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Regional differences in telecommunications infrastructure and development of enterprises

1, Introduction

In an era of knowledge-based economy the universal and continuous access to information becomes particularly important. Nowadays, one can see the growing importance of information as a strategic resource in the economic processes. The spatial nature of business enterprises implies the need to create conditions to improve the flow of information between the different actors of the market. In the business activities of enterprises, the rapid flow of information plays a key role, in conjunction with the need to respond effectively to market needs, as well as the adjustment of market offer. Without major objections, it can be assumed that today - in an era of increasing competition - obtaining information, as well as its rapid circulation, significantly determines the smooth functioning of market entities. This makes the telecommunication infrastructure to play an important role in business operations, because by determining the availability of information, it determines the efficiency of their operations, and even the ability to function (e.g. electronic

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commerce), thanks to the efficient transportation of many information resources. It pointed out that at the present stage of development; it is the infrastructural elements, that were considered by the World Economic Forum, for the factors underlying the competitiveness of individual economies (Schwab 2010, p. 9). The result is that investment in infrastructure (including telecommunications), should be given priority in local programs of development, especially since the main objective of the NSS in 2007-2013, is to create conditions for the growth of knowledge-based economy and entrepreneurship.

The aim of this article is to determine the effect of various elements of telecommunication infrastructure for the development of enterprises in individual voivodeships. The concept of enterprise development, was understood as process of change in the enterprise in time, of quantitative, qualitative and effective character. The first part presents the theoretical arguments, in favour of the positive influence of the equipping individual regions in telecommunications infrastructure on enterprises development. In the second part of the article, an analysis of the empirical impact of the telecommunications infrastructure on companies' development has been performed. The study included all 16 Polish voivodeships. The study used correlation analysis and the development of a synthetic measure of Hellwig (SMR). The main criterion for selection of variables was their completeness and availability for all sites surveyed in 2006-2010. The source of data describing the individual elements of the telecommunications infrastructure, and measures of business development in each province was BDL GUS and UKE materials.

2, Telecommunications infrastructure as an element of technical infrastructure

Defining the infrastructure, the authors often emphasize the fact that it determines the proper functioning of many areas of social and economic life. L. Kupiec provides the definition of infrastructure, as a complex of public facilities, essential to ensure proper functioning of the national economy and life of the population, respectively arranged in space along with the historically shaped and occurring at the same time the characteristic relationships between its various elements (Kupiec 2005, p. 11). Ch. D. Jacobson, J. A. Tarr argues that this element of socio-economic system can be regarded as a structural system and network (roads and highways, waste disposal systems, water supply and sewerage, electrical and gas lines, telecommunication networks) connecting the modern cities and metropolitan areas, and enable conducting social and economic activities (Jacobson, Tarr 1995, p.3). Due to the functions of the infrastructure, the

authors usually distinguish its two kinds: technical infrastructure (economic) and social (subsystems providing services in, among others, education, science, health, public administration, culture, welfare, safety and social organizations). Among the technical infrastructure, the most distinguished are transport (used to move cargo and people), energy (electric power facilities, gas and heating plants) water (for water movement), and communications objects. Communication is defined as "knowledge and practical field of human activity in the field of communication and social interaction required by the technical means available in a particular space and time" (Kupiec 2005, p. 153). The communication can be divided into two divisions, namely: postal and telecommunications. Today the telecommunications department is particularly important. According to the Telecommunications Law, telecommunication consists of broadcasting, receipt or transmission of information, regardless of their nature by wire, radio or optical waves or other means using electromagnetic energy (Telecommunications Act, 2004, Article. 2, par. 42). It can be assumed that telecommunications is an activity that allows transmission at a distance of different kinds of information (in the form of written word, speech and video) within the specified time, using electrical signals (both digital and analogue). This information may be transmitted to the recipient immediately or with some delay (for example, they are then stored in the device's memory).

Telecommunications infrastructure is provided by telecommunications equipment, in particular by the lines, cable ducts, poles, towers, masts, cables, wires and equipment, used to provide telecommunications (Telecommunications Act, 2004, Article. 2, par. 8th).

The primary area of telecommunications, which plays a vital role in any economy is telephony (both landline and mobile), which significantly facilitates the harmonious cooperation between different actors or sectors. Despite technological advances, landline phone is still one of the principal means of communication in business. Transmission of information at a distance by means of landline telephony requires: transmitter device - processing information in the form of electricity; receiver device - processing electricity into the information in its original version; transmission channel (track) - allowing the transmission of electricity between the transmitting and receiving devices (e.g. copper wire, optical fibre). The third of these elements makes the landline telephony characterized by immobility, which in many cases is not applicable in business. Today the fastest growing telecommunications subsystem is a mobile telephony. L. Kupiec defines mobile telephony as "a telephone communication system separate from the mobile satellite based on low-power radio

transmitters, localized in specific areas of the country (cells), and using digital or analogue recording, used for the integration and transmission of various telecommunications services" (Kupiec 2005, p.173). The growing popularity of this form of communications, primarily due to a virtually unlimited mobility. Mobile telephony also has a number of other essential assets such as: ability to use value-added services (mobile marketing, mobile payments), a wide range of mobile services (except telephony, one can identify, inter alia, short text messages, faxes, e-mails), diversity of functions of mobile phones (including the diary, alarm clock), ease of data transmission.

Another element of the telecommunications network is telegraph networks providers mainly telex and telegraph services. It is noteworthy to mention, that telegraphic communication allows both the flow of information and its recording, but in the Internet age, interest in the use of the telex network services is decreasing. Another element of the mobile telecommunications are dispatching networks, applicable in businesses that use large storage spaces or operate in the field, because they ensure voice communication to employees away from each other. But it is mainly used in public services (army, police).

An area of telecommunications, which has gained rapidly in importance in business enterprises is data transmission. It involves the transmission of digital data between devices (e.g. computers) used for the storage and processing. It's obvious that the data transmission between computers (or other computing devices) requires a data network.

It is noteworthy to mention, that in a modern ICT infrastructure, there is a progressive convergence of the two structures of communication that once were considered separately, namely: the digital computer networks and telecommunication networks (NetWorld 1999, p. 3). Generally we can distinguish three categories (due to the territorial coverage) of data transmission networks (ICT networks) - LAN, MAN and WAN. The most common type of network, are local area networks - LANs which are private networks, integrating dozens (even hundreds) of workstations distributed over a small area. LANs are characterized by a high speed communication, a relatively low construction costs and the low level of errors. They can be created on the base of different technologies, and the most widespread standard is the Ethernet (Ethernet consists of many technologies of data transfers in computer networks, using various transmission media). MAN metropolitan networks are built in large cities and neighbourhoods, allowing merger of enterprises significantly distant from each other (MAN network coverage is approximately 100 km). WAN (Wide Area Network), combine LANs and enable transmission of data

over long distances (for this reason there may be some delays and transmission errors) and a lower speed than the LAN. Among WAN networks one can distinguish a national scale networks - including Research and Academic Computer Network (Naukowa i Akademicka Sieć Komputerowa, NASK), Polish Telecommunication Company Network (Sieć Telekomunikacji Polskiej S.A.) POLPAK and international scale networks - such as the Internet.

Companies often seek to create a network for creating network working conditions in connection with many benefits of this form of use of computers, among which one can distinguish: the ability to share the network devices (including printers, hard drives) and other resources (files and programs), the ability to communicate between users located far away from each other by such electronic means as e-mail, which greatly accelerates the collaboration between distributed users, to make changes to documents on-line, remote login (the ability to log into another computer connected to the network), able to conduct business via the Internet (electronic commerce, collaboration with other entities, marketing); opportunity to implement real-time video conferencing (which allows you to reduce (even eliminate) the costs of transport).

The specific role of telecommunications infrastructure in creating the conditions for business development, due to the fact that quantitative and qualitative state of this kind of infrastructure, significantly determines the availability of individual entities to information. In all economies, the information plays important economic functions, among which we distinguish four main ones (Oleński 2006, pp. 121-198):

- it is an economic resource, essential to the functioning and development of society and economy. Information economic resource consists of all potentially useful collections of information, meta-information and para-information, collected and stored at a time in places and forms, and using technology and organization to allow access to this information and its use by end users,
- it is a manufacturing factor that determines the possibilities and how to use the other factors of production,
- as a product, it is generated, collected, stored and shared, as a result of processes that have the characteristics of production processes,
- it is a commodity - it can be traded and as a commodity market it is in the form of products or services.

In the economy based on knowledge, the information has become an essential factor in manufacturing, often cited alongside labour, land, capital, and often decisive for the productivity and financial results of the company. It is

an integral part of every decision-making process in business operations. The amount of it and access to it, determines its usefulness in economic processes. Undoubtedly, access to information resources determines the effective use of other prodution factors. Therefore, it can be assumed that access to information (as well as its skilful use), promotes the achievement of the company's competitive advantage. In times of economy based on knowledge, lack of access to modern telecommunications infrastructure in many areas of Poland (especially in rural areas), results in lasting digital exclusion, which makes it difficult to achieve a competitive advantage among companies.

The importance of the telecommunications infrastructure for business, is evidenced by the fact that the amount of information increases roughly in proportion to the square of production (Kupiec 2005, p. 166). Already in 1963, A. Jipp showed that there is a positive correlation between the level of dependence on the development of telecommunications infrastructure and the level of GDP (or GNP) per capita of a given country. Regardless of the degree of development of the country and time period, the correlation index values are very high and oscillate within the limits between 0.91 and 0.96 (Alleman et al. 1994, pp. 13-14). Therefore, the question is: What role does telecommunications infrastructure play in the microscale? How does the infrastructural equipment of the individual regions affecty the development of companies operating there?

Condition and quality of technical infrastructure (including telecommunications), significantly affects the competitiveness of the country, and the development and modernization of its elements creates more investment attractiveness for potential investors. This is important due to the fact that entrepreneurs are interested in developing in-house only those elements of infrastructure that at best complement the existing infrastructure of the given area.

Expansion of telecommunications infrastructure is of particular importance for today's enterprises, undertaking competitive actions, for which two attributes of information are primarily important: availability and certainty (Rosa 2004, p. 64). To move from an economy based on labour and capital to knowledge-based economy, the universal access to modern information and communication technologies is required, besides that there are necessary investments in technical infrastructure (telecommunications). The result of the development of electronic communication (which also includes telecommunications) are: increased productivity and mobility of labour, reduced cost of production, better quality and adapting to consumer needs and promoting new products (Fereńc 2008, p.5). The list of effects of development of electronic communication

in business operations may be supplemented by such as, inter alia: acceleration of the implementation of contracts (by reducing the time flow of information); shorter term settlement of liabilities to suppliers; reduction of inventory costs (through support of supply chain management) to facilitate order processing and payment formalities (electronic money transfer); creation of new distribution channels; access to new sources of information about the competitors' offer; avoidance of intermediaries; creation of the corporate image and the views of consumers.

3. Spatial differentiation of telecommunications infrastructure and development of companies in different provinces

In the analysis of spatial differentiation of voivodeships, in terms of development of telecommunications infrastructure, we are dealing with a number of research objects described by a numerous set of variables. Therefore, it is difficult to express this diversity with a single, measurable attribute (this also applies to the complex process of companies' development). This means that in order to analyse differences and to explore the regions infrastructure variety and dependencies between the development of enterprises and facilities of the regions in telecommunications infrastructure, taxonomic methods will be used based on synthetic measures of development.

In the analysis of the spatial arrangement, it is often necessary to compare multivariate objects and their organization. One of the most often used practical methods of linear pattern is the Hellwig pattern development method. Application of the synthetic measurement of development is justified by the fact that it replaces a description of the investigated objects with multiple attributes (in this case, the variables describing the equipment of voivodeships in the individual elements of telecommunications infrastructure), described by one aggregated size, which greatly facilitates the analysis of the similarities of the tested objects (we have set a reference point - not unlike in the case of the non-pattern measurements) and their classification. SMR values increase with the decreasing distance of the object from the model (the higher the level of infrastructure development, the higher the value of the indicator of development), an artificially constructed object, characterized by an optimal (maximum value of stimulants and minimum values of destimulants) (Malinowski 2011, p. 246). Given the limited volume of the article, the process of arranging the linear regions due to the level of development of telecommunications infrastructure (and the level of business development) will not be presented.

For the requirements of study, due to merit a formal analysis of the variables, 7 sub-indices were proposed, reflecting the availability of business for the telecommunications infrastructure in each voivodeship: X1 - the main telephone links per 100 km^2, X2 - standard main link per 100 km^2, X3 - BTS stations (1800 Mhz) per 100 km^2, X4 - companies benefiting from the internal LAN network (in %), X5 - companies with access to the Internet (in %), X6 - companies having Intranet (in %), X7-the percentage of enterprises with broadband Internet access (in %). Selection of variables was largely conditioned by the availability, completeness of data for all voivodeships and their validity. Initially it was assumed that the final set of diagnostic features, will be characterized by suitably high value and information capacity. However, due to limited access to variables reflecting the features of individual regions in telecommunications infrastructure, it is omitted in further analysis of the validation checks for their ability and capacity of discriminant information.

Table 1. Measures of diversity of telecommunications infrastructure in Poland in 2006 and 2010

	Min. value	Max. value	Average value	Coef-ficient of variation	Standard devia-tion	Me-dian	First quar-tile	Third quartile
	2006.							
X1	1609.78 (14)	11275.26 (12)	3745.67	63.06%	2362.01	3004.38	2322.47	4401.48
X2	1423.98 (14)	9964.15 (12)	3315.01	62.73%	2079.42	2725.83	2044.99	3829.57
X3	0.13 (10)	3.49 (12)	1.12	70.47%	0.79	1.13	0.49	1.49
X4	49% (4)	63% (7)	53.25%	7.71%	4.11%	52%	50%	56.25%
X5	83% (14)	96% (10)	88.81%	3.54%	3.15%	88.5%	86.75%	91%
X6	23% (5)	36% (7)	28.56%	12.52%	3.58%	28%	26.75%	31%
X7	38%(14)	55%(7)	44.19%	9.57%	4.23%	43.5%	41%	47%

X1	1033.33(14)	7534.74 (12)	2677.87	62.65%	1677.67	2066.89	1555.91	3018.59
X2	895.14 (14)	6454.17 (12)	2304.36	61.30%	1412.65	1832.98	1361.79	2560.38
X3	1.03 (10)	10.09 (12)	3.14	69.22%	2.17	2.71	1.97	3.49
X4	60.20% (13)	77.20% (10)	69.84%	6.70%	4.68%	70.3%	66.43%	72.88%
X5	91.60% (3)	98.50% (8)	95.65%	1.77%	1.69%	95.95%	95.08%	96.5%
X6	29.60% (13)	48.90% (7)	40.97%	11.03%	4.52%	40.95%	38.6%	43.98%
X7	57.00% (13)	75.00% (10)	67%	7.65%	5.13%	67%	64%	69.75%

Values in parentheses: 1-dolnośląskie, 2-kujawsko-pomorskie, 3-lubelskie, 4-lubuskie, 5 - łódzkie, 6 - małopolskie, 7-mazowieckie, 8 - opolskie, 9 - podkarpackie, 10-podlaskie, 11-pomorskie, 12-śląskie, 13-świętokrzyskie, 14-warmińsko-mazurskie, 15-wielkopolskie, 16-zachodniopomorskie.

Source: own study

Spatial variation of development of telecommunications infrastructure at the level of individual voivodeships is very high. This is because such internal heterogeneity of the country's development, historical, diverse operational efficiency of local authorities (including the elimination of gaps in infrastructure). Large variations of infrastructural facilities were recorded especially in the case of indicators reflecting the number of telephone and standard main lines per 100 km^2, and the number of BTS stations (1800 MHz) per 100 km^2. Evidence of this is the particular very high coefficient of variation (for each variable, both in 2006 and 2010 it exceeded 60%). It is also worth noting that by analysing the dispersion measure of the first three indicators (for data from 2010) one can assume the right-sided distribution of these characteristics. In 2010, for three quarters of voivodeships, the X1 index value ranged below 3018.59, the minimum value of 1033.33 and 7534.74 the maximum. An index value of X2 for 75% of voivodeships ranged below 2560.38 (the minimum value of 895.14 and the maximum of 6454.17), while in the case of X3 the indicator below 3.49 (at the minimum value of 1.03 and maximum of 10.09.) For other indicators, reflecting the availability of the companies to the telecommunications infrastructure, a lower rates of variation were reported, among which only the index reflects the percentage of enterprises having access to the Intranet, the coefficient of variation was higher than 10%.

Table 2. Synthetic measures of level of development of telecommunications infrastructure and level of development of enterprises in 2006-2010

Voivodeship	SMR of companies					average value of the SMR	SMR of communications infrastructure					average value of the SMR
	2006	2007	2008	2009	2010		2006	2007	2008	2009	2010	
Dolnośląskie	0.446	0.439	0.376	0.461	0.368	0.418	0.377	0.430	0.427	0.493	0.517	0.449
Kujawsko-pomorskie	0.368	0.314	0.305	0.348	0.333	0.334	0.353	0.409	0.365	0.259	0.370	0.351
Lubelskie	0.239	0.199	0.245	0.240	0.171	0.219	0.185	0.315	0.165	0.174	0.163	0.200
Lubuskie	0.306	0.314	0.228	0.359	0.256	0.293	0.153	0.215	0.259	0.203	0.298	0.225
Łódzkie	0.305	0.343	0.284	0.388	0.387	0.341	0.204	0.293	0.121	0.362	0.422	0.280
Małopolskie	0.423	0.407	0.383	0.445	0.400	0.412	0.380	0.482	0.524	0.484	0.518	0.478
Mazowieckie	0.601	0.576	0.487	0.668	0.502	0.567	0.536	0.607	0.641	0.604	0.642	0.606
Opolskie	0.203	0.249	0.255	0.202	0.316	0.245	0.278	0.385	0.309	0.264	0.304	0.308
Podkarpackie	0.328	0.272	0.224	0.298	0.257	0.276	0.118	0.250	0.271	0.277	0.352	0.253
Podlaskie	0.274	0.313	0.251	0.317	0.191	0.269	0.259	0.172	0.217	0.131	0.322	0.220
Pomorskie	0.402	0.387	0.298	0.468	0.389	0.389	0.316	0.421	0.432	0.448	0.464	0.416
Śląskie	0.489	0.492	0.402	0.428	0.431	0.448	0.642	0.652	0.662	0.881	0.805	0.728
Świętokrzyskie	0.366	0.414	0.380	0.343	0.344	0.369	0.175	0.141	0.205	0.184	0.082	0.157
Warmińsko-mazurskie	0.182	0.244	0.177	0.182	0.186	0.194	0.083	0.199	0.164	0.034	0.180	0.132
Wielkopolskie	0.423	0.403	0.376	0.501	0.447	0.430	0.297	0.372	0.277	0.374	0.386	0.341
Zachodniopomorskie	0.188	0.268	0.202	0.224	0.206	0.218	0.274	0.365	0.313	0.256	0.299	0.302

Source: Own study based on GUS and UKE data

The observed disparities in the development of telecommunications infrastructure, mean that the companies operate in a heterogeneous developmental conditions prevailing in the voivodeships. Analysis of the level of development of enterprises can be made at the level of quantitative, qualitative, or effective. Development can be understood as "taking place during the process of change. In case of the enterprise it can apply to both parts and whole, it can take place in all areas, i.e., realized aims, structure, technology, and refer to the human factor" (Machaczka 1998 p. 14). It is obvious that not every change that takes place in the company contributes to its development. The development is a broader concept than change. It should also be noted that the development of the company should not be confused with its growth. Growth means quantitative changes occurring in the company of a positive character. However, development involves both quantitative changes (e.g. increase in sales volume) and qualitative (e.g. change in the structure), as well as efficiency changes, which are the basis for the development of each company. Without changes in the efficiency of the company, it's hard to talk about its development. Besides that, the development also may include changes both positive (e.g. increased sales) and negative (e.g. decrease in the number of employees).

In order to analyse the level of development of companies, the following factors were included: Y1 - entrepreneurship index (number of enterprises per 1000 inhabitants), Y2 - value of revenue for a company; Y3 - value of earnings per 1 worker; Y4 - deductible costs of the overall activities of a company; Y5 - index of gross profitability turnover; Y6 - index of assets profitability; Y7 - index of own equity profitability; Y8-index of 1st degree liquidity, Y9 - 2nd degree liquidity profitability index; Y10 -third degree liquidity profitability index; Y11 - short-term investments per 100 km^2 ; Y12 - long-term investments per 100 km^2; Y13 - net turnover profitability index. Most of the indices are of stimulant character, and some are formally of nominant character (liquidity indices). In the case of a variable nominants, stimulation was carried out, where the nominal values of the liquidity Ist, IInd and IIIrd degree were adopted 20%, 100% and 200%, repectively. The table below shows the values of telecommunications infrastructure SMR and SMR of companies.

Data from the table above confirms considerable differentiation in the level of infrastructure in individual voivodeships. The highest SMR telecommunications infrastructure is in the following voivodeships: śląskie, mazowieckie and małopolskie, as a result of the relatively high diagnostic value of each variable. The lowest values of SMR infrastructure in the analysed period, were recorded in the eastern Polish voivodeships - warmińsko-mazurskie, świętokrzyskie

and lubelskie. It should be noted that the SMR's time series of telecommunications infrastructure and SMR of companies, are stationary, which has been verified on the basis of statistics Quenouilla, which increases the reliability of correlation analysis.

Table 3. The values of the correlation coefficient between the synthetic measures of level of development of telecommunications infrastructure and level of development of enterprises

Description	2006	2007	2008	2009	2010
The correlation coefficient	0.7472	0.6333	0.7088	0.6952	0.7063

Source: own study

The performed analysis has shown that there is a positive correlation relationship between the equipment of various regions in telecommunications infrastructure and the level of development of companies. In the analysed period, we can see a high degree of dependency on the level of significance $p < 0.05$. Critical value of the correlation coefficient at 0.05 significance level is $r^*_{0.05(16)} = 0.4973$. Calculated values of the correlation coefficient over the analysed period, ranged between 0.63 and 0.75, andi in the whole analysed period exceeded the critical value, which demonstrates the significance of the correlation coefficient at 0.05 significance level.

4. Conclusion

Taking into account the spatial aspect of the business activity, the special role is played by the spatial conditions of enterprise development (including infrastructural environment). From the point of view of the discussion, the words of G. Nizard become significant; he claims that "what is happening in the environment is more important for the survival of the organization than what takes place within it" (Nizard 1998, p.25). The study shows that between the telecommunications infrastructure indicators and measures of development of enterprises in different voivodeships, there is high correlation dependence. This is due to the fact that the individual elements of technical infrastructure (including telecommunications infrastructure) determine a smooth and proper

functioning of enterprises. However, one should remember that a well-developed (in quantitative and qualitative terms) technical infrastructure is a necessary condition but is not sufficient for the development of enterprises. The result is that companies decide to develop other, extra-infrastructural factors that lie both in the environment and in the company itself.

Summary

Regional differences in telecommunications infrastructure and development of enterprises

The aim of this article is to determine the effect of various elements of telecommunication infrastructure for the development of enterprises in individual voivodeships. In the first part of the article the present author has characterized the telecommunications infrastructure and presented it as a factor in the development of enterprises. In the second part, based on statistical data, the relationship between the development of telecommunications infrastructure and the enterprise development in individual voivodeships in 2006-2010 was examined.

Streszczenie

Regionalne zróżnicowanie infrastruktury telekomunikacyjnej a rozwój przedsiębiorstw

Celem artykułu jest określenie wpływu infrastruktury telekomunikacyjnej na rozwój przedsiębiorstw w poszczególnych województwach. W pierwszej części artykułu scharakteryzowano infrastrukturę telekomunikacyjną oraz przedstawiono ją jako czynnik rozwoju przedsiębiorstw. W części drugiej, na podstawie danych statystycznych zbadano zależności pomiędzy rozwojem infrastruktury telekomunikacyjnej i rozwojem przedsiębiorstw w poszczególnych województwach w latach 2006-2010.

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