM SPSS Statistic Program Version 27. The analytical framework of the paper is based on the Kleinbaum and Klein [2010] methodology of logistic regression analysis. The logistic model is based on the following logistic function:

$$f(z) = \frac{1}{1 + e^{-z}}$$

Table 1. List of independent variables used in the empirical analysis

No.	Variable	Explanation of the variable	The type of factor	The expected direction of impact on the participation of LGUs in innovation networks
1	SLI	Cooperation with SLI such as technology transfer centers, BEI, science and technology parks, technology incubators, academic business incubators, regional and local loan funds, seed capital funds, advisory and training centers, business angel networks, or chambers of commerce (no – 0; yes – 1).	Institutional	Positive
2	BEI	BEI per 10,000 ENE such as technology transfer centers, BEI, science and technology parks, technology incubators, academic business incubators, regional and local loan funds, seed capital funds, advisory and training centers, business angel networks, or chambers of commerce (up to 150 BEI – 1; from 151 to 250 – 2; from 251 to 350 – 3; from 351 to 450 – 4; from 451 to 550 – 5; from 551 to 650 – 6; from 651 to 750 – 7; over 751 – 8).	Institutional	Positive
3	NRE	NRE per 10,000 working-age population such as newly registered public and private enterprises (up to 100 – 1; from 101 to 150 – 2; from 151 to 200 – 3; from 201 to 250 – 4; from 251 to 300 – 5; over 300 – 6).	Economic	Positive
4	ENE	ENE in total such as public and private enterprises (up to 500 – 1; from 501 to 1,000 – 2; from 1,001 to 1,500 – 3; from 1,501 to 2,000 – 4; over 2,000 – 5).	Economic	Positive
5	DEB	Debt of LGU per capita (from PLN –2,000 to –1,000 [–2]; from –999 to –0.01 [–1]; PLN 0 [0]; from 0.01 to 999 [1]; from 1,000 to 2,000 [2]).	Economic	Negative
6	TIP	Total income of LGU per capita (up to PLN 4,500 – 1; from 4,500.01 to 5,000 – 2; from 5,000.01 to 5,500 – 3; from 5,500.01 to 6,000 – 4; from 6,000.01 to 6,500 – 5; over PLN 6,500.01).	Economic	Positive
7	TEP	Total expenditure of LGU per capita (up to PLN 4,500 – 1; from 4,500.01 to 5,000 – 2; from 5,000.01 to 5,500 – 3; from 5,500.01 to 6,000 – 4; from 6,000.01 to 6,500 – 5; over PLN 6,500.01).	Economic	Negative
8	NCI	Amount of cultural infrastructure such as libraries, cinemas, theaters, and cultural centers, i.e., (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11).	Cultural	Positive
9	PDE	Population density of LGU territory per 1 km2 (up to 100 per 1 km2 – 1; from 101 to 250 – 2; from 251 to 500 – 3; from 501 to 1,000 – 4; over 1,000 – 5)	Demographic	Positive
10	NIN	Numbers of LGU inhabitants (up to 5,000 inhabitants – 1; from 5,001 to 10,000 – 2; from 10,001 to 15,000 – 3; from 15,001 to 20,000 – 4; from 20,001 to 50,000 – 5; from 50,001 to 100,000 – 6; over 100,000 – 7).	Demographic	Positive
11	ALM	Age of LGU manager (aged over 60 years – 1; from 56 years to 60 years – 2; from 51 years to 55 years – 3; from 46 years to 50 years – 4; from 41 years to 45 years – 5; from 36 years to 40 years – 6; from 31 years to 35 years – 7; age up to 30 years – 8).	Managerial	Positive
12	GLM	GLM (men – 0; female – 1; diverse – 2).	Managerial	Neutral

(*Continued*)

Table 1. Continued

No.	Variable	Explanation of the variable	The type of factor	The expected direction of impact on the participation of LGUs in innovation networks
13	ELM	ELM (technical secondary school – 1; secondary school – 2; higher education – 3; higher administrative education – 4; higher law education – 5; higher economic education – 6).	Managerial	Positive
14	ILM	Political ILM (politically dependent – 0; politically independent – 1).	Political	Negative
15	TLG	TLG (rural municipalities – 1; urban-rural municipalities – 2; urban municipalities – 3; cities on district rights – 4).	Administrative	Positive
16	VOI	Voivodeship (seat of LGU in one of the following voivodeships, ordered by the level of economic development from the least economically developed to the most economically developed according to Michoń [2017]: Warmińsko-Mazurskie – 1; Świętokrzyskie – 2; Lubelskie – 3; Podlaskie – 4; Kujawsko-Pomorskie – 5; Opolskie – 6; Podkarpackie – 7; Łódzkie – 8; Lubuskie – 9; Zachodniopomorskie – 10; Śląskie – 11; Małopolskie – 12; Pomorskie – 13; Wielkopolskie – 14; Dolośląskie – 15; Mazowieckie – 16).	Geographical	Positive

Source: The authors' own compilation.

ALM, age of LGU manager; BEI, business environment institutions; ELM, education of LGU manager; ENE, entities of the national economy; GLM, gender of LGU manager; ILM, independence of LGU manager; LGU, local government units; NCI, number of cultural infrastructure; NIN, number of inhabitants; NRE, newly registered entities; SLI, special local institutions; TEP, total expenditure per capita; TIP, total income per capita; TLG, type of local government; VOI, voivodeship.

To obtain the logistic model from the logistic function, we express z as the linear sum α plus β_1 times X_1 plus β_2 times X_2, and so on to β_k times X_k, where the Xs are independent variables of interest like local context factors such as institutional (X_1), economic (X_2), geographical (X_3), demographic (X_4), cultural (X_5), political (X_6), managerial (X_7), and administrative (X_8), and α and the β_i are constant terms representing unknown parameters.

$$z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

We substitute the linear sum expression for z in the right-hand side of the formula for f(z). The probability being modeled can be denoted in terms of the following:

$$\mathrm{P}(D = 1 \mid X_1, X_2, \ldots, X_k).$$

Further, the logistic model for the probability of the LGUs' participation in the innovation networks can be expressed as the following:

$$\mathrm{P}(D = 1 \mid X_1, X_2, \ldots, X_k) = \frac{1}{1 + \mathrm{e}^{-(\mathrm{a} + \Sigma \beta_i X_i)}}$$

The authors feel the need to mention that the present study was characterized by certain limitations. First, the small sample size (184 LGUs participating in the study, and 49 LGUs who were members of innovation networks) is not fully representative and thus does not allow for full generalization of the research results for the LGU population. Second, there were no representatives of the possible variety of innovation network members. The authors studied only LGUs and assumed that other network members

would answer in a similar way to LGUs. Third, the authors did not investigate all local context factors that may influence LGU participation in the innovation networks, but focused only on institutional, economic, geographical, demographic, cultural, political, and administrative factors. There are other local contexts such as historical, social, technological, or infrastructural factors that may matter. Fourth, the study is partly based on the truthfulness of the answers given by the LGUs. Finally, almost 50% of all LGUs that participated in the study were from 4 out of the 16 voivodeships that Poland totally contains.

The strengths of this methodology are: (i) a cohesive research sample of LGUs that participate and do not participate in innovation networks was considered, which allows for a comparison of local context between these two groups of LGUs; (ii) an electronic survey was used that was comprised of indirect questions, filtering questions, or questions with detailed definitions; (iii) local context factors were identified based on literature review; and (iv) the logistic regression model was employed, which predicts the dependent data variable by analyzing the relationship with the independent variables.

4 Results

The statistical results (Table 2) of quantitative variables showed that LGUs who participated in the study had by average on their territory 411 (from 44 to 950) BEI (per 10,000 ENE) compared to the country average of 864; 135 (from 42 to 598) NRE (per 10,000 working-age population) compared to the country average of 95; or 1,370 (from 104 to 8,870) ENE in total compared to the country average of 1,175. Moreover, by average, the TIP of these LGUs were 5,431 PLN (from 3,989 to 9,798 PLN) compared to the country average of 5,969 PLN; and the TEP was 5,416 PLN (from 3,871 to 10,351 PLN) compared to the country average of 6,051 PLN. LGUs who participated in the study by average (from –1,200 to 2,000 PLN) had no indebtedness compared to the country average of –82 PLN. The amount of cultural infrastructure such as libraries, cinemas, theaters, and cultural centers characterizing LGUs was, by average, 3 (from 0 to 59), in comparison with the country average of 1. Further, LGUs had, by average, a population density per 1 km2 of 311 (from 9 to 3,243) compared to the country average of 123, as well as 11,567 (from 200 to 99,350) inhabitants compared to the country average of 15,496.

The categorical variables like SLI, MIN, VOI, ILM, ELM, GLM, or TGL showed that only 26.6% of LGUs who participated in the study were members of innovation networks, and only 21.20% of them cooperate with SLI. In the study, 57% of LGUs were rural municipalities (compared to 61% in population), 22% were rural-urban municipalities (compared to 26% in population), 15% were urban municipalities (compared to 10% in population), and 6% were cities on district rights (compared to 3% in population). Moreover, almost 50%

Table 2. Descriptive statistics of quantitative variables

	Mean	Std. deviation	*N*	Minimum	Maximum	Reference to the country average
BEI	411.6995	226.25260	184	44	950	864
NRE	135.9457	53.90801	184	42	598	94.56
ENE	1,370.4511	1,757.34608	184	104	8,870	1,175
DEB	18.9948	397.11936	184	–1,200	2,000	–82
TIP	5,431.8032	972.57948	184	3,988.76	9,797.6	5,969.49
TEP	5,416.9598	1,039.39375	184	3,871.5	10,350.7	6,051.49
NCI	2.5109	5.24481	184	0	59	1.1
PDE	311.4239	568.89024	184	9	3,243	123
NIN	11,567.4674	15,782.55126	184	200	99,350	15,495.58

Source: Authors' own compilation, based on the IBM SPSS Statistic Program Version 27 as well as on Local Data Bank of Statistics Poland for 2019 available at https://bdl.stat.gov.pl/bdl/start

BEI, business environment institutions; ENE, entities of the national economy; NCI, number of cultural infrastructure; NIN, number of inhabitants; NRE, newly registered entities; TEP, total expenditure per capita; TIP, total income per capita.

Table 3. Correlation coefficient between quantitative variables

MIN	BEI	NRE	ENE	DEB	TIP	TEP	NCI	PDE	NIN
Pearson correlation	0.131	0.130	0.170	−0.157	0.070	0.124	−0.012	−0.033	0.067
Sig. (one-tailed)	0.038	0.039	0.011	0.016	0.172	0.047	0.437	0.329	0.182
N	184	184	184	184	184	184	184	184	184

Source: Authors' own compilation based on the IBM SPSS Statistic Program Version 27.

BEI, business environment institutions; ENE, entities of the national economy; NCI, number of cultural infrastructure; NIN, number of inhabitants; NRE, newly registered entities; TEP, total expenditure per capita; TIP, total income per capita.

Table 4. Contingency coefficient

MIN		SLI	ALM	GLM	ELM	ILM	VOI	TLG
Nominal by nominal	Phi	0.470	0.184	−0.049	0.233	0.150	0.272	0.256
	Approximate significance	0.001	0.513	0.503	0.075	0.388	0.554	0.007
Nominal by nominal	Cramér's V	0.470	0.184	0.049	0.233	0.150	0.272	0.256
	Approximate significance	0.001	0.513	0.503	0.075	0.388	0.554	0.007
N	184	184	184	184	184	184	184	184

Source: Authors' own compilation based on the IBM SPSS Statistic Program Version 27.

ALM, age of LGU manager; ELM, education of LGU manager; GLM, gender of LGU manager; ILM, independence of LGU manager; LGUs, local government units; SLI, special local institutions; TLG, type of local government; VOI, voivodeship.

of all LGUs that participated in this study were from the Mazowieckie, Malopolskie, Kujawsko-pomorskie, and Lubelskie voivodeships. Surprisingly, less than 2% of LGUs' mayors were up to 30 years old and almost 90% of LGUs' mayors had higher education and 83% of them were male. In addition, 65% of LGUs' mayors were politically independent.

Independent variables (quantitative ones), such as (i) BEI per 10,000 ENE (BEI); (ii) NRE per 10,000 working-age population (NRE); (iii) ENE in total; (iv) debt per capita (DEB); and (v) TEP, are correlated with a dependent variable, i.e., the number of LGUs participating in the innovation networks (see Table 3). These correlations are significant at the 0.01 level (two-tailed).

For independent variables (categorical ones), the so-called contingency table was prepared, and Cramér's V coefficient was chosen to evaluate the relationship between the number of LGUs participating in the innovation networks and independent variable such as: (i) cooperation with SLI; (ii) ALM; (iii) GLM; (iv) ELM; (v) political ILM; (vi) TLG; or (vii) voivodeship/province (VOI). Unfortunately, only TLG and cooperation with SLI were related to the number of LGUs participating in the innovation networks (Table 4).

A logistic regression model predicts the LGUs' participation in the innovation networks (dependent data variable) by analyzing the relationship with the set of defined local factors (independent variables). Logistic regression also estimates the probability of an event occurring, such as LGUs' participation in the innovation networks or lack thereof, based on a given local factor dataset of independent variables. Independent variables, which were correlated with dependent variables such as (i) BEI per 10,000 ENE; (ii) NRE per 10,000 working-age population; (iii) ENE in total; (iv) debt per capita (DEB); (v) TEP; (vi) cooperation with SLI; and (vii) TLG, were introduced into the model.

The research hypothesis has not been confirmed because only one institutional factor, namely cooperation with SLI, influenced the number of LGUs participating in the innovation networks. The model was based on only one independent variable, an institutional factor, namely cooperation with SLI; despite this being so, it was able to make a correct prediction in 91.1% of the cases of LGUs' non-participation in the innovation networks as well as in 51% of the cases of their participation. The overall percentage of correct prediction was 80.4% (Table 5).

Table 5. Logistic regression analysis

Case processing summary

Unweighted Cases[a]		***N***	**Percent**
Selected cases	Included in analysis	184	100
	Missing cases	0	0
	Total	184	100
Unselected cases		0	0
Total		184	100

[a]If weight is in effect, see classification table for the total number of cases.

Dependent variable encoding

Original value	**Internal value**
0	0
1	1

Block 0: Beginning block

Classification Table[a,b]

	Observed		**Predicted**		
			MIN		**Percentage correct**
			0	1	
Step 0	MIN	0	135	0	100
		1	49	0	0
	Overall percentage				73.4

[a]Constant is included in the model.

[b]The cut value is 500.

Variables in the equation

		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp (B)**
Step 0	Constant	−1.013	0.167	36.925	1	<0.001	0.363

Variables not in the equation

			Score	**df**	**Sig.**
Step 0	Variables	SLI	40.6	1	<0.001
		TLG	9.927	1	0.002
		BEI	3.176	1	0.075
		NRE	3.123	1	0.077
		ENE	5.286	1	0.021
		DEB	4.558	1	0.033
		TEP	2.83	1	0.093
	Overall Statistics		45.205	7	<0.001

Block 1: Method enter

Omnibus tests of model coefficients

		Chi-square	**df**	**Sig.**
Step 1	Step	42.493	7	<0.001
	Block	42.493	7	<0.001
	Model	42.493	7	<0.001

(*Continued*)

Table 5. Continued

Model summary

Step	–2 Log likelihood	Cox & Snell R square	Nagelkerke R square
1	170.781[a]	0.206	0.3

[a]Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Classification table[a]

Predicted					
Observed			MIN		Percentage correct
			0	1	
Step 1	MIN	0	123	12	91.1
		1	24	25	51
	Overall percentage				80.4

[a]The cut value is 500.

Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp (B)
Step 1a	SLI	2.178	0.439	24.555	1	–0.001	8.826
	BEI	0.001	0.001	0.822	1	0.365	1.001
	NRE	0.005	0.004	1.209	1	0.272	1.005
	ENE	0	0	0.118	1	0.731	1
	DEB	–0.001	0.001	1.174	1	0.279	0.999
	TEP	0	0	0	1	0.991	1
	TLG	0.225	0.254	0.788	1	0.375	1.252
	Constant	–2.986	1.236	5.833	1	0.016	0.051

Source: Authors' own compilation based on the IBM SPSS Statistic Program Version 27.

[a]The variable(s) entered on step 1 are SLI, BEI, NRE, ENE, DEB, TEP, and TLG.

BEI, business environment institutions; ENE, entities of the national economy; NRE, newly registered entities; SLI, special local institutions; TEP, total expenditure per capita; TLG, type of local government.

5 Discussion

This study examined whether local context defined by the following set of indicators, that is to say – (i) institutional; (ii) economic; (iii) geographical; (iv) cultural; (v) demographic; (vi) administrative, (vii) managerial; or (viii) political, influence the LGUs' participation in innovation networks. Our results are in line with those of Ketterer and Rodríguez-Pose [2016], who emphasize that for economic growth in the European regions in the period 1995–2009 institutional factors were more relevant than geographical ones. Similarly, Skog [2016] argues that local institutions are very important for each local network evolution.

Fitjar et al. [2016] highlighted that in the case of Norwegian innovation networks the "right" distance, i.e., "not too close and not too far" from another member of the network, matters, and that geographical factors are important. Our study has shown that almost 50% of all LGUs (who comprised the respondents for this study) were from 4 out of the 16 voivodeships totally contained in Poland. This may indicate that LGUs cooperating in the network tend to be concentrated, although ultimately the analysis showed that their location is not statistically significant.

The present study's results for Poland are in contrast with those of Gonzalez et al. [2013], who provided evidence that the innovative activities of LGUs in Spain depend on their typologies or strategic profile. Polish LGU administrative factors such as types of LGU did not affect LGUs' participation in the innovation networks. Surprisingly, LGUs from rural municipalities were the most active in participation in the innovation

networks. This interesting observation may be indicative of a strategic approach to the development of municipalities; it may be explained that LGUs that are aware of their limitations are characterized by a greater tendency to seek support from the network. This is an approach that allows them to strengthen their development potential, as many of the innovative solutions can be relatively easily replicated and scaled-up at low cost.

Based on survey results of LGUs in the United States, Damanpour and Schneider [2009] highlighted that both innovation characteristics and LGU manager characteristics influenced the adoption of innovation. This is in contrast to our results, because in the case of Polish LGUs, managerial factors such as the LGU manager's age, gender, or education and political factors such as the LGU manager's political independence did not influence the LGUs' participation in the innovation networks.

Based on the survey carried out with Italian LGUs, Reginato et al. [2011] stressed that the social, cultural, and structural (demographic and cultural) characteristics affected the innovation ecosystem at a local level. According to our study, a similar relationship did not exist in Polish conditions. Cultural factors measured by cultural infrastructure, demographic factors reflected by the number of inhabitants, and local population density did not affect LGUs' participation in the innovation networks. This is consistent with the conclusion made earlier that networking may be driven by weaknesses. The need for networking arises rather in rural municipalities, which are smaller and economically weaker than urban municipalities.

6 Conclusion

The research hypothesis has not been confirmed. The cultural, demographic, managerial, political, and geographical factors were not correlated with the number of LGUs participating in the innovation networks. The economic and administrative factors were not statistically significant for the number of LGUs participating in the innovation networks. The study confirmed the importance of the institutional factor.

In 80.4% of the cases, the analyzed institutional factor correctly predicted LGUs' participation in the innovation networks.

Polish LGUs highlighted how important local factors are for the innovation ecosystem at a local level and that cooperation with SLIs such as technology incubators or technology transfer centers may change LGUs' activities to make the ecosystem more innovative and supportive for the evolution of local innovation network ecosystems. Operative local innovation networks may enhance local economic development by increasing the potential to undertake various initiatives that a single municipality would not be able to undertake alone. This may explain why rural municipalities were the most active of all LGUs in participation in the innovation networks (intermunicipal ones).

Taking into account that: (a) innovation networks are not popular among Polish LGUs; (b) participation in innovation networks has many advantages (e.g., fostering local innovation culture or local development process); and (c) factors that proved to be significant can be influenced by the public policy, a new policy instrument should be applied to enhance LGUs' participation in the innovation networks. These can be incentives for supralocal development strategies and supralocal cooperation. This instrument may help to link complementary projects and facilitate the implementation of innovative projects that need the cooperation of several municipalities (in the fields of transport, a smart city, social innovation, etc.).

Further investigation is required to determine whether other local context factors of LGUs, i.e., historical, social, technological, geographical location (division of regions), or infrastructural indicators, may influence the engagement of LGUs in innovation networks.

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Appendix 1

Survey sent to all Polish local governments (LG); translated into English

1. Location (please enter the name of the LG)
2. Voivodeship (please enter the name of the voivodeship)
3. Type of LG (please select the appropriate answer)
4. Has your LG cooperated in the last 3 years with special local institutions (SLI) (e.g., technology transfer centers, business environment institutions [BEI], science and technology parks, technology incubators, academic business incubators, regional and local loan funds, seed capital funds, advisory and training centers, business angel networks or chambers of commerce, etc.)?
5. Please indicate the names of SLI (e.g., technology transfer centers, BEI, science and technology parks, technology incubators, academic business incubators, regional and local loan funds, seed capital funds, advisory and training centers, business angel networks or chambers of commerce, etc.) with which the LG has cooperated most intensively in the last 3 years. Please indicate up to three of the most important such institutions.
6. Please indicate if the LG is or was a member of an innovation network, understood as the relationships between at least three independent organizations – connected with each other by a set of long-term cooperation ties – that seek innovation, in the last 3 years.
7. Please indicate the innovation networks to which the LG belongs.
8. Please indicate the benefits derived corresponding to the LG's participation in the innovation network.
9. Please indicate the role of LGs in the innovation network.
10. Please indicate what types of innovations the network, of which the LG is/was a member, is working on.
11. Please indicate how many entities belong to the innovation network of which the LG is a member.
12. Please indicate which entities, apart from the LG, are also members of the innovation network.
13. Please indicate the organizational and legal forms of the innovation network leader entity of which the LG is/was a member.
14. Please indicate whether the network, of which the LG is/was a member, has (had):
    - ☐ A Code of Ethics
    - ☐ Formalized rules of cooperation between network members
    - ☐ Sanctions for breaking the rules
    - ☐ Common values and norms
    - ☐ A monitoring system for obeying the rules
    - ☐ A network governance code
    - ☐ Common culture
    - ☐ Not applicable
15. Please indicate the key values applying to the innovation network of which the LG is (was) a member.
16. Please indicate the coordination mechanisms applying to the innovation network of which the LG is (was) a member.
17. Please specify to what extent the following statements are true (based on a 7-point Likert scale)
    - ☐ Our network is based on compliance with established rules
    - ☐ Our network is based on innovative flow, competitive advantage, and satisfactory financial results
    - ☐ Our network is based on the common interest over the individual interest
    - ☐ Our network is based on the stability of network members, structures, and relations
    - ☐ Our network is based on the continuous transfer of knowledge between members
    - ☐ Our network is free of opportunism, distrust, or rent-seeking behavior
    - ☐ Our network is supported by the institutional environment
    - ☐ Our network is based on efficient delegation of tasks by the leader and partner management

18. Please rate the activity of the innovation network, of which the LG is/was a member, in each of the following areas.
    - ☐ Commercialization of innovations
    - ☐ Providing research infrastructure
    - ☐ Exchanging of know-how
    - ☐ Exchanging of good practices in the field of applying for funding for research with high application potential or patenting
    - ☐ Joint application projects financed from external sources
    - ☐ Research & Development
    - ☐ Applying for national and/or EU funds for research and/or research with high application potential
    - ☐ Advising on innovation
    - ☐ Working on a joint patent application
    - ☐ Advising on protection of intellectual and industrial property
    - ☐ Advising on financing research with high application potential
    - ☐ Technology transferring
    - ☐ Other
19. Please list the scientific and research institutions that your network has cooperated with in the last 3 years.