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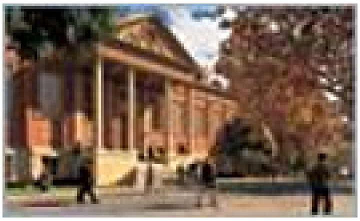

Building entrepreneurial capacity in rural areas

The use of AHP analysis for infrastructure evaluation

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Abstract

Purpose – The purpose of this paper is to verify the development of economic activities in rural areas in terms of their public infrastructural equipment.

Design/methodology/approach – As a case study, the Polish rural areas were selected. A two-stage survey was conducted in 2015. The first stage involved entrepreneurs from rural areas. The second stage of survey was data collection for rural areas regarding economic activity and infrastructural equipment. In total, 121 objects (communes) were selected. The multicriteria analytic hierarchy process (AHP) method was used for the analysis.

Findings – The results demonstrate that for each kind of business, communication accessibility is the most important criterion. By contrast, environmental awareness and concern for the environment is the least important element for pursuit of the economic activity in rural areas.

Research limitations/implications – Limitations are connected mainly with the applied AHP method. The number of the comparable elements at the same hierarchy level is limited due to practical purposes. In addition, an assumption of full comparability of elements (criteria and alternatives) in the hierarchy model can be discussed. Furthermore, data quality and availability limit the scope of the empirical work. This study is a major simplification of reality modeling, but it gives practical benefits by simplifying the decision support procedure.

Practical implications – The findings of this paper contribute to the advancing theory of local development, with public infrastructure being one of its basic elements (factor of production). This paper explores the importance of physical infrastructure for different economic activities, and thus offers theoretical insights in two areas. First, this paper indicates the uneven weight of each infrastructure element for the various business sectors. Second, based on the collected data, this study also contributes to the literature, by using the AHP method to explore the relationships between infrastructural equipment and economic activity in rural areas. As the practical implication for local and regional development policies, this study indicates, that the most important criterion for each kind of economic activity is communication accessibility. This kind of public investment should be undertaken primarily to support entrepreneurship, especially in rural areas.

Originality/value – The uniqueness of the method lies in assumption about the uneven weights of infrastructure elements and therefore their impact on the process of ranking the objects (rural areas). The weight of individual infrastructure elements will vary depending on the kind of economic activity; therefore, the way of ordering will also be different for each economic activity.

Keywords AHP, Rural areas, Competitiveness, Infrastructure, Comparative analysis, Economic activity

Paper type Research paper

Since the time of writing this paper Andrzej Wozniak regrettably died.

This work constitutes a presentation of key ideas which accompany the project formation titled "Knowledge management in the process of building competitiveness and innovativeness of rural areas pursuant to the rules of the sustainable development – an empiric verification on the example of the Małopolskie voivodeship" financed by the National Science Centre based on the decision number DEC-2011/01/DHS4/05909.

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Introduction

It is widely recognized that infrastructure is beneficial to growth and development at all local and regional levels. Investment in network infrastructure can boost long-term economic growth (Crescenzi and Rodriguez-Pose, 2012; Égert *et al.*, 2009). The level of infrastructural equipment in an area affects not only the quality of life, but also significantly determines creativity and the opportunity to develop different types of business. This seemingly obvious dependence is not always possible to verify with standard statistical or taxonomic models. The majority of empirical studies on the relationship between infrastructure and regional growth are econometric studies (Kadokawa, 2012). This study uses the hierarchic structure to show and evaluate relationships between infrastructure and business type. Particular attention has been paid to physical infrastructure, which is the basis of the territorial/location equipment. Also, the rural context is regarded.

The slow development of an element of the physical infrastructure, or even the lack of it, is significant for the specific economic activity (growth). For example, catering services require a regulated water and wastewater management. Shifting this obligation to the investor, due to the performance costs, effectively limits the growth of this entrepreneurship. Alternatively, a well-developed local roads network, by the poor spatial availability of the regional or local unit, triggers transport initiatives (private carriers).

Haughwout (1998) and Kadokawa (2012) noted that the role of infrastructure varies across industries, because individual industries vary in their location requirements, products, and market conditions, and each of these factors can influence the role and benefits of the infrastructure in the industry.

In every community, there are entrepreneurial entities, which, if appropriate conditions (including infrastructure) are created, spur to action, and initiate creation of many businesses and therefore jobs or self-employment. The tasks of the local authorities should include encouraging such attitudes, for common interests of all inhabitants and people responsible for the development of the area. The purpose of local economic development is to meet the important needs, inter alia, by creating workplaces. This is especially important in rural areas, where entrepreneurship and new work places and businesses are necessary for further economic development. Among the many potential issues regarding the local infrastructure, differences in the impact of infrastructure support across business types and regions are particularly important for policy planners.

The development of entrepreneurship may be accompanied by infrastructural development, and better infrastructural state may determine enterprise growth. This means that the basic infrastructure equipment and business development are interdependent (Calderón and Servén, 2014; Francois and Manchin, 2013).

Despite the conviction that infrastructure is a key ingredient in a country's economic success, the relationship between infrastructure and growth is unclear, difficult to estimate and often misunderstood. It is interesting, therefore, to investigate and evaluate the relationship that may exist between the level of infrastructural development and different types of business.

This research focuses on the development of economic activities in rural areas in terms of their public infrastructural equipment. The multicriteria method was used for the linear ordering of areas regarding the level of various economic activities and the level of infrastructural development as well.

Therefore, the following research questions arise:

RQ1. Can such a relationship be determined based on statistical data?

RQ2. Are different types of business in various ways "sensitive" to the overall level of public infrastructure?

RQ3. Finally, is it possible to determine which infrastructure elements correspond closer to the development of a particular type of business?

The structure of this paper is as follows. The next section reviews relevant literature regarding the importance of infrastructure for development and entrepreneurial capacity, especially in marginally rural areas. The third section describes data and the method used for analysis. The next section presents the results of the analytic hierarchy process (AHP) analysis. This is followed by a discussion of results, main conclusions and also highlighting some implications for rural policy.

Theoretical framework

Rural development and economic activity

The importance of rural areas can be shown through statistical data. More than half of the population of the European Union (EU) lives in predominantly or intermediate rural areas. These regions account for 45 percent of the gross value added and provide over 50 percent of the employment in the EU (Eurostat). Rural areas cover over 90 percent of the territory of the EU, and account for more than 56 percent of the population. Traditionally, rural areas have been associated with economic activities based on natural resources, notably agriculture and forestry. However, the decline in the relative importance of agriculture and the need for a more diversified rural economy has led to the emergence of new activities and new areas of rural entrepreneurship. Rural space is no longer confined to agricultural activities and land uses, but is extended to include multisectoral activities (Labrianidis, 2006).

The significant roles of entrepreneurship as a driver of economic growth and diversification in rural areas have long been recognized in literature and at European policy level (Clark *et al.*, 2007; Erdiaw-Kwasie and Alam, 2016). The scientific literature reports great interest in the occurrence and the determinants of rural economic activities (Barbieri and Mahoney, 2009; Gorton *et al.*, 2008; Grande, 2011; Hansson *et al.*, 2013; Maye *et al.*, 2009; Vik and McElwee, 2011). Many studies also focus on pluriactivity and multifuctionality in rural areas (e.g. Alsos *et al.*, 2003; Blad, 2010; Jaafar *et al.*, 2015; Lagerkvist *et al.*, 2007; McNamara and Weiss, 2005).

Specifically, the EU Rural Development Policy 2014-2020 helps EU's rural areas to meet and face the wide range of environmental, economic and social challenges and take advantage of the opportunities in the twenty-first century. The second pillar of the Common Agricultural Policy (CAP) is devoted to these objectives (European Commission, 2010). In particular, the rural population entrepreneurship increase is one of the priorities of the EU agricultural and rural development policy. Employment and firm growth are key elements of the EU's Europe 2020 strategy for smart, sustainable and inclusive growth (European Commission, 2011a, b).

In many cases, enterprise and entrepreneurship are also considered in the scientific literature as direct commercial business performance factors, which contribute to the economic commercial results. They are the drivers of economic growth in Europe's rural areas, thus determining the rural population's economic productivity, value-added development speed, and growth of the quality of life (Bygrave, 1993; Bosworth, 2012; Meccheri and Pelloni, 2006; Zhao *et al.*, 2011).

It is clear that the future success of the rural economy is inextricably linked to the capacity of rural entrepreneurs to innovate, and identify new business opportunities that create jobs and income in rural areas (Harpa *et al.*, 2014). Furthermore, the potential of human resources, natural environment and its biodiversity, raw materials and other economic resources in these areas is great.

The creation of businesses in rural areas is therefore additionally important. It is not simply a creation of added value or a result of personal ambition, but is also a consequence of territorial dynamics. The importance of economic activities cannot be measured only by the number of jobs created. It is part of a whole whose complementary aspects can join and contribute to sustainable development.

A great attention is paid to young people seeking to engage in agricultural activities and other businesses in rural areas (Astromskienė *et al.*, 2014).

Unfortunately, entrepreneurs in rural areas are confronted with a unique set of challenges that are not generally encountered in an urban context. These challenges derive mainly from the varying degrees of accessibility of rural areas, less developed physical infrastructure and also small size and low population densities of rural communities, and their social and economic composition. Small businesses in rural areas often lack even basic governmental supports, including welfare and financial services, training and education programs, and other incentives for local community support for economic activities (Atherton and Hannon, 2006; Ateljevic, 2009; Fuduric, 2012; Webber *et al.*, 2007).

Designated peripheral regions, which are very often rural, within the EU have economies and standards of living that are below average. One of the primary reasons recognized by the local governments for this poor economic standing has been low levels of innovation within indigenous small- to medium-sized enterprises (SMEs). These SMEs have difficulties in growing and exporting, or being part of successful supply chains (McAdam *et al.*, 2004). Poor economic standing is also a consequence of the poor infrastructural support.

Importance of the infrastructural support

Providing any type (agricultural and non-agricultural) of employment in rural areas depends mostly on the physical infrastructure availability: running water, sewerage systems, gas supply, telecommunication, etc. Infrastructure is one of the factors associated with higher levels of productivity. The positive influence of the public infrastructure on employment is logical and expected, since the public sector is a key employer in many rural areas (Agarwal *et al.*, 2009; Moss *et al.*, 2004).

The term "infrastructure" is associated with the physical facilities of areas and nations. Infrastructure represents these types of capital goods that serve the activities of many social and business needs, including roads, communication networks, financial support, energy, and water supplies, i.e. all capital goods that support production and marketing for industries within a region or a country. Many types of elements of infrastructure have been defined. Generally, these can be distinguished as physical (technical), social and economic infrastructures (Schilling and Porter, 2012). Physical infrastructure refers to the basic physical structures required for an economy to function and survive, such as transportation networks, a power grid and sewerage and waste disposal systems. Viewed by some developmental economists as part of a three-pillar system, along with human capital and good governance, physical infrastructure is a prerequisite for trade and other productive activities (Schilling and Porter, 2012).

The quality of infrastructure directly affects a region's economic growth potential and the ability of an enterprise to engage effectively. Socio-economic development can be facilitated and accelerated by the presence of adequate infrastructure.

Aschauer (1990) pointed out the significant importance of public infrastructure and added public capital to the conventional production function. Plumber and Taylor (2001) stated that infrastructure support and institutional thickness, including access to capital in useable forms, are of particular importance in enhancing the local economic capacities in the flexibility, learning-regions, and competitive-advantage approaches. Infrastructure contributes to growth and development via productivity gains, and by reducing adjustment costs, especially for small firms (Agénor and Moreno-Dodson, 2006, Roig-Tierno *et al.*, 2015). Moreover, infrastructure investment may have a positive effect on growth that goes beyond the effect of the capital stock because of economies of scale, the existence of network externalities and competition-enhancing effects (Égert *et al.*, 2009). Public capital in infrastructure may raise the marginal productivity of all factor inputs (capital and labor), thereby lowering marginal production costs and increasing the level of private production. In turn, this scale effect on output may lead, through the standard accelerator effect, to higher private investment, thereby raising production capacity over time and making the growth effect more persistent (Agénor and Moreno-Dodson, 2006).

The importance of infrastructure is also supported by policy regulations. Infrastructural investments meet the main objectives of the European rural polices and priorities, inter alia: CAP, Europe 2010 Strategy, Local development strategies, and Rural Development Programmes (RDPs). Among a number of actions that could help boost the rural entrepreneurship, the main ones have been identified: exploring opportunities in emerging sectors, the social aspects of entrepreneurship and overcoming obstacles to entrepreneurship (infrastructural lacks).

Physical infrastructure also serves in the provision of environmental services, such as preserving biodiversity, protecting water quality and availability, preserving air quality, reinforcing resilience to flooding and/or fire and maintaining landscape values. That is why the development and support of basic services for the economy and rural population is important and is financed by various European and national programs (European Commission, 2011a, b).

It can be concluded that there is a wide consensus that some basic level of infrastructure is necessary for development. However, it must be remembered that the connection between infrastructure and growth varies across countries and over time, as well as within countries and within sectors themselves (Cockburn *et al.*, 2013). Also, the ranges of estimates of the effects of infrastructure have varied widely in the literature (Bronzini and Piselli, 2009; Crescenzi and Rodriguez-Pose, 2012).

That is why, in this paper attention is focused on infrastructural preferences of businesses developed in peripheral, rural areas. It is assumed, on the basis of literature, that various activities require various infrastructural facilities.

Data and method

Data

As a case study, the Polish rural areas were selected. A two-stage survey was conducted in 2015. The first stage involved 15 entrepreneurs from rural areas, who were asked as experts to indicate the importance of infrastructure facilities for the companies' development (entrepreneurship). These firms are involved in certain common activities in rural areas: wholesale and retail trade; repair of motor vehicles and motorcycles; construction; and manufacturing.

The second stage of survey was data collection for rural areas regarding economic activity and infrastructural equipment. This survey covers a sample of one hundred twenty one rural Polish municipalities – objects (from one region to keep territorial cohesion), classified according to Local Administrative Units at level 2. The analyzed Malopolska region is crucial in many aspects; it is important, not only for the proper functioning of both economy and social life, but also for the natural environment of Poland. In many parts of the Malopolska region, farm production should be connected with protective and conservative measures. Agriculture in the province, so far focused only on the production, should change into multifunctional one in the immediate future (Lech-Turaj and Szłapa, 2008). The activity and entrepreneurship of residents, and intellectual capital, are the key areas which determine the development potential of this region (Larsen *et al.*, 2012).

Objects for this survey were described by economic activity according to the International Standard Industrial Classification of all Economic Activities ISIC Rev. 4 and Statistical Classification of Economic Activities in the European Community NACE Rev. 2, expressed as a percentage share of firms registered in 21 sections: A, B, C,…,U.

For each object, a set of data regarding basic infrastructural equipment was also prepared.

Five main infrastructural indicators were collected: water supply system (km per 100 km^2); sewage system (km per 100 km^2); gas network (km per 100 km^2); communication accessibility (point scale, where 8 = very good and 1 = very weak); and illegal dumping sites – landfills (m^2 per 100 km^2).

Method

In this methodological approach, it has been assumed that the linear order of the areas (objects) due to infrastructure development should take into account the type of business activity.

Such formulation of the research problem suggests the use of the multicriteria method, which permits the arrangement that includes the unequal weight of sorting criterion, i.e. of each infrastructure element.

From a variety of multicriteria decision-making (MCDM) methods, the AHP was used due to the relatively simple process of numerical calculations and due to some of its advantages over other MCDM tools such as ELECTRE, TOPSIS, and ANP.

The AHP can be used in the multi-level hierarchical structure on different criteria and constrains (Boroushaki and Malczewski, 2008; Mishra *et al.*, 2015; Saaty, 1977, 2000; Triantaphyllou and Mann, 1995). The method has steps to determine the relative importance of weights of each criteria, before determining the final score (Bunruamkaew and Murayam, 2011).

As an MCDM method, the AHP has been applied for solving a wide variety of problems that involve complex criteria across different levels, where the interaction among criteria is common (Feizizadeh *et al.*, 2014; Singh and Nachtnebel, 2016; Tiwari *et al.*, 1999). The AHP is often used to make decisions that are subject to numerous criteria and subcriteria. It is helpful in choosing the optimal location for a particular investment, taking into account a variety of criteria, giving them the appropriate weight (validity).

For the purpose of this study, the AHP procedure was run in five main stages to solve the problem of object (municipalities) ordering:

(1) Decomposition of multicriteria problem into the hierarchical structure – basic infrastructure elements (facilities) are the main elements of the structure as scheduling criteria. According to the AHP technique, they will be ranked at the local level. Thus, separate criteria will be important factors for municipalities' linear alignment.

(2) Establishing local priorities (weights) for all elements of the structure – in this stage, a number of matrices were created with pairwise comparisons of selected municipalities in relation to the corresponding elements of the infrastructure. The each value in the matrix represents the importance of the ith criterion relative to the jth criterion, valuated according to Saaty's numerical nine-point scale. These relations are calculated as $a_{i,\ j} = (1)/(a_{j,i})$ and $a_{i,i} = 1$. This means that if the ith element dominates at the a level above the jth element, the opposite relationship will be written as its inverse. An element compared to itself accepts the value 1.

(3) Calculation of the maximum eigenvalues for each matrix $\lambda_{\max}$ and eigenvector ω – eigenvector of the matrix $\omega = (\omega_i, \ldots, \omega_n)$ was determined by normalizing the geometric mean calculated for each row of the matrix according to the following equation:

$$\omega_i = \frac{r_i}{\sum_{i=1}^{n} r_i} \quad (1)$$

where $r_i = [\prod_{j=1}^{n} a_{ij}]^{1/n}$; r_i – geometric mean; a_{ij} – matrix element; n – matrix dimension, for $i, j = 1, 2, \ldots, n$.

The maximum eigenvalue $\lambda_{\max}$ for the matrix can be calculated as follows: $\lambda_{\max} = (1/n)\sum_{i=1}^{n} \lambda_i$, where λ_i is the matrix eigenvalue.

(4) Verification of the pairwise comparison's compliance using the consistency index (CI) – the $\lambda_{\max}$ value is an important validating parameter used in the AHP to calculate the consistency ratio (CR) (Saaty, 2000) of the estimated vector, in order to validate whether the pairwise comparison matrix provides a completely consistent evaluation (Kannan *et al.*, 2008):

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n-1} \leqslant 0.10 \tag{2}$$

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \leqslant 0.10 \tag{3}$$

(5) Calculation of global priorities (weights) for individual municipalities and their ranking.

The uniqueness of the presented approach lies in assumption about the uneven weight of each infrastructure element and therefore its impact on the process of ranking objects (rural areas). The weight of individual infrastructure elements will vary depending on the kind of business. Therefore, the way of ordering will also be different for each economic activity.

The linear arrangement of rural areas by the public (physical) infrastructure equipment was the first stage of conducted analysis. The next stage was to determine the ranks arising from the ordering of the areas because of most common economic activity growth, i.e. wholesale and retail trade; repair of motor vehicles and motorcycles; and construction and manufacturing.

The correlation occurrence between these arrangements allows the verification of the dependence among a number of economic entities in the rural municipality and its technical infrastructure. Spearman's rank correlation coefficient determines this dependence.

Spearman's coefficient, unlike the Pearson's correlation coefficient, is used to test any monotonic relationship between data and is expressed as follows:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} D^2}{n(n^2-1)} \tag{4}$$

where n – number of observations; D – difference between ranks for the ith object.

Ranks define the position of observation after the data arrangement (ordering). The closer r_s is to ± 1, the stronger the monotonic relationship. The strength of the correlation for $|r_s|$ is described as follows: ⟨0.0-0.2) – no linear correlation; ⟨0.2-0.4) – weak correlation; ⟨0.4-0.7) – moderate correlation; ⟨0.7-0.9) – strong correlation; more than 0.9 – very strong correlation.

The significance of the Spearman coefficient was revised adopting the null hypothesis H_0: $r_s = 0$. Because Spearman coefficient is calculated for several elements of the statistical sample, a random variable $u = (1)/(\sqrt{(1/n-1)})$ adopts a standardized normal distribution $N(0, 1)$, which is sufficient to calculate the u value of the sample considered and compare it with the critical value u_a, which for the corresponding materiality levels should be as follows:

- $\propto = 0.1$, $u_{0.1} = 1.64$
- $\propto = 0.05$, $u_{0.05} = 1.98$
- $\propto = 0.01$, $u_{0.01} = 2.58$.

When $|u| \geqslant u_a$, H_0 is rejected; and if $|u| < u_a$, there is no basis for rejecting H_0.

A hierarchical structure for the municipalities' linear arrangement regarding the technical infrastructure is shown in Figure 1.

During AHP procedure, the pairwise comparison matrix was generated employing a scale ranging from 1 to 9, in which 1 implies equal importance and 9 implies extreme importance between two criteria, and thus reducing the complexity (Saaty, 1980, 1990). Through a pairwise comparison matrix, the AHP calculates the weighting for each criterion (infrastructure element) by taking the eigenvector corresponding to the largest eigenvalue of the matrix, and then normalizing the sum of the components to unity (Feizizadeh *et al.*, 2014).

The following scheme of application of the nine-point scale was adopted for comparison objects, characterized by numeric values:

- for each standardized diagnostic variable, a range of a set of data $R_k = x^k_{\max} - x^k_{\min}$ was calculated, where k is means variable; and
- R_k was divided by 9 (levels of Saaty's scale) to determine the thresholds of valuation differentiation: $p_k = (R_k)/(9)$; a measure of advantage of the ith municipality over the jth due to $a^k_{i,j}$ criterion is the multiple of threshold in absolute difference of variables between the compared objects: $a^k_{i,j} = (x^k_i - x^k_j)/(p_k)$.

Results

To arrange the areas (alternatives) according to the AHP principles, and to determine the global weights for these areas, first, local weights for accepted criteria were calculated (1-5).

An important objective of the proposed method is to adopt a varied meaning of infrastructure's elements for various types of economic activity, while determining the criteria weights.

An analysis of economic activities in rural areas shows that the most popular activities are connected with Section G – wholesale and retail trade, and repair of motor vehicles and motorcycles. Over 24 percent of the whole entities operate in this sector. Every fifth rural company (21 percent) falls in section F (construction) and only over 11 percent in Section C (manufacturing). Section H (transportation and storage) has a share of 7 percent and other activities are less important with share not exceeding 5 percent.

Therefore, the procedure of determining the criteria weights was performed four times, separately for each most common activity. Due to the significant differences between objects and the possibility of using the AHP method, whole data set was divided into four more similar groups (using standard deviation method), with varying sizes regarding the analyzed economic activity. The main characteristics of data are included in Table I.

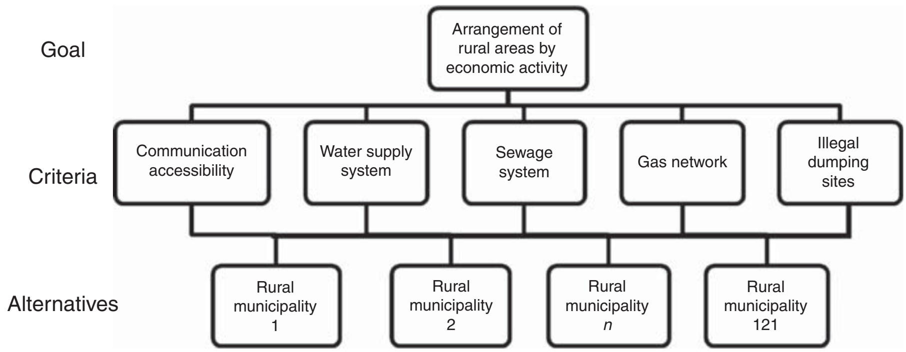

Figure 1.
A hierarchical structure of the problem

Variable	Mean	SD	Min	Max	*n*
Wholesale and retail trade (G)	23.5	5.3	8.7	35.6	121
G.g.1	31.2	2.0	28.9	35.6	16
G.g.2	26.1	1.4	23.8	28.8	51
G.g.3	20.8	1.6	18.2	23.3	36
G.g.4	14.4	2.7	8.7	18.1	18
Construction (F)	22.4	9.7	9.1	55.3	121
F.g.1	38.9	7.3	31.5	55.3	21
F.g.2	26.0	3.1	21.6	31.5	29
F.g.3	17.4	2.4	13.0	21.3	57
F.g.4	10.4	1.2	9.1	12.4	14
Manufacturing (C)	11.9	5.9	3.5	37.9	121
C.g.1	24.8	6.3	18.3	37.9	15
C.g.2	14.0	1.3	12.2	17.3	25
C.g.3	9.2	1.5	6.1	11.9	74
C.g.4	5.0	0.9	3.5	5.9	7
Transportation and storage (H)	7.1	3.7	1.9	32.2	121
H.g.1	13.6	4.7	11.0	32.2	18
H.g.2	8.4	1.0	7.2	10.2	31
H.g.3	5.4	1.0	3.4	7.1	60
H.g.4	2.7	0.6	1.9	3.3	12

Table I. Descriptive statistics for economic activity in rural areas

Because four economic activities predominate above all the others in rural areas, further analysis was limited to those sections.

To calculate the local weights for five criteria (infrastructural elements), matrixes of pairwise comparison between all criteria had to be constructed. In total, 15 entrepreneurs (experts) from considered branches (sections) were selected and asked about the importance of infrastructure facilities for their businesses or for a new one in the same section.

Based on experts' valuations, matrixes of criteria assessment were constructed for each considered section separately, i.e. four 5×5 matrices.

These matrices were used to determine the rank of each criterion for a particular business.

These ranks (local weights) organize various infrastructure facilities in terms of the higher level criterion (goal).

Table II shows the sample comparison matrix for technical infrastructure in the aspect of the most popular economic activity, i.e. wholesale and retail trade. It was found, for example, that communication and other network infrastructure are far more important (values 5 and 4) than presence of illegal landfills.

Normalized comparison matrices were checked for compliance and consistency of the valuations. It should be assumed that all valuations were made properly, because all calculated CR values are less than the threshold (Table III).

In the next stage of analysis, pairwise comparisons were made between selected rural areas (alternatives) in terms of every infrastructural element as a comparison criterion.

Criteria	1	2	3	4	5
1. Communication accessibility	1.0	3.0	4.0	4.0	5.0
2. Water supply system	0.3	1.0	2.0	3.0	5.0
3. Sewerage	0.3	0.5	1.0	3.0	5.0
4. Gas network	0.3	0.3	0.3	1.0	4.0
5. Illegal dumping sites – landfills	0.2	0.2	0.2	0.3	1.0

Table II. Pairwise comparison matrix of the criteria in terms of the economic activity wholesale and retail trade

Detailed comparisons were made for the best and worse municipalities regarding share of companies in the analyzed economic section.

Weight matrices for the analyzed groups of municipalities considering five infrastructural elements (criteria) were obtained. To calculate the global weights (municipalities' ranking) due to all infrastructure elements combined, matrix multiplication was performed, respectively, using four local weight vectors given in Table IV. This resulted in four global weight vectors allowing a ranking of municipalities in each business section.

Definitely, the most important criterion for any business is communication accessibility. In addition, access to water supply system proved to be important for experts. Relatively, entrepreneurs pay least attention to the illegal dumpsites.

In order to determine the relations between the level of infrastructural equipment and the type of economic activity in rural areas, the Spearman's rank correlation coefficient was used.

The calculated Spearman's rank correlation coefficients indicate that only the correlation for activity F (construction) is moderate, $r_s = 0.52$, and statistically important, at $\propto = 0.05$.

Discussion

To address the research questions presented in this paper, relationship between infrastructure equipment and business activity can be verified with statistical data. Such formulation makes it possible to use different quantitative methods. In this paper, the AHP analysis was used for linear arrangement of the objects (areas). Many other approaches can be used for linear arrangement, such as synthetic measure, diagrams or iterative methods.

The innovatory approach is that for object arrangement, different weights of infrastructural elements were included. Traditionally, in taxonomy the importance of elements building the synthetic measure is equal. Introducing the problem in the hierarchy form seems to be appropriate, and it allows the verification of the intended purpose of the research. Of course, the hierarchy could be more complex with additional levels and additional criteria (enriched with additional infrastructure elements). However, to verify the validity of the AHP method, the hierarchy is sufficient.

Table III. Compliance and consistency of the valuations

	λ_{max}	CI	CR $\leqslant$ 0.10
Wholesale and retail trade, repair of vehicles	5.38	0.10	0.09
Construction	5.38	0.10	0.09
Manufacturing	5.29	0.07	0.07
Transportation and storage	5.35	0.09	0.08

Table IV. Calculated criteria weights

Activity criteria	Wholesale and retail trade	Construction	Manufacturing	Transportation and storage
1. Communication accessibility	0.44	0.43	0.35	0.46
2. Water supply system	0.23	0.24	0.26	0.21
3. Sewerage	0.17	0.18	0.20	0.19
4. Gas network	0.10	0.10	0.12	0.10
5. Illegal dumping sites	0.05	0.05	0.06	0.04

The assumption of the study was to find differences in the arrangement of alternatives (municipalities) depending on economic activities. The data set was determined, inter alia, by data availability. The broader overview should include more elements of infrastructure. A poor correlation was found between the kind of rural entrepreneurship and the overall level of basic public infrastructure. Correlation was calculated as important only for the activity F (construction). This means that areas with popular construction activity also have high level of physical infrastructure; that for this kind of activity, infrastructural equipment is crucial; and that development of construction activity is most "sensitive" with regard to the level of public infrastructure.

For other businesses, the calculated correlations are not significant. No relationships between the linear ordering of objects according to infrastructure and economic activity may be explained by the presence of other elements affecting the development of entrepreneurship in rural areas, poor infrastructure equipment of these areas, or time delay and the sequence of the analyzed processes. It has been shown that the effects of good infrastructure level can be observed after approximately three years (Krakowiak-Bal, 2007). Some publications indicate the important role of investment in relation to web access, telecommunication and e-infrastructure, which seems to be important for entrepreneurship in remote, rural areas (Edwards *et al.*, 2009; Röller and Waverman, 2001; Sutherland *et al.*, 2009).

Answering the question which infrastructure element corresponds to the specific business type, it has been found that for all analyzed activities the most important infrastructural element is communication accessibility. For trade, manufacturing and transport activities, it is almost twice more important than the others infrastructural elements. This is confirmed by data in Tables II and IV. It is also consistent with other studies by Agénor (2013), Bougheas *et al.* (2000), and Calderón and Servén (2014) who argue that transport and telecommunications services facilitate innovation and technological upgrading by reducing the fixed cost of producing new varieties of intermediate inputs. In addition, more effective transport networks may reduce installation costs of new investments (Calderón and Servén, 2014; Kadokawa, 2012).

Alternatively, it has been found that environmental awareness and concern for the environment is the least important element for pursuit of economic activity in rural areas. The importance of illegal dumping sites is less than 0.06, while the problem of illegal waste dumps in Poland concerns mainly rural areas, where 69 percent of these dumps are located (Central Statistical Office of Poland, 2015). Analysis has also shown the low level of infrastructure equipment in rural areas in Poland and its great diversity. Average values for infrastructure indicators are presented in Table V.

The largest differences were observed in the sewage system and illegal landfills. There is still lack of investments in these areas. It should be noted that not only the level but the quality of physical infrastructure also matters (Burn *et al.*, 2005; Francois and Manchin, 2013).

Conclusion

The proposed method of linear ordering of objects, multidimensional by its nature, with the use of discrete multivariable analysis, gives a good purposeful arrangement and can clearly

	Criteria				
	Communication accessibility (point scale)	Water supply system	Sewerage system	Gas network	Illegal landfills
Average	4.88	114.87	71.45	124.55	126.18
SD	1.74	85.39	74.36	98.66	394.93
Coefficient of variation	0.36	0.74	1.04	0.79	3.13

Table V. Basic statistics of infrastructure criteria interpret the results. Unfortunately, it is not an easy method in terms of numerical calculations. This method is especially difficult when the ranking is made for a large number of objects. This is due to the essence of the AHP method, which consists in pairwise comparisons of all the objects with each other, by each criterion separately. The arrangement of rural areas was made by four main economic activities (G, F, C and H). The method assumption was to find differences in municipalities' rankings depending on the infrastructure equipment and business activity.

The deviations in the ranking of municipalities in each group are noticeable; however, they refer to a small number of municipalities. This means that the adopted method of ranking objects (municipalities) using the hierarchical analysis process AHP is effective and fairly resistant to minor changes in the weights of accepted criteria. Assuming that each type of business puts a different emphasis on different elements of the technical infrastructure, which is crucial for this activity, the municipalities' ranking was made assigning different weights to each ranking criteria.

The most important criterion for each business is communication accessibility. The water and sewerage infrastructure is less important; it counts mostly for the manufacturing businesses.

The kind of rural entrepreneurship is weakly correlated with basic physical infrastructure. This may be associated with still lower infrastructural development of rural areas and also the strong influence of "beyond infrastructure" factors on the business development as personal predispositions, social conditions, activity of local authorities, etc.

Nevertheless, the question about which infrastructure is appropriate for which economic activity is still open. The role of infrastructure in local development is undisputed, especially in rural areas. The basic local development theories should be recalled, especially new trade theory, geographical growth center, core and peripheries, and cluster theory.

Contribution

The findings of the paper contribute to the advancing theory of local development, with public infrastructure being one of its basic elements (factor of production). This paper explores the importance of physical infrastructure for different economic activities. Thus, it offers theoretical insights in two areas. First, this paper has indicated the uneven weight of each infrastructure element for the various business sectors.

Second, based on the collected data, this study has also contributed to the literature by using the AHP method to explore the relationships between infrastructural equipment and economic activity in rural areas.

As a practical implication for local and regional development policies, this study indicates, using AHP method, that the most important criterion for each kind of economic activity is communication accessibility. This kind of public investment should be undertaken primarily to support entrepreneurship, especially in rural areas.

Limitation and future research

The research limitations are connected mainly with the applied AHP method. The number of the comparable elements at the same hierarchy level is limited due to practical purposes.

In addition, an assumption of full comparability of elements (criteria and alternatives) in the hierarchy model can be discussed. Furthermore, data quality and availability limit the scope of the empirical work. This study is a major simplification of reality modeling, but it gives practical benefits by simplifying decision support procedure.

It is a methodical attempt and the results indicate the need for continued research in different regions, on a larger sample or with more detailed analysis of business types.

Further research should undertake time-delayed correlations. This could verify that business growth may be a consequence of good infrastructure facilities.

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