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The potential of smart development of urban-rural communes in peripheral region (a case study of the Lublin Region, Poland)

Abstract
The purpose of the work is to characterize the potential for the smart development of urban-rural communes of the Lublin Province as potential catalysts for the implementation of the smart villages' concept. In order to determine the potential for the smart development, the zero-unitarization method was used. In specific areas of smart village concept a synthetic index was determined. The study negatively verified the relationship between the level of potential for the smart development of the studied communes and the accessibility of transport and communication of the region's capital. The study also revealed a positive correlation between the size of the urban centre in the urban-rural commune and the level of the potential of smart development of urban-rural communes.

Keywords
Smart villages concept • operacionalization of *smart village* potential • the method of zero-state unitarisation • peripheral region • urban-rural communes

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Introduction

In the European Union's rural development policy, the concept of smart development of *smart villages* emerged in the face of the need to implement the Europe 2020 strategy, the priorities of which include development: smart, sustainable and inclusive. The concept of smart development, along with the concept of inclusive development, is a response to the search for ways to realize the concept of sustainable development against the deepening problems of rural development, especially including the peripheral areas and challenges related to climate changes. In European Union documents, the concept of *smart villages* has appeared recently.[1] In *EU Action for Smart Villages* we find that *smart villages* refers to "rural areas and municipalities that want to base their development on their strengths and resources. Traditional and new networks and services in a *smart village* are strengthened by means of digital technologies, telecommunications, innovation and better use of knowledge, for the benefit of residents and enterprises" (European Commission 2017). As the Commissioner for agriculture and rural development Phil Hogan emphasized, the foundation of *smart villages* are local communities that are developing a strategy for smart use of local resources in local development, but it is necessary to provide better broadband connections and infrastructure. Afterwards, this improved connectivity should be used to improve the quality of life and standard of living in rural areas, which means better access to jobs and higher-quality services. Digital infrastructure should be supported, but also the position of rural population should be strengthened in order to develop off-line solutions that strengthen the vitality of rural areas – through social innovation and smart specialization (Speech 2018).

In the model of smart development of rural areas, especially peripheral ones, the local potential of the village in the form of economic, social, environmental and cultural capital ought to be found in the foreground (Bryden & Dawe 1998). This potential, according to the concept of neo-endogenous development, should be influenced at the level of governmental structures of national and EU programmes supporting technological and social innovation, as without this support it would be difficult to launch the local potential of rural areas.

The components of the local potential of a village are usually rare goods in the form of natural resources, which form the basis for industries or activities embedded in the economic structure of the local market. However, their functioning should be based on the conceptual and technological transformation of the products and services offered (broadening, changing the concept, increasing the number of recipients, using new technologies in creation and sales), resulting in an increase in their value (valorization). Among the industries that can be a stimulus for intelligent rural development, those of health, recreation, organic production, traditional food production, handcrafts or cultural services are mentioned (Naldi et al. 2015). They are often market niches that require discovery and development according to local conditions. It is believed that in addition to transformations in the market offer, to activate smart development processes, rural economic entities should introduce organizational and marketing changes,

[1] The concept is formulated to a certain extent as the analogy of the concept of *smart city* (in terms of conceptualization and operationalization, where it points to the six basic smart areas: intelligent management, economy, mobility, natural environment, society and quality of life).

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involving the intensification of business cooperation (clusters), establishing public-private partnerships and new relationships with growth areas. The pattern of these relations may be based on cooperation with a large enterprise as a source of knowledge, and on technologies and solutions applied to regional and international markets, which will allow them to reach supralocal markets (Teräs et al. 2015). The implementation of the concept of intelligent local development should contribute to and involve the emergence of local innovation systems. First and foremost, the resources of rural areas provide opportunities to create and implement social innovation (an important role is played by Local Action Groups functioning within the LEADER programme, which contribute to a large extent to local development based on the concept of embeddedness). Lack of local, social innovation systems reduces the chances to counteract various social issues (Zwolińska-Ligaj et al. 2018).

The key determinant of the implementation of the *smart villages* concept is the diversity of rural areas in terms of distance, dependence on external markets and natural resources. In rural policy 3.0, OECD distinguishes three different types of rural areas in terms of development opportunities that impact on the contemporary development challenges of rural areas: rural inside a functional urban area (FUA), rural outside, but in close proximity to an FUA/remote area and with good transport communication to the city (maximum 60 minutes of travelling to cities with a population of at least 50,000), and rural remote/remote peripheral areas (OECD 2018, p. 17). Peripheral areas have the most difficult conditions for the implementation of the *smart villages* concept, because they do not have equal access to resources and markets as the other types of rural areas mentioned above, and they differ from them in terms of socio-economic conditions and social structures. In general, they are characterized by a low availability, negative migration balance and a low level of education of residents; they do not have a large potential for endogenous development (Naldi et. al. 2015). However, in the case of these regions, there are some possibilities to activate smart factors in the process of their development. Amenities in rural areas may include natural facilities, such as land or water resources, as well as man-made facilities, such as recreational and social amenities – local culture and tradition, including food, crafts, festivals and ways of life. However, these different types of facilities are interdependent and their positive effects on rural development are interrelated (Markeson & Deller 2012).

Summarizing, in peripheral regions, internal development impulses may also be launched (Rappaport 2009, Gosnell & Abrams 2011), e.g. by using local *amenities* (Dissart & Marcouiller 2012), developing a creative economy (McGranahan et al. 2011) and other resources to build specialized connections with urban markets (Naldi et al. 2015). With regard to rural areas, the greatest opportunities for adaptation of concepts occur in the areas adjacent to urban development centres.

The Lublin Province constituting the studied area is located at the eastern border of Poland with the EU. It belongs to the least developed regions of the EU (the so-called lagging regions), with clearly visible unfavourable features of peripherality in its various areas (Eurostat Regional Yearbook 2018). The purpose of this work is to characterize the potential for smart development of urban-rural communes of the Lublin Province as potential catalysts for implementation of the *smart villages* concept. Urban-rural communes, in comparison with rural communes, are characterized by greater development potential, and therefore wider possibilities for implementing the *smart villages* concept. At the same time, they should be treated as centres affecting the processes of the development of surrounding rural areas (communes). Therefore, the assessment of the potential for smart development of this type of territorial unit is justified. Taking into account the specificity of the studied region in the research process, the following hypothesis was formulated: the proximity of the capital of the region has a positive impact on the potential for smart development of urban-rural communes. In the study, the relation between the size of the urban centre in the urban-rural commune and the level of the potential for smart development of urban–rural communes is examined.

Methods and research material

In the work, the methods of analyzing the subject literature, statistical analysis and cartographic presentation are used. In order to organize the analyzed territorial units in relation to the potential of the *smart village*, the method of zero unitarization was used. The formula of quotient conversion (Kukuła 2014) was used to normalize variables.

After the normalization of variables for individual areas of *smart villages*, synthetic indicators were determined, followed by the general synthetic indicator of the potential for smart development according to the formula (Kukuła 2014):

$$Q_i = \frac{1}{m}\sum_{j-1}^{m} Z_{ij} \qquad (i = l, \ldots, r)$$

Finally, the communes were divided into three groups – low, medium and high potential for smart development (according to Kukuła 2014). For this purpose, the range of the synthetic variable was determined according to the formula: $R(Q_i) = \max Q_i - \min Q_i$ and the parameter of division k was determined according to the formula: $k = \frac{1}{3}R(Q_i)$.

Three groups of territorial units were separated on the basis of the following formulas for determining ranges of values of the synthetic index:

1) a group with a high level of potential:

$$Q_i \in \left[\max_i Q_i - k, \max_i Q_i\right]$$

2) a group with an average level of potential:

$$Q_i \in \left[\max_i Q_i - 2k, \max_i Q_i - k\right)$$

3) a group with a low level of potential:

$$Q_i \in \left[\max_i Q_i - 3k, \max_i Q_i - 2k\right)$$

In the study of the relationship between the level of the synthetic index of the potential for smart development of urban–rural communes and the integrated indicator of transport and communication accessibility (Jakubowski 2010) of these communes towards the regional capital, Pearson's correlation coefficient was applied. The results of the research were developed using the statistical package Statistica 10.

Operationalization of the smart development of urban–rural communes

The concept of *smart villages* represents a complex phenomenon requiring the careful selection of diagnostic variables during operationalization. Based on the literature review (Naldi et al. 2015, Obrębalski 2016, Hajduk 2016), the areas of evaluation of this phenomenon were distinguished and then the diagnostic variables describing the identified areas were selected. The study assumed that the *smart village* concept could be operationalized as part of the diagnosis in the following six areas: management, quality of life, economy, society, natural environment and mobility.

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The variables adopted for operationalization were mainly to reflect the potential of human and social capital conditioning the acquisition of technological innovations and the development of social innovations, as well as the creative sector development potential, the processing status in terms of local resources, access to the internet, communication accessibility and the occurrence of local amenities.

In the multidimensional study, it was considered legitimate to establish a system of weights for partial structures and features (Wysocki 2010). The basis for the value of the weights granted were substantive premises – an expert method was used. A pool of 100 points was distributed among six areas of the potential for smart development, giving the highest weight to "Economy" – 30 points, then to "Society" – 20 points, "Mobility" – 20 points, "Natural Environment" – 10 points, "Quality of life" – 10 points and "Management – 10 points. Then, similarly, a pool of 100 points was separated by determining the weight of features in individual areas. The construction of a set of diagnostic indicators was based on a review of resources of the Local Data Bank of the Central Statistical Office of Poland (BDL GUS), data of the Office of Electronic Communications (UKE) and the Central Register of Vehicles and Drivers system in Poland (CEPiK).

The study covered all urban-rural communes of the Lublin Province (26).[2] In the process of defining a set of indicators describing particular areas, the following assumptions were adopted: data availability, substantive usefulness – significance of information and the ability to comprehensively characterize the studied areas of the *smart villages* concept in relation to the possibility of unambiguous interpretation and an acceptable level of volatility (value of the coefficient of variation above 10%) and the degree of correlating with each other (value of the correlation coefficient below 0.7). The time range of the acquired data covered the period 2015–2016. Ultimately, 22 variables that meet the above conditions were used in the study. In the group of variables, only the variable X_{10}, "The percentage of unemployed registered in the total population of working age", was a negative factor, and the others were stimulants. The list of variables, together with the specification of their time range, are presented in Table 1.

The "Management" area described variables expressing both the potential for commune authorities to influence local processes that fit into the concept of smart development, such as "The percentage of councillors representing professionals out of the total number of councillors" (X_1) and the effects of decisions made by them. It was assumed that the efficiency of local government authorities reflects the effects in the form of funds obtained from the EU, which was expressed by the indicator X_2 – "Total value of qualified expenditure of completed projects co-financed from EU funds under the programmes: Innovative Economy (IE), Human Capital (HC), Infrastructure and Environment (IaE), Development of Eastern Poland (DEP), Regional Operational Programme (ROP) of the Lublin Province per inhabitant" and the state of advancement in reference to commune area management – reflected by the indicator X_3 – "The percentage of the commune area covered by local spatial development plans out of the total area of the commune". The three variables were assigned equal weights (33 points).

Within the "Quality of Life" area, variables describing the variety of leisure time options and the development of knowledge and skills, important from the point of view of building a knowledge-based economy, as well as the activity of local entities to improve housing conditions, are included. Thus, the study included a weight of 40 points, Variable X_4 – "The number of business entities of R section per 100 inhabitants" – describing the activities of business entities associated with culture, entertainment and recreation. Variable X_5 – "The number of specialist laboratories per 10,000 inhabitants" (with a weight of 20 points) – described the availability of specialist laboratories in the commune's cultural institutions, such as polytechnic, computer and multimedia for learning foreign languages. Variable X_6 (with a weight of 20 points) – "The number of residential premises completed per 1,000 inhabitants" – described housing conditions.

In the "Economy" area, the development of the agro-food processing sector was taken into account, which is an important factor in the management of local resources using the variable X_7 – "The percentage of new-registered entities in the agro-food processing sector out of the total number of new-registered entities".[3] Another element for measuring the potential of local economies in the field of smart development is the participation of entities representing highly specialized industries necessary to service developing innovative sectors of the economy (represented by the K section of the Polish Classification of Activities (PCA) – financial and insurance activities, and section L – activities related to servicing the property market), and development of industries based on the use of knowledge, including professional, scientific and technical activities requiring specialist knowledge (section M) and ensuring production and dissemination of information (section J).[4] The variable X_8 – "The percentage of entities from sections J, K, L, M out of the total number of entities" – was used for the measurement. The above two variables were granted the biggest weightings in the area of "Economy" (30 points each). Other variables reflecting economic conditions were characterized by the state of development of creative sector entities: Variable X_9 – "The percentage of new-registered creative sector entities out of the total number of new-registered entities" (20 points); and the ability of the local economy to provide jobs: Variable X_{10} – "The share of the unemployed registered people out of the working age population" (20 points).

To characterize the "Society" area, references were used to measure elements of human and social capital. The elements of the greatest importance were those describing the state of development of the non-governmental sector: Variable X_{11} – "The number of foundations, associations and social organizations per 1,000 inhabitants" (35 points) – and assessing the attractiveness of the cultural and sports and recreational offer of the municipality (assessment of local amenities): Indicator X_{12} – "The number of participants in mass events of municipality institutions per 1,000 inhabitants" (30 points). The set of variables describing the potential of human capital was supposed to describe the factor of knowledge generated by the whole (in the age section) municipality, which is why the conditions in the field of human capital were described by measures: X_{13} – "The number of borrowings of public library collections per 1,000 inhabitants" (15 points); X_{14} – "The percentage of additional foreign language learning in primary schools" (10 points); and X_{15} – "The number of Third Age University members per 1,000 inhabitants" (10 points).

The "Natural Environment" area provided information about the capacity of local socio-economic systems to limit their pressure on the natural environment and was described by measures: X_{16} – "The percentage of population connected to wastewater treatment facilities"; and X_{17} – "The length of the sewerage network in relation to the length of the water supply network". Also included are the valuable resources of the local natural environment (amenities related to natural resources): Variable X_{18} – "The percentage of protected areas (landscape

[2] Compare: Zwolińska-Ligaj et al. 2018.

[3] Changes in the methodology in 2014 made it impossible to build a longer time series for the calculation of indicators X_9 and X_8 for the period 2014–2016 (data for the period 2015–2016 were adopted).

[4] GOFIN.PL 2018

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Table 1. Variables describing particular areas of the smart villages concept

***Smart village* area**	**Variable**	
	number	**Name and time (range)**
Management	X_1	The percentage of councillors representing professionals out of the total number of councillors (2016)
	X_2	The total value of qualified expenditure of completed projects co-financed from EU funds under the programmes: IE, HC, IaE, DEP, ROP of the Lublin Province per inhabitant (2015)
	X_3	The percentage of the commune area covered by local spatial development plans out of the total area of the commune (2016)
Quality of Life	X_4	The number of business entities of R section per 100 inhabitants (2016)
	X_5	The number of specialist laboratories per 10,000 inhabitants (2016)
	X_6	The number of residential premises completed per 1,000 inhabitants (2014–2016)
Economy	X_7	The percentage of new-registered entities in the agro-food processing sector out of the total number of new-registered entities (2015–2016)
	X_8	The percentage of entities from sections J, K, L, M out of the total number of entities (2016)
	X_9	The percentage of new-registered creative sector entities out of the total number of new-registered entities (2015–2016)
	X_{10}	The share of registered unemployed people out of the working age population (2016)
Society	X_{11}	The number of foundations, associations and social organizations per 1,000 inhabitants (2016)
	X_{12}	The number of participants in mass events of municipality institutions per 1,000 inhabitants (2014–2016)
	X_{13}	The number of borrowings of public library collections per 1,000 inhabitants
	X_{14}	The percentage of additional foreign language learning in primary schools (2014–2016)
	X_{15}	The number of Third Age University members per 1,000 inhabitants (2016)
Natural Environment	X_{16}	The percentage of population connected to wastewater treatment facilities (2016)
	X_{17}	The length of the sewerage network in relation to the length of the water supply network (%, 2016)
	X_{18}	The percentage of protected areas (landscape and national parks and nature reserves) out of the total area of the commune (2016)
Mobility	X_{19}	The percentage of residential premises in the commune within the scope of the NGA Internet out of the total number of residential premises in the commune (2016)
	X_{20}	The number of vehicles registered in the commune per 1,000 inhabitants (2016)
	X_{21}	The percentage of budget expenditure on transport and communication out of total commune expenditure (2014–2016)
	X_{22}	The length of bicycle paths per 10,000 km^2

Source: own study based on BDL GUS (2018), UKE (2018) and CEPiK (2018) data

and national parks and nature reserves) out of the total area of the commune". The above components of the assessment of the natural environment were considered equivalent (33 points).

Within the last study area – "Mobility" – both the conditions for facilitating movement in physical space and access to information and communication via Internet resources were included, the latter being considered a priority. Access at the local level to the potential benefits of using the modern information exchange infrastructure was determined in the study by taking into account the availability of the NGA[5] Internet, and assumed the indicator X_{19} – "The percentage of residential premises in the municipality within the scope of the NGA Internet out of the total number of residential premises in the commune" (50 points). Due to the limited access inhabitants of rural areas have to means of public transport, the study included Variable X_{20} – "The number

[5] Next Generation Access – the term defining the next generation access networks, with the quality parameters exceeding the commonly used access telecommunications networks (Biernacki 2014)

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Table 2. The structure of urban-rural communes of the Lublin Province in terms of the level of the synthetic indicator of the potential for smart development

The level of potential smart development	The range of values of the synthetic index Qs	The number of communes in the class	Share of communes in the class (%)
High	*Qs∈<0.4178; 0.5343>*	*8*	*30.77*
Average	*Qs∈<0.3014; 0.4178)*	*12*	*46.15*
Low	*Qs∈<0.1849; 0.3014)*	*6*	*23.08*
Total		*26*	*100.00*

Source: own study based on BDL GUS (2018), UKE (2018) and CEPiK (2018) data

of vehicles registered in the commune per 1,000 inhabitants", characterizing individual mobility (20 points). The study also assumes that the condition of spatial mobility is determined by, among others, involvement of local authorities in the improvement of the local transport and communication conditions and the state of the infrastructure allowing for environment-friendly mobility. Therefore, the following variables were taken into account: X_{21} – "The percentage of budget expenditure on transport and communication out of total commune expenditure" (20 points) and X_{22} – "The length of bicycle paths per 10,000 km^2" (10 points).

Characteristics of the potential for smart development of urban–rural communes in the Lublin Province and discussion of results

The lowest value of the variable of the synthetic indicator of the potential for smart development was 0.1849; the highest, 0.5343. The range of the synthetic variable reached the value of 0.3433, and the parameter of division was equal to 0.1164. Based on this, the compartments were determined, on the basis of which the examined territorial units were qualified to one of the three levels of the potential for smart development (Table 2). The structure of the analyzed urban-rural communes of the Lublin Province in terms of the number of units representing the three distinct types of the synthetic indicator for smart development was characterized by the highest share of units representing the average and the high level of the smart development potential index. The least numerous group was that of communes included in the lowest-valued range of studied phenomena. The spatial distribution of the studied urban-rural communes by the level of the synthetic indicator of the potential for smart development is presented in Figure 1.

Communes included in the group with the highest values of the synthetic potential for smart development were located in the western part of the province, at a distance from the eastern border of Poland with the EU. Their distribution is characterized by co-occurrence, usually in sparse concentrations, with communes representing the average level of smart development potential.

At the next stage of the study, using the Pearson correlation coefficient, the hypothesis was verified regarding the relationship between the level of the synthetic indicator of the potential for smart development of communes and the index of transport and communication accessibility (Jakubowski 2010) of these communes.[6] A positive correlation at a low level was found between the analyzed variables (r=0.39). But this correlation was not statistically significant (p=0.07). So, the relationship between the level of potential for the smart development of the studied communes and the accessibility of transport and communication to the region's capital were negatively verified. Further study examined the relation between the size of the urban centre in the urban-rural commune and the level of the potential for smart development of urban-rural communes. It was statistically significant at a moderate level (r=0.6), (p= 0.01).

It should also be noted that in the group of analyzed municipal urban–rural units the highest level of smart potential occurred for communes with the status of poviat cities, but in particular those in which the number of inhabitants in the urban centre measured over 10,000 (Łęczna, Parczew, Janów Lubelski). These types of units are to fulfil the functions of coordinating and performing tasks with a supralocal scope (Rajman 2006). The mosaic arrangement of dispersion of communes with different levels of smart development potential coincides with the results of analyses carried out for communes in Poland under the delimitation of the state health spheres: growth areas and problem areas (Śleszyński et al 2017, p. 255) indicated that in many regions of the country we still deal with a very mosaic system of variables describing the level of development in the social, economic and environmental sphere. Well-developed units are sometimes directly adjacent to very lagging and problematic regions. This is proof of insufficient diffusion of development factors and their limited impact. This is an indication for the purpose of strategic intervention, which should try to eliminate barriers in such a diffusion (e.g. by facilitating commuting to work, favouring the deglomeration of jobs and public services in metropolitan regions, supporting cooperation of local government units within existing or potential functional regions).

Summary

In the lagging region studied, it seems the region's capital does not sufficiently affect the strengthening of the potential development of urban-rural units. Statistically, urban-rural units located closer to this centre did not show significantly higher levels of smart development potential than those located peripherally in relation to the region's capital.

In the light of the results of the level of smart development potential, only a small group of urban-rural communes surveyed with urban centres of more than 10,000 inhabitants acting as poviats seems to be predestined to launch endogenous development.

Due to the shortage of potential catalysts for the implementation of the *smart villages* concept in the studied urban-rural communes in the Lublin Province, it is necessary to pay attention to the need to establish partnerships between these communes and larger urban centres in order to increase development potential. The concept of *smart villages*, taking into account the need to develop urban-rural partnerships with the

[6] The integrated index of transport and communication accessibility of Jakubowski includes: location along national roads (being the most important elements of linear transport infrastructure), location along railway lines and understood as time availability, measured by average travel time to: the capital of the region, the capital city, the nearest city performing essential services functions of subregional importance and to the nearest border crossing.

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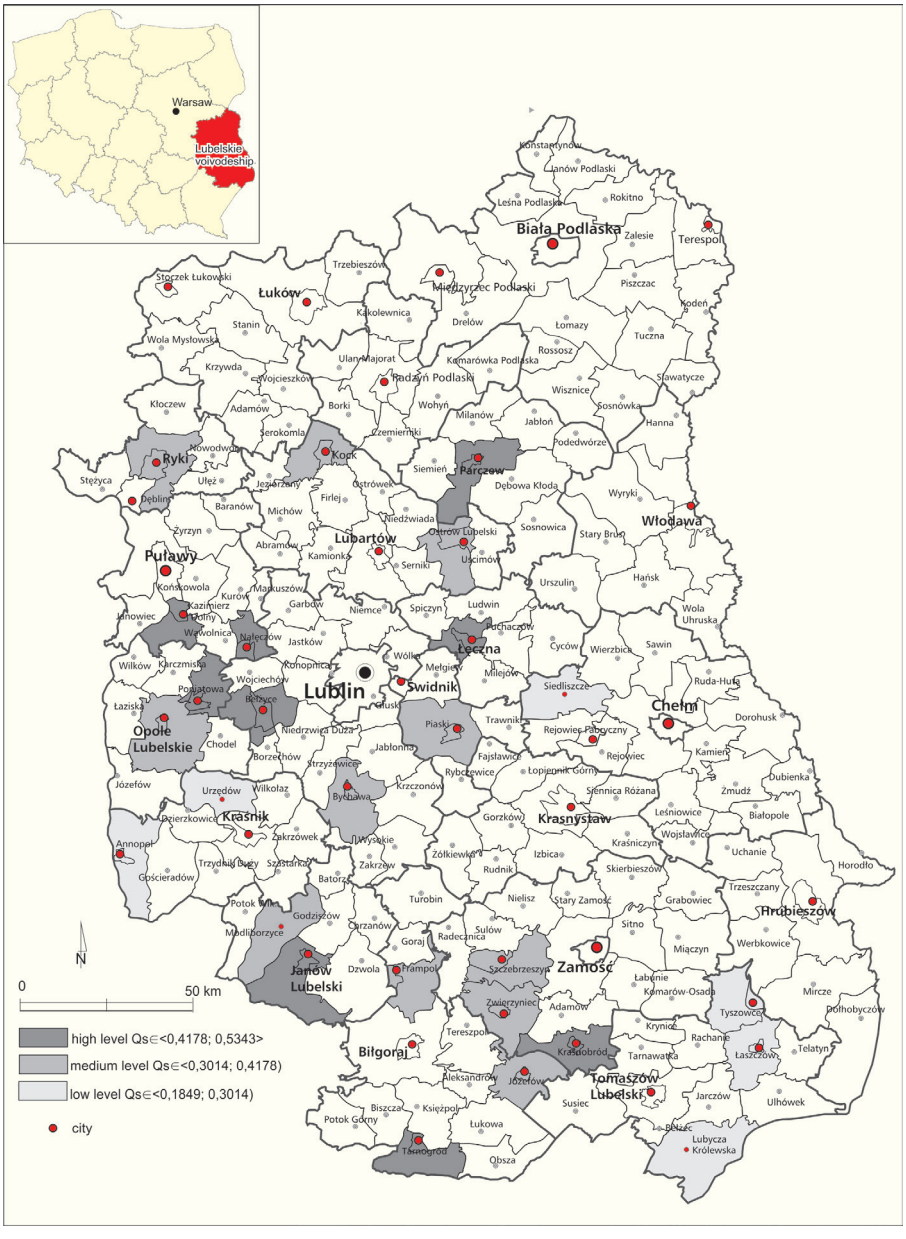

Figure 1. Urban-rural communes in the Lublin Province according to the level of the synthetic indicator of the potential for smart development. Source: own study

current state of polarization of development in Poland and the small scale of partner relationships in the village-city system, is difficult to implement. There is an evident need for strategic intervention to strengthen and develop urban-rural partnerships in the region.

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